Ministry of Construction
Republic of the Union of Myanmar

Preparatory Survey for the East-West Economic Corridor Highway Development Project (New Bago-Kyaikto Highway Section) in the Republic of the Union of Myanmar

Final Report

Volume 2

Technical Study Report for Upgrading of the Thuwunna Research Laboratory and Training Center

February 2020

Japan International Cooperation Agency

Oriental Consultants Global Co., Ltd.
Nippon Koei Co., Ltd.
International Development Center of Japan Inc.
Metropolitan Expressway Co., Ltd.

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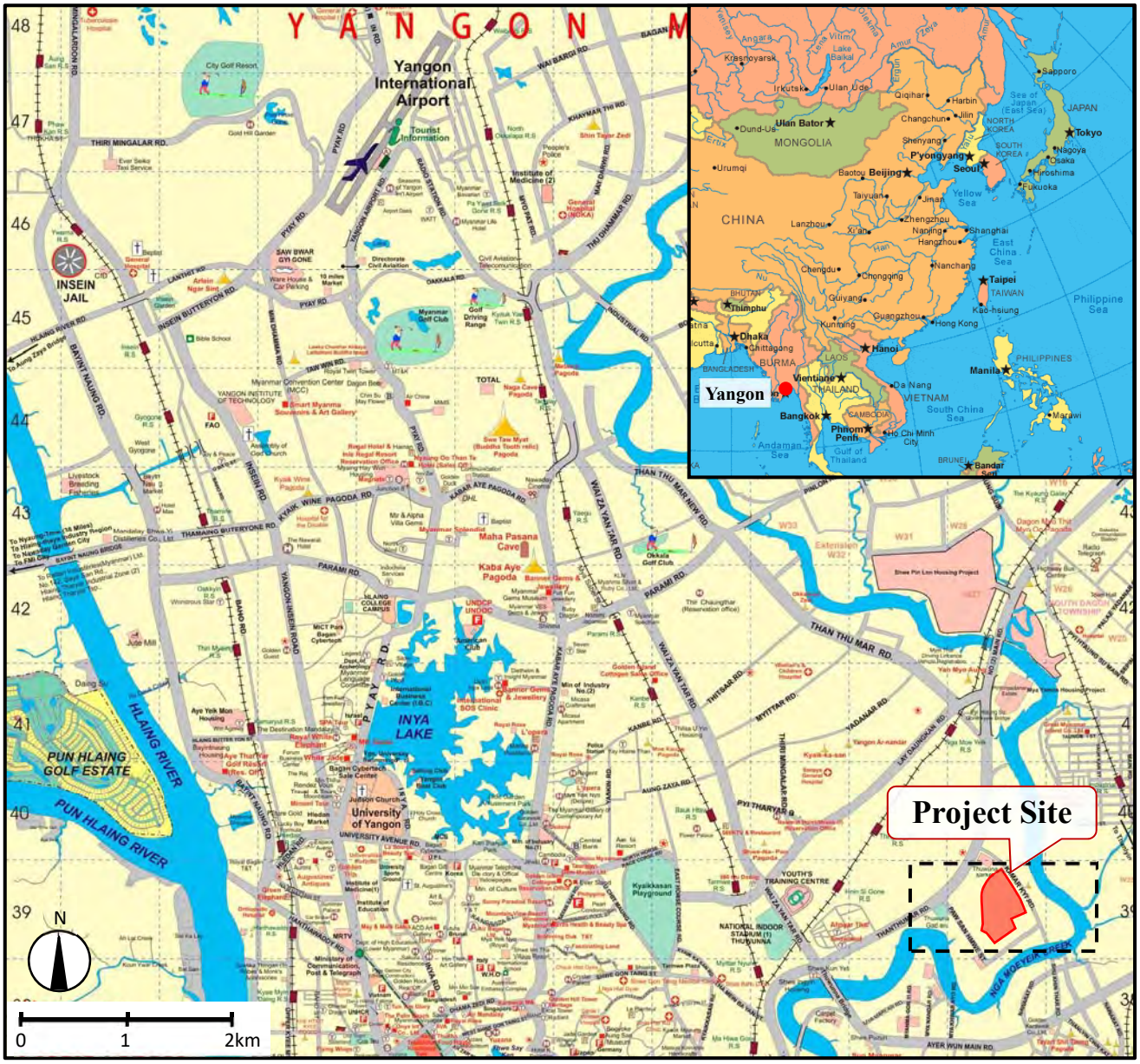
*MMK: Myanmar Kyat



Location Map of the Project Site

Bird's Eye View of Thuwunna Research Laboratory and Training Center

Perspective View of the Vocational Training Center

Perspective View of the Hostels

Interior Perspective View of Research Laboratory

Table of Contents

[Appendices]

List of Figures and Tables

List of Figures

List of Tables

Abbreviations

Abbreviations	English
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ASEAN	Association of South-East Asian Nations
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ASTM	American Society for Testing and Materials
AVR	Automatic Voltage Regulator
AVS	Automatic Voltage Switcher
B.E.	Bachelor of Engineering
B.Tech	Bachelor of Technology
BRL	Bridge Research Laboratory
BS	British Standards
BiRL	Building Research Laboratory
CBR	California Bearing Ratio
COE	Center of Excellence
CTC	Thuwunna Central Training Center
DDG	Deputy Director General
DG	Director General
DOB	Department of Bridge
DOBi	Department of Building
DOH	Department of Highways
DRRD	Department of Rural Road Development
DTM	Digital Terrain Model
ECC	Environmental Compliance Certificate
ECD	Environmental Conservation Department
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FRP	Fiber Reinforced Plastics
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation)
GTC	Government Technological College
GTHS	Government Technology High School
GTI	Government Technical Institute
HRD	Human Resource Development

Abbreviations	English
IBC	International Building Code
ICB	International Competitive Bidding
IEE	Initial Environmental Examination
IP	Internet Protocol
IRP	Income Restoration Program
ISO	International Organization for Standardization
JAVADA	Japan Vocational Ability Development Association
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JPY	Japanese Yen
LAN	Local Area Network
LCC	Life Cycle Cost
MDF	Main Distribution Frame
MES	Myanmar Engineering Society
MMK	Myanmar Kyat
MNBC	Myanmar National Building Code
MOC	Ministry of Construction
MOEE	Ministry of Electricity and Energy
MONREC	Ministry of Natural Resources and Environmental Conservation
MOPF	Ministry of Planning and Finance
MQCS	Mandalay Quality Control Section
MRA	Mutual Recognition Arrangement
MTC	Mechanical Training Center
MTU	Mandalay Technological University
NDT	Non-Destructive Test
NESP	National Education Strategic Plan
NSSA	National Skill Standards Authority
ODA	Official Development Assistance
OIC	Officer-in-Charge
PDA	Pile Driving Analyzer
PMU	Project Management Unit
QCS	Quality Control Section
RAP	Resettlement Action Plan
RDS	Research and Development Section
RLTC	Research Laboratory and Training Center
RRL	Road Research Laboratory

Abbreviations	English
RRRL	Regional Road Research Laboratory
SIT	Sonic Integrity Test
SLT	Static Loading Test
TU	University of Technology
TVET	Technical and Vocational Education and Training
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPS	Uninterrupted Power Supply
USD	United States Dollars
UU	Unconsolidated-Undrained
VSDP	Vocational Skills Development Program
WHO	World Health Organization
WWTP	Wastewater Treatment Plants
YCDC	Yangon City Development Committee
YESC	Yangon Electricity Supply Cooperation
YQCS	Yangon Quality Control Section
YTU	Yangon Technological University

EXECUTIVE SUMMARY

1. HUMAN RESOURCE DEVELOPMENT AND RESEARCH AND LABORATORY TEST ACTIVITIES FOR THE CONSTRUCTION SECTOR IN MYANMAR

1.1 Current State of Human Resource Development on Infrastructure Construction (Road, Bridge, and Building) in Myanmar

1.1.1 Overview of Human Resource Development in the Infrastructure Sector (Road, Bridge, and Building)

(1) Education System in Myanmar

The education system in Myanmar falls roughly into two categories: basic education and higher education. Basic education comprises six years of elementary school (one year in pre-primary and five years in primary school), four years of junior high school, two years of high school and various vocational schools, whereas higher education consists of junior colleges and universities. There was no compulsory education setting until recently, but now, of the six years of elementary school excluding one year of pre-primary education, five years are set as compulsory education. The curriculum of all schools (whether public schools, monastic schools or private schools) for both basic education and higher education is formulated by the Ministry of Education. The textbooks used must be prepared by the same ministry as well[1]. Although the government has been working to promote education such as making education free since 2010 for elementary school, 2013 for middle school and 2015 for high school, etc., the enrollment rates for each stage of schooling are at 86.4%, 63.5% and 32.1%,[2] respectively. When comparing Myanmar's primary and higher education enrollment rates with those of other ASEAN countries, for example, it can be said that the country is currently developing along with the reform of its education system.

(2) Human Resource Development Organization in the Infrastructure Sector (Road, Bridge, and Building)

Human resource development in the infrastructure sector (Road, Bridge, and Building) in Myanmar is mainly conducted as a 1) formal learning from upper secondary education (high school) to university and postgraduate level, and a 2) non-formal learning including pre-employment and in-service training.

(3) Degree and Position of Infrastructure Sector (Road, Bridge, and Building)

In the case of government officials, the upper limit of the position at the time of employment and the chances of getting promoted are regulated depending on the degree acquired in formal education.

[1] It is said that the plan is to gradually allow schools to introduce their own curriculum and teaching materials from 2017, although the actual situation has remained to be confirmed.
[2] Announced by the Ministry of Education in 2016. All rates are net enrollment rates.

1.1.2 Current Situation of Human Resource Development for Engineer in the Infrastructure Sector (Road, Bridge, and Building) in Myanmar

According to the economic policy based on the 12 items launched in March 2016 as announced by the new administration of Myanmar, the "development of human resources who can realize a modern and developed economy and enhancing vocational training education" is considered as a priority policy. Technical and Vocational Education and Training (TVET) necessary for the training of skilled workers is positioned as an important component of the "National Education Strategic Plan (NESP)" formulated in February 2017.

On the other hand, the National Skill Standards Authority (NSSA) was established in 2007 as an administrative organization responsible for developing engineers. NSSA prepares for free movement of skilled labor force through ASEAN integration, and aims to establish national vocational skill standards to improve labor productivity. In addition, the NSSA is expected to be responsible for accrediting educational institutions which meet the ASEAN standards, and developing a system for performing skills verification of human resources. A total of 173 functions were defined and approved by the Cabinet to be divided into 4 levels: Level 1 – Semi-Skilled Worker; Level 2 – Skilled Worker; Level 3 – Advanced Skilled Worker; and Level 4 – Supervisor/Technician.

In response to this, with the support of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Swiss government, the organization of skills to be acquired at each level is being promoted sequentially from fields with high needs in the industry. In addition, Japan Vocational Ability Development Association (JAVADA) has been supporting the training of technical skill examiner for machine maintenance and plasterers as part of the skills evaluation system transfer promotion projects since FY 2013.

The activities of the NSSA are defined in the “Employment and Skills Development Law”. Under the administration, the new “TVET Law”, which was being considered for establishment for many years, will be the core system for developing engineers.[3]

1.2 Current Status of Research and Laboratory Activities Related to the Infrastructure Sector (Road, Bridge, and Building) in Myanmar

1.2.1 Outline of Research Activities

(1) Higher Education Institutions

There are a total of 168 higher education institutions (as of 2013) in Myanmar established under 12 provinces mainly by the Ministry of Education and the Ministry of Science and Technology[4]. In order to improve access to higher education, a number of higher education institutions for undergraduate students have been established recently in the region since 2000. However, the problem of securing experienced teachers has arisen within a short period.

There are 61 higher education institutions under the Ministry of Science and Technology. Among them, only YTU and MTU offer postgraduate master courses related to research or higher education.

According to the “Science and Technology Human Resource Development Plan (2011/12-2030/31)” established by the Ministry of Science and Technology in 2012, every five years sequentially from the first phase (2011-2015), after being designated as a Center of Excellence (COE) – with YTU and MTU at the top – a designated COE university was planned to be strengthened as a research-centered university. For the fourth term (2026-2030), plans for other universities – not only for education, but also for research – other than those designated as COEs have been presented.

[3] See “TVET Country Profile - Myanmar- (UNEVOC/UNESCO, November 2018 The current status of enactment)” for the current status of enactment.
[4] See “Preparatory survey report on the project for enhancing technological universities in Myanmar” (2014)

(2) Public Research Institutes

Public research institutes under MOC are described from Sections 2.1.2 to 2.1.5 of this report.

(3) Private Research Institutes

Research on infrastructure by private companies is often conducted as part of inspection services. In some cases, companies have been receiving foreign capital investment. In general, there are many cases where private research environments, such as facilities and equipment, are better than those in public institutions.

1.2.2 Outline of Laboratory Test Activities

(1) Inspection Guideline

In September 2013, the Myanmar National Building Code (MNBC) was enacted. MNBC was prepared by the MOC in cooperation with the Myanmar Engineering Society (MES) and the United Nations Human Settlements Programme (UN-Habitat) based on the International Building Code (IBC). After which, MNBC was updated to become a standard reflecting more local circumstances, and it was revised in 2016 as "MNBC 2016". "MNBC 2016" is set as the only standard to be followed. Myanmar Engineering Society (MES) also recommends developers to comply with "MNBC 2016".

(2) Inspection Agencies

Infrastructure-related inspection agencies in Myanmar, which conduct quality confirmation and certification of construction materials, are mainly classified into two groups: public and private. In either case, many of them are in charge of inspection as well as other operations such as survey, design, construction, manufacturing and research.

(3) Public Agencies

The following organizations have been identified as inspection agencies under the MOC.

1) Research and Development Section (RDS)

Role / Function:

- Strength testing of airport runway and road pavement surface as well as soil quality testing
- Material testing of roads within jurisdiction (i.e. crushed stone, sand, bitumen, sealant, cement, concrete block)
- Various designs of asphalt concrete and concrete
- Implementation of cement stabilization treatment method, lime stabilization treatment method as well as cement and granular asphalt treatment method
- Design of pavement and road retaining wall
- Production of asphalt mix emulsion
- Annual lectures on road materials and quality control in CTC training courses
- Implementation of research projects regarding on-site material utilization as well as road pavement and slope collapse repair
- Collaboration with international technology groups for sustainable development in the road sector

Inspection Work:

Material tests mainly for road construction sites in a section of the Thuwunna district and simple material tests in minilabs installed at 16 local offices in DOH are being conducted.

2) Quality Control Section (QCS)

Role / Function:

- Soil quality surveys and tests of bridges, retaining walls and buildings planned by the five departments of MOC;
- Concrete and material quality control for bridge construction site; and
- Non-Destructive Test (NDT), loading test, and cable tensile test on cable-stayed bridges.

Inspection Work:

The following tests are mainly conducted:

- Soil
- Cement
- Fine Aggregate
- Compression Test
- Bentonite Test for bored pile works

(4) Private Agencies

Private agencies are described from Sections 1.2.2 (4) of this report.

1.3 Organize Problems and Confirmation of Needs

1.3.1 Problems Related to Human resource Development

(1) Issues on Human Resource Development at MOC

- The opportunities for improvement of the central government's essential roles and functions such as policymaking, formulation of land development plan, investment planning for infrastructure development, preparation of necessary laws and regulations, financial management and so on, are not sufficient. Due to this, development priority has been given towards improvement of infrastructures and skills.
- As for the whole of MOC, the management ability of officers to consider infrastructure development from the construction market and socio-economic point of view is not enough.
- In response to the training conducted at CTC, the human resource development division of each department is involved only in selecting training participants, and no opinion is reflected on the content of the training program.
- Both CTC and MTC offices have severely deteriorated and there is also lack of facilities and equipment.
- Since instructors are selected from the staff of each department, it is difficult to secure high-quality instructors.

(2) Issues on Human Resource Development in Higher Education Institutions

According to the National Development Plan, particularly under the "Science Technology Human Resource Development Plan (2011 / 12-2030 / 31), "YTU and MTU have both been designated as core universities (COEs) which lead national engineering education and research. Their goal is to achieve an ASEAN level university by 2020. However, before the democratization in 2011, universities had limited contact with private companies, thus university education did not suit the level of skills and technology that private companies required.

1.3.2 Problems Related to Research and Laboratory Activities

- Public organizations (i.e. administrative organizations, higher education institutions, etc.) are expected by the industry to provide various research and inspection services that use inspection / measuring equipment which are difficult for companies to procure individually. In any case, facilities and equipment need to be maintained to meet the service requirements.
- The inspection equipment in RDS (under DOH, research and development office) developed by ADB are not used due to lack of space in the facility and non-conformity.
- Research and inspection agencies under MOC lack the knowledge and experience to obtain ISO9001 certification. In addition, after acquiring the ISO, it is necessary to develop a function to determine the conformity of materials and related products in Myanmar with the ASEAN standard (MRA: Mutual Recognition Arrangement).
- There is a shortage of national budget for research and inspection.

1.3.3 Confirmation of the Necessity of the Loan Project

As mentioned above, with the change in the economic and social environment guided by the democratization policy of the Thein Sein regime – which began following the transfer of power to civilian administration in March 2011 – a mature society was required in response. Until recently, administrative functions have been focused on the development of infrastructure that contributes to the development of the nation. Parallel to the development of infrastructure, the completion of planning, executing and managing policies and plans for the future is also desired moving forward. Moreover, maintaining legal system and assuring quality with the same level as international standards are also being considered.
In order to cope with requirements of the infrastructure-related field, it is necessary to strengthen MOC's organization, capacity of staff, and maintenance of facilities and equipment that can strengthen the organization and its capacity.

2. OUTLINE OF THE THUWUNNA CENTRAL TRAINING CENTER AND RESEARCH LABORATORIES

2.1 Target Site

The target site of the project is located in Thingangyun Township, north east of the central area of Yangon. The site includes the research laboratories of the Department of Highways (DOH), the Department of Bridge (DOB), the Department of Building (DOBi), the Department of Rural Road Development (DRRD), and the facilities of the Thuwunna Central Training Center (CTC) which are all under the MOC. The current status of each existing facility and infrastructure are described in the below section.

2.1.1 Thuwunna CTC

CTC was established in 1966 as a technical training center for the Ministry of Construction (MOC) staff, and has been conducting technical training for the MOC staff (both engineers and administrative staff), as well as vocational training and assessments for skilled laborers.
CTC facilities are roughly divided into training buildings, trainee dormitories, office, common areas and staff residence. Technical training for MOC staff as well as technical training and assessment of skilled laborers are all held in the same facilities on site. Because the location of CTC facilities has a particularly high level of water, there are buildings which suffer from severe deterioration, where the walls are likely to come off from structural frames. Such buildings are currently used as warehouses where unused equipment items are piled up. The procedure to discard such unused equipment would take a quite long

time, so even the equipment which had been broken for years had to be kept on site, i.e. in existing deteriorated buildings. On the other hand, many rooms in existing training buildings are kept clean and tidy.
On site, there are two wells of approximately 200 m deep which are purified by the water treatment facilities provided on site. There are toilets and rainwater storage tanks made of concrete in several locations on site which are utilized during training and for daily use such as cleaning. The sewage on the site is not connected to the public sewerage system; thus, all sewerages are infiltrated after treatment in septic tanks. Although a request for drainage improvement has been sent to the Yangon City Development Committee (YCDC), YCDC representatives only came to conduct a field survey, and there has been no answer regarding the matter since then.
As for the existing equipment, besides furniture, the lecture room is equipped with audio-visual equipment such as projectors and personal computers, and the practical training room is provided with some equipment such as electrical planer and electrical saw – which were procured through JICA Technical Cooperation implemented in 2016 – for carpentry course for the building section.

2.1.2 DOH Research Laboratory

The Road Research Laboratories (RRL) under the umbrella of the Construction Department of the DOH, which changed its name to the Research and Development Section (RDS) in 2015, was established in 1974 as a sand and aggregate testing laboratory. RDS is responsible for general road material testing, road pavement design, etc.
The RDS's research and testing facility is comprised of only one building consisting of a management office, four research and testing laboratories (asphalt, concrete, sand, and aggregate), and a meeting room. On the north side of the site, there is a well and a water treatment facility. The water from the well is used for testing. As of April 2019, new parking lots and warehouses are being planned to be constructed on site.
As for the equipment, many of the existing equipment items still works fine; however, some existing equipment that no longer work due to malfunction and deterioration are seen here and there. In recent years, ADB funded a project for the procurement of advanced testing equipment such as Hamburg Wheel Tracker and JICA Technical Cooperation procured Automatic Triaxial Testing Machine in 2016.

2.1.3 DOB Research Laboratory

The Bridge Law, which was enacted in 2017, regulates the Department of Bridge (DOB) to be in charge of bridge planning, design, construction, maintenance, as well as coordination with related agencies. In addition to independently designing and constructing bridges with a length of more than 180 feet (about 54 m), the department also constructs small-scale bridges on local roads under the supervision of the local government and bridges under the supervision of the Ministry of Railways upon request.
And the Quality Control Section (QCS) is under the umbrella of the DOB's management department. Yangon Quality Control Section (YQCS) is responsible for quality management of bridges on the south side of the country. The roles and activities of YQCS mainly cover the quality control of on-site soil, concrete, and deformed rebar of bridges.
The YQCS facilities are roughly divided into administration office; concrete and steel research and testing laboratory; sand and aggregate research and testing laboratory; and soil survey laboratory.
As of Equipment, from 2015 to 2017, the department has procured equipment for inspecting bridges in operation and most of equipment of approximately 90 items for the concrete test during the past five years. The department has secured budget from the annual development budget, and recruited machine parts, and ten more several items such as compressive testing equipment and load cell and spare parts through the assistance of ADB and JICA. The soil testing equipment has also been procured within the past five years.

2.1.4 DOBi Research Laboratory

The Department of Building (DOBi) performs design, construction and maintenance of public buildings owned by the ministries such as hospitals, schools and government offices (including local government offices). The central design department is in charge of design, and the construction department is responsible for construction and maintenance. The Building Research Laboratory (BiRL), which is under the umbrella of the Design, Estimate and Research Department of DOBi, was established in 1968 in Yankin Township (Yangon) as the Office of Building Research. In 1987, Researches and Quality Control of Building was constructed in Thuwunna.
The BiRL conduct supervision, confirmation and evaluation of building materials quality as indicated in the special specifications. The department has the following responsibilities: Building of materials testing, Formation and dispatch of quality control teams, Quality inspection of concrete and rebar.
The facilities are roughly divided into administration office; concrete research and testing laboratory; sand and aggregate research and testing laboratory; and steel research and testing laboratory.
As of equipment, DOBi has procured testing machines and parts such as compressive machines and load cells in cooperation with ADB and JICA, because the testing specifications have shifted from BS to ASTM similar to other departments. Since DOBi is still in transition period, there are BS testing machines in existence which are still being used continuously. The department has implemented modifications of the facility as well as procurement of testing equipment. It has been accredited as an ISO-certified research and testing facility and has been ahead of other departments in recent years.

2.1.5 DRRD Research Laboratory

The Department of Rural Road Development (DRRD) was established in August 2017 when the road and bridge division was transferred from the Department of Rural Development (DRD) under the Ministry of Agriculture, Livestock and Irrigation (MOALI) to MOC. The main activities of DRRD include material testing and soil testing of aggregate, cement and concrete materials for the purpose of quality control of local paved roads. The department recently became independent from the DOH and has procured basic testing equipment using the annual development budget.
However, it is difficult to say that the facilities are sufficiently equipped with on-site survey equipment. The department is planning to equip the facilities with sufficient equipment in consideration of the requirements specified in ASTM test specifications.

2.1.6 Current Infrastructure Surrounding the Project Site

(1) Water Supply

The city water main pipe managed by YCDC (Yangon City Development Committee) is laid under the road traversing south to north of the Project site. However, the amount of current water source is mostly well water lifted from two boreholes which are located at the south-east corner of the CTC compound. The well water lifted from No.1 and No.2 boreholes is treated by a primitive gravel filtration system with no chlorine sterilization and is stored in a concrete underground tank. The treated water is distributed by pumps to each elevated tank which is located next to toilet huts. The toilets and other taps are supplied with water by gravity. Only the DOBi is fed in with the main city water.

(2) Waste Water Drainage and Sewer

No main city sewer surrounding the Project site is available. Thus, wastewater drain and sewer from toilet and wash rooms in each building is collected by waste drainage pipe and currently drained outside the building through septic tanks located in nearby toilets, and treated water by septic tank is infiltrated into the ground through soaked well.

(3) Power Supply

Currently, two medium voltage power lines of 11 kV, 3-phase, 3-wire system are taken into the site of the existing Thuwunna CTC from the 11 kV overhead high tension distribution line supplied around the site by Yangon Electricity Supply Cooperation (YESC) which is affiliated with the Ministry of Electricity and Energy (MOEE). Tapped power service lines are connected to the indoor cubicle type switchboard equipment provided in the Substation Room. Low voltage power of 380/220V, 3-phase, 4-wire system stepped down with the transformers provided in the cubicle will be distributed to each building on site.

3. OUTLINE OF THE PROJECT

3.1 Objective of the Project

MOC has a plan to establish the new department called "Thuwunna Research Laboratory and Training Department" which will be responsible for all research and laboratory functions and training functions, which has been provided by CTC and 4 Research Laboratories under DOH, DOB, DOBi and DRRD. And the name of the target facility for this project is currently under consideration in the MOC, but is tentatively named "Thuwunna Research Laboratory and Training Center (Thuwunna RLTC)."
This project aims to strengthen high quality human resource development and quality control in the construction sector in Myanmar, and the center will have a research and development functions in the future.
In consideration of the abovementioned plan, this project aims to strengthen the functions of Thuwunna RLTC by reconstructing the Training Facility and Research Laboratories, Hostels and procuring the necessary training and laboratory equipment for these facilities.

3.2 Contents of the Project

Facilities and the equipment which are necessary for achieving the abovementioned objectives are being planned:

Table S 3.1 Summary of the Facilities

Block	Facilities	Floor Area
MOC Training Center	Lecture room, training room, survey/quality management room, veranda, terrace/deck, exhibition space, hall/waiting room, staff meeting room, library, computer room, staff office, instructor room, maintenance staff room, support staff room, health room	6,100m^2
Vocational Training Center	Lecture room, training room, warehouse, veranda, terrace/deck, staff office, instructor room, reception desk	6,180m^2
Research Laboratory	Inspection room, warehouse, veranda, terrace, staff office, locker, support staff room	7,620 m^2
Hostel	Hostels for MOC staff and skilled labors, with dining hall	7,280 m2
Outdoor Exhibition	Environmental roadway pavement field experiment, Life-size full-scale model (cross section sample of bridge, bridge pier sample and shield etc.), barrier-free experience corner	750 m^2
Road on the Premises	Paved Road, Main Gate, Sidewalk, Bridge	20,400 m^2
Adjustment Pond	Overflow Pipe, Flap Gate	28,250 m^2

Source: JICA Sstudy Team

Table S 3.2 Summary of the Equipment

Item No.	Description	Quantity	Use
Thuwunna CTC			
1-1	Cutting machine for brick	10	Practical Training
1-2	Bending machine for rebar	8	Practical Training
1-3	Cutting machine for rebar	8	Practical Training
1-4	Tying machine for rebar	8	Practical Training
1-5	Total station	10	Practical Training
1-6	Theodolite	10	Practical Training
1-7	Level	10	Practical Training
1-8	Concrete mixer	5	Practical Training
1-9	Los Angeles abrasion machine	1	Practical Training
1-10	Concrete compression machine	1	Practical Training
1-11	Desktop computer	10	Lecturing
1-12	Laptop computer	10	Lecturing
1-13	Printer color	10	Lecturing
1-14	Copier medium	10	Lecturing
1-15	Projector	10	Lecturing
1-16	Plate Compactor	10	Practical Training
1-17	Recessed screens	10	Practical Training
DOB (Soil Testing)			
2-1	Double Tube Core Barrel Complete Assembly	5	Quality Control
2-2	Consolidation Test Apparatus	2	Quality Control
2-3	Oven	1	Quality Control
DOB (Concrete Testing)			
2-4	Flow Table Test (Flow of hydraulic cement Mortars and cement pastes) Apparatus	1	Quality Control
2-5	Turbidimeter Test Apparatus with accessories	1	Quality Control
2-6	Soundness Test (Autoclave) Apparatus with accessories	1	Quality Control
2-7	Compressive Strength Test	1	Quality Control
DOBi (Concrete Testing)			
3-1	Mortar Mixer	3	Quality Control
3-2	Automatic Blaine Fineness Apparatus	1	Quality Control
3-3	Electronic Analytical balance	3	Quality Control
3-4	Curing Bench	1	Quality Control
3-5	Flow Tables Machine	2	Quality Control
3-6	Concrete curing specimen tank	2	Quality Control
3-7	S.I.T (Sonic Integrity Test)	1	Quality Control
3-8	Ultrasonic Pulse Velocity Tester	1	Quality Control
3-9	Pulse Echo Foundation Tester	1	Quality Control
3-10	Flat Jacks	1	Quality Control
3-11	Laboratory Ovens	1	Quality Control
3-12	Electromagnetic Sieves Shaker	1	Quality Control
3-13	Rotary Automatic scales	3	Quality Control
3-14	Water Stills	2	Quality Control
3-15	Pulse Echo Foundation Tester	1	Quality Control
3-16	Cross Hole Ultrasonic Monitor	1	Quality Control
3-17	Compression Machine 3000 KN	2	Quality Control
DOBi (Soil Testing)			
3-18	Direct Shear Test Apparatus C/W All Accessories	1	Quality Control
3-19	Horizontal Sample Ejector	1	Quality Control
3-20	Moist Cabinet	1	Quality Control
DOBi (Steel Testing)			
3-21	Universal Tensile Testing Machine (1000 kN)	1	Quality Control
3-22	Cold Bend Testing Machine	1	Quality Control
3-23	Floor-standing Optical Emission Spectrometers	1	Quality Control

Item No.	Description	Quantity	Use
DOBi (Office Equipment)			
3-24	Copier	5	Data Processing
3-25	Computer (Laptop)	11	Data Processing
3-26	Printer (A3)	5	Data Processing
3-27	Computer (desktop)w/ desk	3	Data Processing
DOH (Bitumen Testing (Lab-1))			
4-1	Gyratory Compactor	1	Quality Control
4-2	Laboratory Saw	1	Quality Control
4-3	Universal Core Drill for AC	1	Quality Control
4-4	Standard Rotational Viscometer	1	Quality Control
4-5	Oven (0-120^{o} C)	1	Quality Control
4-6	Automatic Asphalt Extraction Apparatus	1	Quality Control
4-7	Draft Chamber	3	Quality Control
4-8	Electromagnetic Sieves shaker	1	Quality Control
DOH (Fine and Coarse Aggregates Testing (Lab-2))			
4-9	Los Angeles Machine	1	Quality Control
4-10	Pilot Compact-line	1	Quality Control
4-11	Electromagnetic Sieve Shaker	1	Quality Control
DOH (Cement Testing (Lab-2))			
4-12	High Pressure Cement Autoclave	1	Quality Control
4-13	Automatic Digital mortar Mixer	1	Quality Control
4-14	Temperature and Humidity Controlled Cabinet	1	Quality Control
DOH (Concrete Testing (Lab-2))			
4-15	Pan-type Mixer with accessories	1	Quality Control
DOH (Soil Testing (Lab-3))			
4-16	Los-Angeles Abrasion Test	1	Quality Control
4-17	Triaxial Compression Test	1	Quality Control
DRRD (Soil Testing)			
5-1	CBR Apparatus	3	Quality Control
5-2	Direct Shear Test Equipment	1	Quality Control
5-3	Moisture Tester	2	Quality Control
5-4	Consolidation Test Equipment	1	Quality Control
5-5	Oven 100 Litters	1	Quality Control
DRRD (Aggregates Testing)			
5-6	Compressive Testing Machine	3	Quality Control
5-7	Los Angeles Abrasion testing machine	1	Quality Control
DRRD (Field Survey/Testing)			
5-8	Total Station	2	Survey/Testing
5-9	Level	1	Survey/Testing
5-10	SIT (Sonic Integrity Testing)	1	Survey/Testing
5-11	Theodolite	1	Survey/Testing
Furniture			
6-1	Experiment Table-1	27	Working and Testing
6-2	Experiment Table -2	19	Working and Testing
6-3	Experiment Table-3	38	Working and Testing
6-4	Experiment Table-4	32	Working and Testing
6-5	Experiment Table-5	21	Working and Testing
6-6	Lab Sink-1	42	Working and Testing
6-7	Lab Sink-2	21	Working and Testing

Source: JICA Sstudy Team

3.3 Design Policy

The Thuwunna RLTC, which is planned to be built under this Project, is a center that integrates the current CTC, DOH Laboratory, DOB Laboratory, DoBi Laboratory, and DRRD Laboratory. It aims to centralize the currently scattered facilities and take the following factors into account: (1) functionality and effectiveness of the training centers and research laboratories; (2) natural and social conditions of

Thuwunna; (3) construction and procurement conditions; (4) maintenance and management ability of the implementing agency; (5) construction period; etc. The design policy shall be determined in consideration of the following:

- As a training and laboratory facility responsible for human resource development and quality control in the field of construction in Myanmar, the facility is planned to further enhance research and human resource development.
- MOC is in the process of strengthening the organization of CTC. In this project, the minimum necessary facilities and equipment shall be designed that can be respond to the new organization.
- To establish a proper facility which contributes to construction-related technology development and quality control as well as facilitate research and development, the facility shall be designed in consideration of the possibility of building expansion in the future.
- Laboratories shall be designed to provide exhibition facilities and libraries to allow more diverse training and for easy access of trainees to acquire more knowledge.
- The Research Laboratory shall be aimed to provide quality control under the ASEAN, and facilities and provision of equipment shall be planned to adapt to ASTM standards.
- Since there is a possibility to restructure the laboratories in future, flexibility of building plan to respond to layout changes will be taken into consideration.
- In regard to equipment, sharing and unified management of common equipment will be considered.
- In order to reduce the burden of maintenance and management in the future, the design shall be prepared in consideration of securing natural lighting and ventilation, ease of maintenance, and reduction of utility costs. In addition, the concept of green building design shall be adopted, and the facility itself shall be an example in which the trainees can learn from.
- To be a suitable environment as training center and research laboratory, the design shall be prepared following the current trends (i.e. universal design, green building, etc.).

4. PROJECT IMPLEMENTATION, OPERATION AND MAINTENANCE STRUCTURE

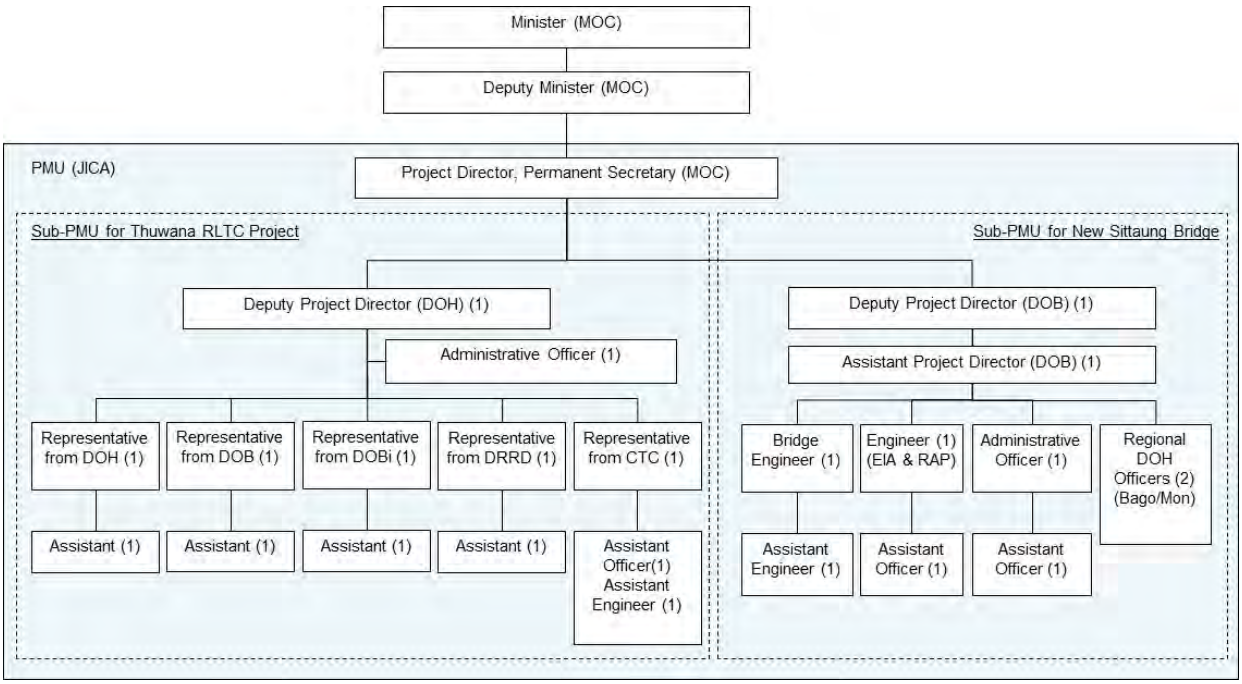
4.1 Project Implementation Structure

The executing agency of the yen loan project is MOC. For smooth implementation of this project, a Project Management Unit (PMU) will be established jointly with the Construction of New Sittaung Bridge Project. The PMU will be composed of relevant organizations related to the implementation of this project. In addition to having a project implementation function, PMU will be responsible for facilitating coordination among relevant organizations. As a cross-organizational unit, it is expected to be established directly under MOC Permanent Secretary in order to minimize the impact of various political, economic and social transformations in the counterpart country on the implementation of this project. The outline of PMU is shown in Table S 5.1 and the Organization of PMU is shown in Figure S 5.1 below:

Table S 4.1 Outline of PMU

Purpose	For smooth implementation of the yen loan project, PMU will be established directly under the MOC Deputy Minister as a cross-sectional unit of relevant organizations on the Myanmar side. One PMU will be established jointly by the Construction of New Sittaung Bridge Project and the Upgrading of Thuwunna RLTC Project.
Main Functions / Activities	1. Implementation and adjustment of necessary procedures on the Myanmar side pertaining to the implementation of the project. 2. Progress confirmation, information sharing / storage and coordination among relevant organizations including those from the Japanese side. 3. Procurement and supervision of consultants. 4. Approval of tender documents, tender implementation, contract with the construction / procurement supplier and construction / equipment installation supervision. 5. Approval of payment to the consultant / vendor. 6. Report to JICA.
Organization	MOC, DOH, DOB, DOBi, DRRD, CTC

Source: JICA Study Team



Source: JICA Study Team

Figure S 4.1 Organization of PMU

4.2 Operation and Maintenance Structure

For Thuwunna CTC, facility management and maintenance is currently performed by electricians (3 people), technicians for water supply (5 people) and gardeners (7 people). For other department labs, the work is conducted mainly by junior engineers in each department. However, since the existing buildings have severely deteriorated and / or have become hazardous, there are some buildings that are no longer being used, and some have been repurposed as storage areas for equipment items and others.

Following the reorganization in the future, it has been decided that four research laboratories belonging to different departments of MOC and CTC under DOH will be integrated into the newly established as "Research Laboratory and Training Department". Therefore, for RLCT, it is proposed to allocate a dedicated maintenance manager to maintain the entire facility. In addition, it is proposed that the maintenance manager of the new facilities shall retain the as-built drawings of the existing facilities, regularly carry out daily inspections and keep records. Furthermore, it will be necessary to establish

maintenance procedures premised on preventive maintenance and documentation of records (computerization, etc.), and it will also be necessary to educate and train the workers in charge of maintenance and inspection works.
As For the establishment of the maintenance system for the equipment, equipment types that have local agents on site should be prioritized when procuring new equipment, and this condition should be reflected in the bidding documents. Each department chief is in charge of the maintenance of the equipment and will take responsibility throughout the duration of the project. It has been said during an interview that improper operation and/or non-availability of necessary spare parts and consumables would most likely cause failure and equipment troubles. Hence, plans for this Project include training of users on operation, frontline maintenance to prevent malfunctioning and securing maintenance services by local agents.
Although the organizational structure of the newly established "Research Laboratory and Training Department" is currently being discussed within the MOC and the contents have not been finalized, the total number of staff is expected to be 100-120 people.

4.3 Evaluation of the Project

4.3.1 Validity of the Project Implementation

The project aims to strengthen the function of RLTC through the reconstruction of Research Laboratory, Training Facilities, Hostels and procurement of necessary training equipment for these facilities. The objectives of this project are to strengthen the government's administration of the construction sector in line with recent changes in the construction sector in Myanmar, and the organizational reform of the Ministry of Construction by upgrading the training facility for MOC staff. In addition, this project will improve the skill level of construction workers by upgrading vocational training facilities, and strengthen quality control of construction works by upgrading research laboratory facilities. Furthermore, this improvement of vocational training will contribute to the market needs in the construction sector and is expected to lead to the improvement of employment rate as well as poverty reduction.
The expected achievement of the project objectives also contributes to the priority areas in the basic policies of Japan's assistance to Myanmar, which are the following: 1) development of infrastructure and related systems necessary for sustainable economic development; and 2) capacity building and development of systems to sustain the economy and society according to Japan's "Government Development Assistance (ODA) Country Data Book 2017".

4.3.2 Indicators for Evaluation

This Project includes two components with different goal values. Hence, it is necessary to set optimal indicators for each goal.
The 1st component – or the redevelopment of training facilities for MOC staff and skilled labor– is expected to contribute towards improving skills and knowledge of various types of human resources in the construction sector in Myanmar. Provision of training will upgrade the skills of MOC staff, including both administrative officers and engineers responsible for construction administration. Vocational training will be provided to skilled workers in a variety of construction fields to meet the required skill level among ASEAN countries.
The 2nd component – or the redevelopment of the Research Laboratories – is expected to upgrade the quality control function of MOC to meet ASEAN standards.

Table S 4.2 Operation and Effect Indicators (Draft)

Operation and Effect Indicators (Draft)	Baseline Value (2019)*[1]	Target Value (2029)	Available means of data and Monitoring methodology
1. Quantitative Indicators			
1-1. Prospective number of MOC staff trained at the Training Center per year	1,061 pers.(2017/18)	2,000 pers.	Collect data from the Center
1-2. Prospective Number of MOC Staff Training Courses	21 courses	30 courses	Ditto
1-3. Prospective number of workers trained at the Training Center per year	Training : 150pers Assessment Course : 160pers	Training : 1,440 pers (30 pers x 16 courses x 3 times) Assessment Course :960 pers (20 pers x 16 courses x 3times)	Ditto
1-4. Prospective number of Vocational Training Courses	Training : 5types Assessment Course : 8 types	Training : 16 types (level I) Assessment Course :16 types	Ditto
1-5. Laboratory test	Laboratories provide BS base test.	All laboratories provide test responding to ASEAN standards.	Ditto
1-6. Quality assurance of Laboratory	Only one laboratory has been applied to ISO.	All laboratories becomes ISO certified laboratories	Ditto
2. Qualitative Indicators			
2-1. Type of training provided in the RLTC	More administration courses are provided, rather than planning and technical courses.	More courses will be provided for planning, project management, and quality assurances.	Collect data from the Center
2-2. Satisfaction degree with training contents by MOC staff	Generally, trainees are satisfied with training contents.	Trainees are satisfied with the training contents, facility and equipment.	Collect data through Q&A to participants
2-3. Evaluation by construction companies		Construction companies are satisfied with level of skilled workers who own the certificate issued by the RLTC	Collect data through Q&A at the target construction companies
2-4. Quality of constructions in the country		Contractors are satisfied with the quality of test provided at RLTC	Collect data through Q&A at the target construction companies

Note*[1]: Baseline value and target value to be arranged through the discussion with the authority of Myanmar side.
Source: JICA Study Team

5. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

5.1 Natural and Social Environmental Features in the Project Area

(1) Natural Environmental

The project area is located in 29 Thuwunna Ward, Thingangyun Township, Yangon Region. Surrounding area has been developed as industrial and residential area. The project area is a compound of Thuwunna Central Training Center (CTC). In the compound of CTC, existing old facilities and open space of the grass-land are observed. Thus any natural vegetation is not observed and only secondary forests and garden species are existing.

(2) Social Environmental

In the project affected area, some accommodation for MOC's employees. However according to CTC, construction of new accommodation and replacement of affected employees will be conducted and completed in 2019 and 2020, thus any resettlement and land acquisition will not be caused in accordance with CTC plan.
The natural and social feature in the project area is shown in Figure S 5.1.

5.2 EIA Laws and Screening

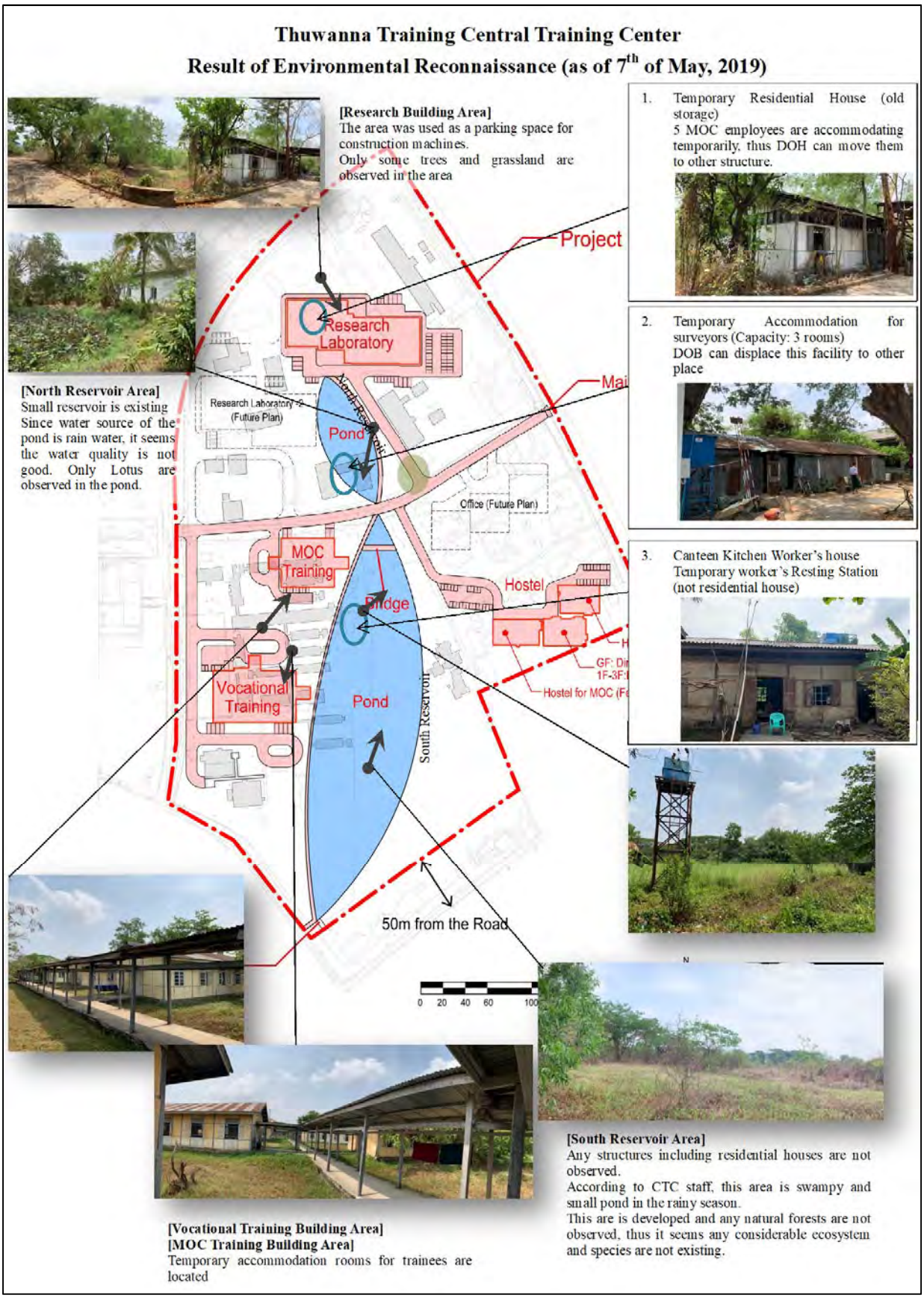
All construction project proponent shall be submit a project proposal to ECD and obtain screening result from ECD in accordance with EIA Procedure 2015. MOC side has submitted a project proposal report to ECD in May 2019 and obtained the result of screening from ECD in July 2019. As the result of screening, the project has classified as "a project which is not required ECC" (IEE, EIA and EMP is not necessary) Thus any approval process are not necessary in accordance with EIA Procedure 2015, however, JICA has requested to prepare EMP (Environmental Management Plan) and implementation of public consultation.

5.3 Environmental Management Plan (EMP)

Since all facilities such as Research Center, Training Center, Vocational Center and Hostel are constructed in the CTC compound, it is not likely to give serious impacts on natural and social environment. Thus general mitigation measures and monitoring for dust, turbid water, construction noise and traffic safety are required.

5.4 Public Consultation

A public consultation has been conducted in accordance with JICA Guidelines on 18th of July 2019. Totally 55 persons including citizens surrounding area and CTC employees have participated and formulated basic consensus of implementation of the project.



Source: JICA Study Team

Figure S 5.1 Natural and Social Feature in the Project Area

1. Human Resource Development and Research and Laboratory Test Activities for the Construction Sector in Myanmar

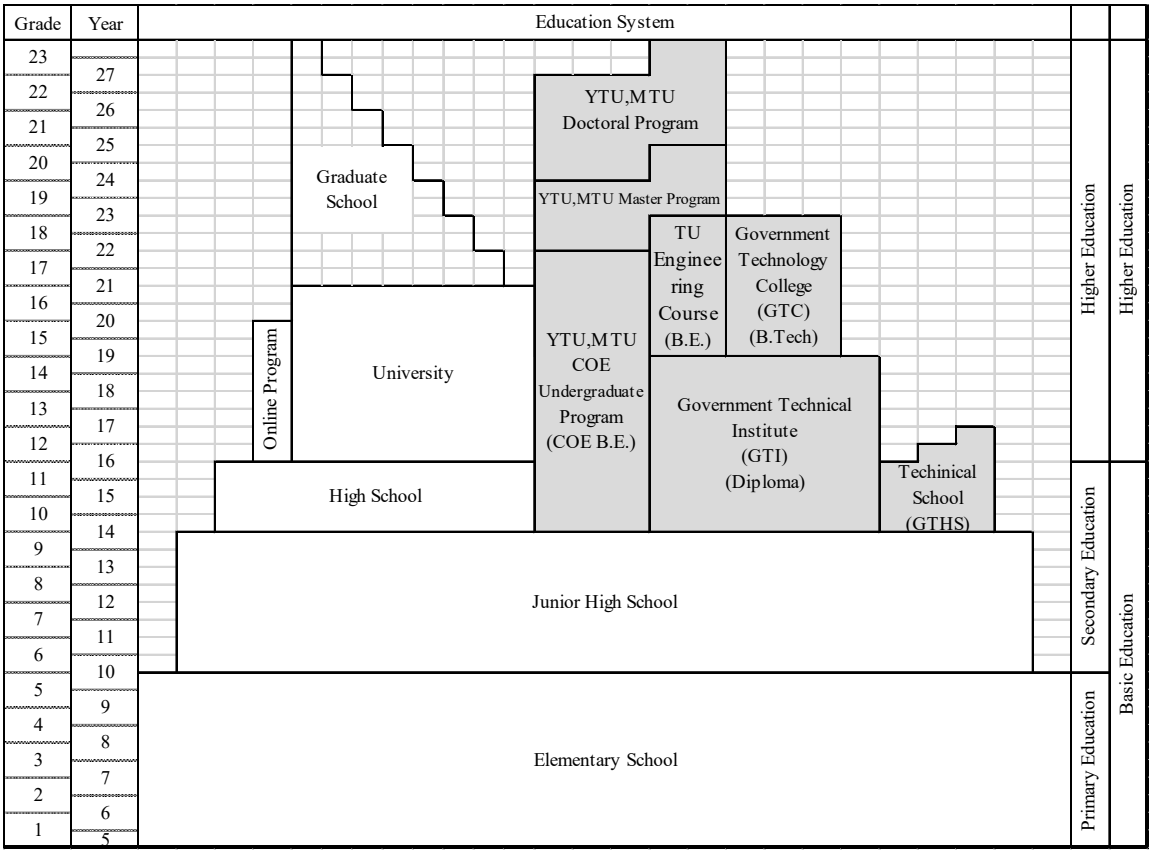
1.1 Current State of Human Resource Development on Infrastructure Construction (Road, Bridge, and Building) in Myanmar

1.1.1 Overview of Human Resource Development in the Infrastructure Sector (Road, Bridge, and Building)

(1) Education System in Myanmar

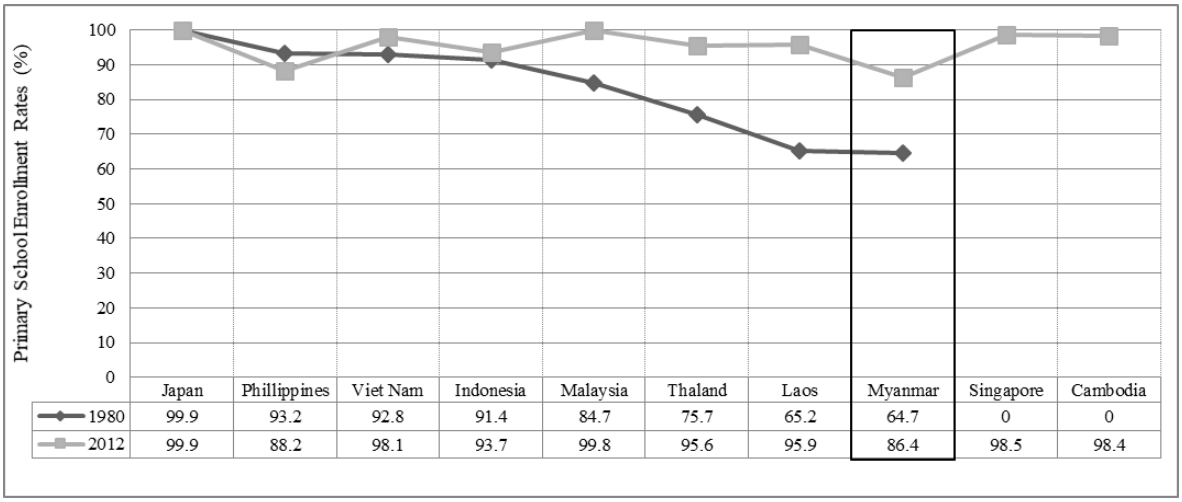
The education system in Myanmar falls roughly into two categories: basic education and higher education. Basic education comprises six years of elementary school (one year in pre-primary and five years in primary school), four years of junior high school, two years of high school and various vocational schools, whereas higher education consists of junior colleges and universities. There was no compulsory education setting until recently, but now, of the six years of elementary school excluding one year of pre-primary education, five years are set as compulsory education. The curriculum of all schools (whether public schools, monastic schools or private schools) for both basic education and higher education is formulated by the Ministry of Education. The textbooks used must be prepared by the same ministry as well [1]. Although the government has been working to promote education such as making education free since 2010 for elementary school, 2013 for middle school and 2015 for high school, etc., the enrollment rates for each stage of schooling are at 86.4%, 63.5% and 32.1%,[2] respectively. When comparing Myanmar's primary and higher education enrollment rates with those of other ASEAN countries, for example, it can be said that the country is currently developing along with the reform of its education system. Below is the data showing Myanmar's education system and the comparison of its primary education as well as higher education enrollment rates with those of other ASEAN countries.

[1] It is said that the plan is to gradually allow schools to introduce their own curriculum and teaching materials from 2017, although the actual situation has remained to be confirmed.
[2] Announced by the Ministry of Education in 2016. All rates are net enrollment rates.



Notes: The courses shaded in gray in the figure above mainly shows specialized curriculum on human resource development in the infrastructure sector. Also, the required number of years of study at the university varies depending on the field of specialization.
Source: Updated by JICA Study Team based on "Preparatory Survey Report on the Project for Enhancing Technological Universities in Myanmar" (2014)

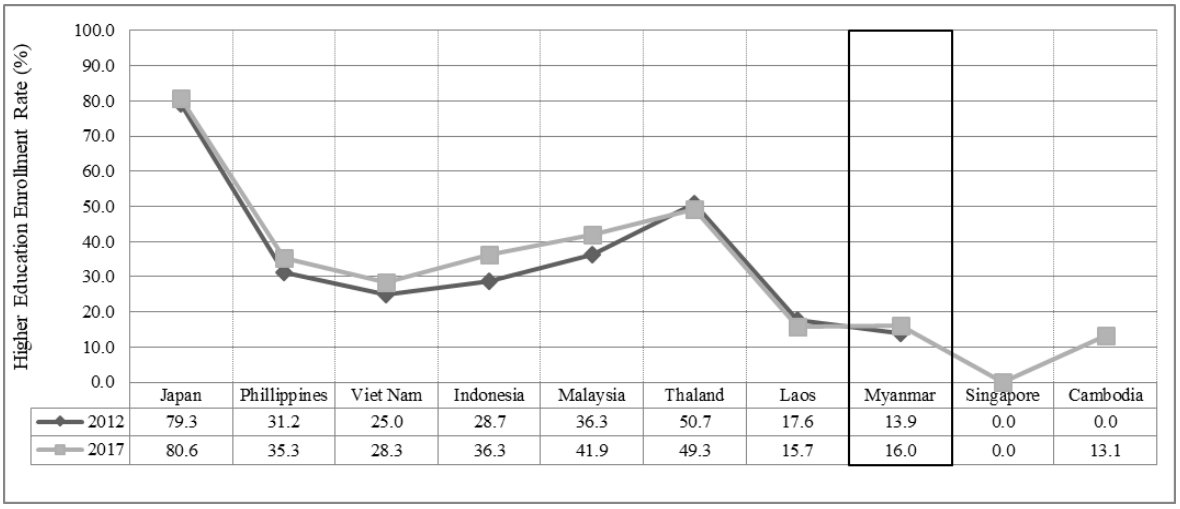
Figure 1-1 Myanmar's Education System



	Japan	Phillippines	Viet Nam	Indonesia	Malaysia	Thaland	Laos	Myanmar	Singapore	Cambodia
1980	99.9	93.2	92.8	91.4	84.7	75.7	65.2	64.7	0	0
2012	99.9	88.2	98.1	93.7	99.8	95.6	95.9	86.4	98.5	98.4

Notes: Net enrollment rate for each country. Data of Japan (1980, 2011), Cambodia (2012), Indonesia (1981, 2011), Laos (1988, 2012), Malaysia (1972, 2013), Myanmar (1978, 2016), Philippines (1981, 2009), Thailand (1974, 2009), Vietnam (1981, 2012), and Singapore (2016) are used, respectively. Singapore and Cambodia have no data corresponding to 1980; Brunei has no data corresponding to both 1980 and 2012. In addition, after 2012, each country generally shows a high flat percentage.

Figure 1-2 Comparison of Primary Education Enrollment Rates in ASEAN Countries



	Japan	Phillippines	Viet Nam	Indonesia	Malaysia	Thaland	Laos	Myanmar	Singapore	Cambodia
2012	79.3	31.2	25.0	28.7	36.3	50.7	17.6	13.9	0.0	0.0
2017	80.6	35.3	28.3	36.3	41.9	49.3	15.7	16.0	0.0	13.1

Notes: Gross enrollment rate for each country. For Vietnam and Thailand, 2016 data are respectively used for 2017 comparison data. Other than that, data from 2012 and 2017 are used. No data were found corresponding to 2012 and 2017 for Singapore and 2012 for Cambodia.
Source: Created by JICA Study Team based on "UNESCO Institute for Statistics".

Figure 1-3 Comparison of Higher Education Enrollment Rates in ASEAN Countries

(2) Human Resource Development Organization in the Infrastructure Sector (Road, Bridge, and Building)

Human resource development in the infrastructure sector (Road, Bridge, and Building) in Myanmar is mainly conducted as a 1) formal learning from upper secondary education (high school) to university and postgraduate level, and a 2) non-formal learning including pre-employment and in-service training (see Figure 1-1). The following is an outline of human resources development organization under the Ministry of Construction and others.

1) Human Resource Development Organization under the Ministry of Construction

a) Thuwunna Central Training Centre (CTC)

It was established under the MOC in 1966 as a skills training center for improving the ability of the MOC staff. MOC's present situation is shown in Chapter 2.

b) Mechanical Training Centre (MTC)

It was established in Yangon province in 1958 and in Mandalay province in 1966 as a branch office of CTC for the purpose of acquiring skills and training of mechanical engineers, heavy equipment operators and drivers from MOC.

2) Human Resource Development Organizations not Under the Ministry of Construction

a) University of Technology (TU)

As for the university institutions for engineering in Myanmar, there are currently 33 technical institutes under the Higher Education Bureau, Ministry of Education,[3] with a total of 18[4] faculties and departments. The education field, faculties and departments that will be installed for each university will be determined by the Ministry of Jurisdiction (former: Ministry of Science and Technology; current: Ministry of Education). The same Ministry also specified to adopt the same syllabus for every university that has the same education field, faculty and department, and teaching materials and equipment will be provided[5].

Due to the education reform in September 2014, the standard school term changed from 5 years to 6 years. Upon graduation, a Bachelor of Engineering (B.E.) will be awarded.

b) Universities offering Engineering COE Undergraduate Program (YTU, MTU)

Yangon Technological University (YTU) is the oldest higher education institution under the Higher Education Bureau, Ministry of Education, and is in a position to advise other university of technology (TU) institutions under the same bureau. In response to the democratization movement, it has become solely a graduate university offering masters and doctoral degrees since 2001. However, since December 2012, a new six-year center of excellence (COE) undergraduate program has started in order to recruit top students into undergraduate programs from all over the lower half

[3] Due to the education reform in September 2014, the Ministry of Science, which had jurisdiction over higher education institutions, was annexed to the Ministry of Education.

[4] Civil Engineering, Electronic Engineering, Power Engineering, Mechanical Engineering, Electronic Mechanical Engineering, Information Engineering, Chemical Engineering, Mine Engineering, Textile Engineering, Petroleum Engineering, Metallurgical Engineering, Architectural Engineering, Biological Engineering, Nuclear Engineering, Geological Engineering, Energy Engineering, etc.

[5] Currently, reforms are being made to allow universities to introduce their own curriculum, syllabus, etc.

part of Myanmar and provide high-quality undergraduate education comparable to neighboring countries.

Mandalay Technological University (MTU) is a higher education engineering institution representing the upper Myanmar area and also serves as a domestic destination for other TU faculty members wanting to study abroad to obtain masters and doctoral degrees. Also, similar to YTU, MTU has recruited top students from all over the upper part of Myanmar since December 2012 and started providing COE undergraduate programs[6].

Upon completion of the six-year engineering COE undergraduate program, a COE degree in engineering (COE-B.E.) will be awarded. Thus, YTU and MTU are tasked with driving the development of highly skilled engineers in the country.

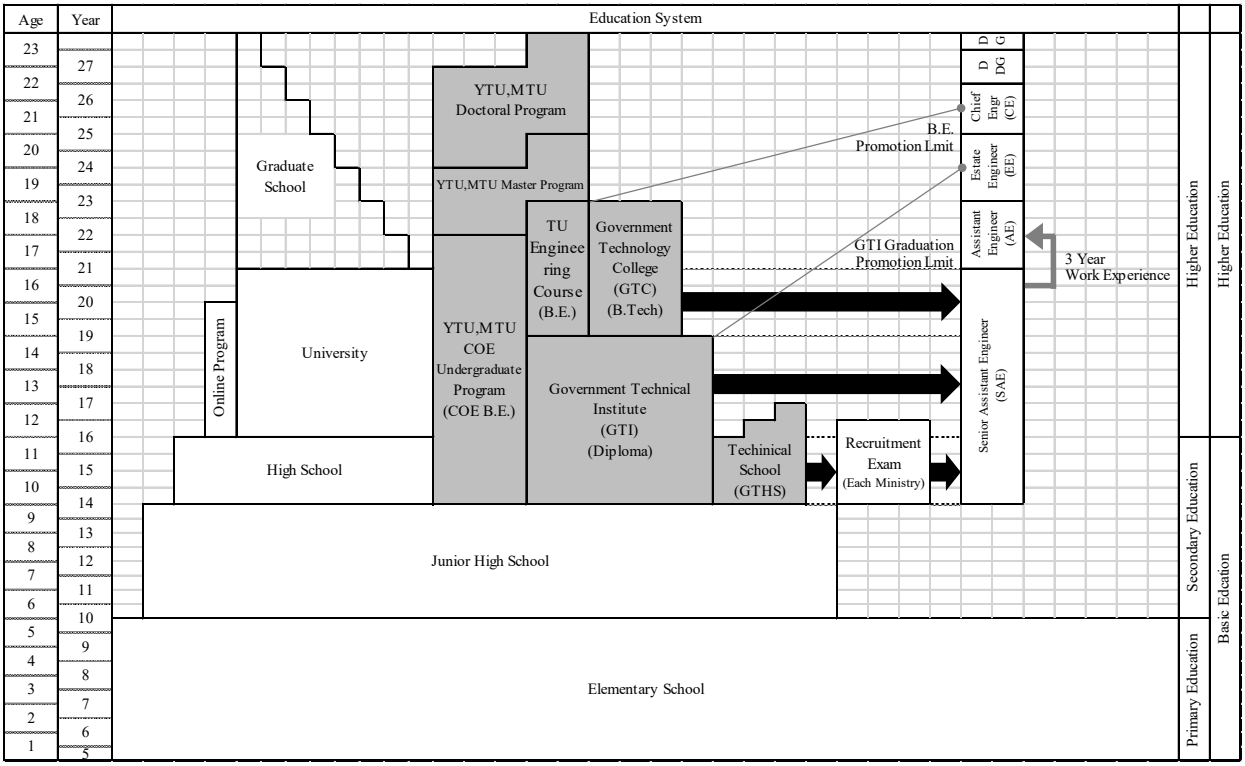
c) Government Technological College (GTC)

Established in three locations (Moehnyin, Shwebo, Myingyan) in the country, GTC was classified as a higher education institution under the jurisdiction of the Higher Education Bureau, Ministry of Education (formerly Ministry of Science and Technology). Due to the education reform, GTC was closed in September 2014 and transformed into a Government Technical Institute (GTI). GTC offers four years of standard education, and a Bachelor of Technology (B. Tech) will be awarded upon graduation. In addition, a B.E. university diploma will be awarded after completion of one-year study in a university. B.Tech ranks lower than university graduation qualifications, and in the case of state officials, having a B.E. will increase their chances of getting promoted to different positions, so there are many cases where they aim for a B.E. after obtaining a B.Tech[7]. Following the above-mentioned educational reform decision, GTC has stopped accepting new students under the old GTC program and began accepting GTI students since 2015. As a result, there are no other institutions that can issue a B.Tech.

(3) Degree and Position of Infrastructure Sector (Road, Bridge, and Building) (Government Official)

In addition, in the case of government officials, the upper limit of the position at the time of employment and the chances of getting promoted are regulated depending on the degree acquired in formal education. The following shows the relationship between the education degree and the position of government officials in the infrastructure sector.

[6] See "Project for Enhancement of Engineering Higher Education (2013~2020) Project Outline"
[7] See "Myanmar Data Collection Survey on Technical and Vocational Education and Training Final Report" (2016)



Notes: DG: Directorate General, DDG: Deputy Directorate General
Source: Created by JICA Study Team based on "Myanmar Data Collection Survey on Technical and Vocational Education and Training Final Report" (2016)

Figure 1-4 Diagram Showing the Relationship Between the Educational Degree and the Position of National Government Officials in Myanmar

1.1.2 Current Situation of Human Resource Development for Engineer in the Infrastructure Sector (Road, Bridge, and Building) in Myanmar

(1) National Policy, Administrative Organization, Improvement of Legal Systems, etc.

According to the economic policy based on the 12 items launched in March 2016 as announced by the new administration of Myanmar, the "development of human resources who can realize a modern and developed economy and enhancing vocational training education" is considered as a priority policy. Technical and Vocational Education and Training (TVET) necessary for the training of skilled workers is positioned as an important component of the "National Education Strategic Plan (NESP)" formulated in February 2017.

On the other hand, the National Skill Standards Authority (NSSA) was established in 2007 as an administrative organization responsible for developing engineers. NSSA prepares for free movement of skilled labor force through ASEAN integration, and aims to establish national vocational skill standards to improve labor productivity. In addition, the NSSA is expected to be responsible for accrediting educational institutions which meet the ASEAN standards, and developing a system for performing skills verification of human resources. A total of 173

functions were defined and approved by the Cabinet to be divided into 4 levels: Level 1 – Semi-Skilled Worker; Level 2 – Skilled Worker; Level 3 – Advanced Skilled Worker; and Level 4 – Supervisor/Technician.

In response to this, with the support of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Swiss government, the organization of skills to be acquired at each level is being promoted sequentially from fields with high needs in the industry. In addition, Japan Vocational Ability Development Association (JAVADA) has been supporting the training of technical skill examiner for machine maintenance and plasterers as part of the skills evaluation system transfer promotion projects since FY 2013.

The activities of the NSSA are defined in the "Employment and Skills Development Law". Under the administration, the new "TVET Law", which was being considered for establishment for many years, will be the core system for developing engineers.[8]

1.2 Current Status of Research and Laboratory Activities Related to the Infrastructure Sector (Road, Bridge, and Building) in Myanmar

1.2.1 Outline of Research Activities

Infrastructure-related research institutes in Myanmar are mainly divided into three categories: higher education institutions, public research institutes and private research institutes.

(1) Higher Education Institutions

There are a total of 168 higher education institutions (as of 2013) in Myanmar established under 12 provinces mainly by the Ministry of Education and the Ministry of Science and Technology[9]. In order to improve access to higher education, a number of higher education institutions for undergraduate students have been established recently in the region since 2000. However, the problem of securing experienced teachers has arisen within a short period.

There are 61 higher education institutions under the Ministry of Science and Technology. Among them, only YTU and MTU offer postgraduate master courses related to research or higher education.

According to the "Science and Technology Human Resource Development Plan (2011/12-2030/31)" established by the Ministry of Science and Technology in 2012, every five years sequentially from the first phase (2011-2015), after being designated as a Center of Excellence (COE) – with YTU

[8] See "TVET Country Profile - Myanmar- (UNEVOC/UNESCO, November 2018 The current status of enactment)" for the current status of enactment.
[9] See "Preparatory survey report on the project for enhancing technological universities in Myanmar" (2014)

and MTU at the top – a designated COE university was planned to be strengthened as a research-centered university. For the fourth term (2026-2030), plans for other universities – not only for education, but also for research – other than those designated as COEs have been presented.

The research fields of YTU and MTU, which currently perform research functions as higher education institutions, are shown below:

Table 1-1 Research Fields of YTU

Name of Department/Research Group/Lab	Research fields
Department	
Civil Engineering	
Joint Projects with Foreign Universities	
NJCHE Program (NUFFIC Delft University of Technology/ UNESCO-IHE)	
SATREPS Project (Tokyo University, Japan)	risk analysis
Seismic Risk Analysis for Critical Urban Infrastructure (De La Salle University, Philippines)	risk analysis
Research Group Titles	
Structural and Construction Studies	
Water Resources Management Studies	Management
Geotechnical Engineering	geotech/environment
Transportation and Urban Development Studies	Planning
Construction Planning and Management Studies	Management
Environmental Studies	geotech/environment
Departmental Research	
Treatment of Food Industry Wastewater by Using Activated Carbon Prepared from Agricultural Waste	geotech/environment
Evaluation of long-term atmospheric corrosion of ordinary structural steel	Material
Appropriate Domestic Wastewater Treatment System for Rural Area	geotech/environment
Architecture	
History of Architecture and Heritage Conservation	Others
Architectural and Design Science	
Urban and Regional Development Planning	Planning
Research	
Civil Engineering	
Environmental Engineering Lab	geotech/environment
Geotechnical Engineering Lab	geotech/environment
Hydraulic Engineering Lab	geotech/environment
Electrical Power Engineering	
Power Engineering Lab	
Electrical System and Control Lab	
Energy System Lab	geotech/environment
Electronic Engineering	
Communication Lab	
Control Lab	
Digital Signal Processing Lab	
Electronic Lab	
Geology Engineering	
Site Effect Determination in Seismic Hazard Analysis	
Rock Mechanics Lab	
Economic and Resources Geology	
Hydrogeology	
Mechanical Engineering	
Thermodynamics Lab	
Fluid Mechanical Lab	
Strength of Materials, Mechanics and Dynamics Lab	
Production Lab	
Mechatronic Engineering	

Name of Department/Research Group/Lab	Research fields
Innovate Control and Robotics Lab (iCAR Lab)	
Image Processing and Machine Vision Lab	
Robotic Technology Lab	
Metallurgist Engineering	
Surveying Lab	
Rock Mechanics Lab	
Adaptive Metallurgy	
Material Science	
Mining Engineering	
Surveying Lab	
Rock Mechanics Lab	
Environmental, Health and Safety, Ventilation Lab	
Mine machinery Lab and Planning Design Lab	
Petroleum Engineering	
Drilling Fluids and Oil well cement Lab	
Nautical Gas Engineering Lab	
Production and Reservoir Engineering Lab	
Textile Engineering	
Bleaching and Dyeing Lab	
Garment Lab	
Fiber Microscopy Lab	
Chemical Engineering	
Energy Lab	
Environmental Lab	
Food Processing Lab	
Computer Engineering and IT	
Energy Lab	
Telecommunication and Networking Lab	
Software Development Lab	
Database and Digital Image Processing Lab	

Source: JICA Study Team in reference to Website of YTU (http://ytu.edu.mm/)

Table 1-2 Research Fields of MTU

Name of Department/Research Group/Lab	Research fields
Department*	
Civil Engineering	
Nuclear Engineering	
Nuclear science and technology	
Nuclear technology-based practices	
Mechatronics Engineering	
Mechatronics design	
Development and control of diverse systems used in a range of industries	
Electronic Engineering	
Metallurgical Engineering and Materials Science	
Biotechnology	
Electrical Power Engineering	
Computer Engineering and Information Technology	
Chemical Engineering	
Mining Engineering	
Remote Sensing	
Remote Sensing	
GIS (Geographic Information System) Technology	

Note*: The departments which provide not only undergraduate courses but also postgraduate ones as research activities are listed here.
Source: JICA Study Team in reference to Website of MTU (https://mtu.edu.mm/)

(2) Public Research Institutes

Public research institutes under MOC are described from Sections 2.1.2 to 2.1.5 of this report.

(3) Private Research Institutes

Research on infrastructure by private companies is often conducted as part of inspection services. In some cases, companies have been receiving foreign capital investment. In general, there are many cases where private research environments, such as facilities and equipment, are better than those in public institutions.

1.2.2 Outline of Laboratory Test Activities

(1) Inspection Guideline

In September 2013, the Myanmar National Building Code (MNBC) was enacted. MNBC was prepared by the MOC in cooperation with the Myanmar Engineering Society (MES) and the United Nations Human Settlements Programme (UN-Habitat) based on the International Building Code (IBC). After which, MNBC was updated to become a standard reflecting more local circumstances, and it was revised in 2016 as “MNBC 2016”. “MNBC 2016” is set as the only standard to be followed. Myanmar Engineering Society (MES) also recommends developers to comply with “MNBC 2016”.

Table 1-3 Contents of MNBC 2016

Part 1	PLANNING, ENVIRONMENT, ADMINISTRATION AND LEGISLATION
Part 2	ARCHITECTURE AND URBAN DESIGN
Part 3	STRUCTURAL DESIGN
Part 4	SOILS AND FOUNDATIONS
Part 5A	BUILDING SERVICES (LIGHTING)
Part 5B	BUILDING SERVICES (ELECTRICAL AND ALLIED INSTALLATIONS)
Part 5C	BUILDING SERVICES (Installation of Lifts and Escalators)
Part 5D	WATER SUPPLY, DRAINAGE AND SANITATION (including SOLID WASTE MANAGEMENT)
Part 6	BUILDING MATERIALS
Part 7	CONSTRUCTION PRACTICES AND SAFETY

Source: MNBC 2016

(2) Inspection Agencies

Infrastructure-related inspection agencies in Myanmar, which conduct quality confirmation and certification of construction materials, are mainly classified into two groups: public and private. In either case, many of them are in charge of inspection as well as other operations such as survey, design, construction, manufacturing and research.

(3) Public Agencies

The following organizations have been identified as inspection agencies under the MOC.

1) Research and Development Section (RDS)

Role / Function:

- Strength testing of airport runway and road pavement surface as well as soil quality testing
- Material testing of roads within jurisdiction (i.e. crushed stone, sand, bitumen, sealant, cement, concrete block)
- Various designs of asphalt concrete and concrete
- Implementation of cement stabilization treatment method, lime stabilization treatment method as well as cement and granular asphalt treatment method
- Design of pavement and road retaining wall
- Production of asphalt mix emulsion
- Annual lectures on road materials and quality control in CTC training courses
- Implementation of research projects regarding on-site material utilization as well as road pavement and slope collapse repair
- Collaboration with international technology groups for sustainable development in the road sector

Inspection Work:

Material tests mainly for road construction sites in a section of the Thuwunna district and simple material tests in minilabs installed at 16 local offices in DOH are being conducted. The areas available for inspection as of March 2018 are as follows:

Table 1-4 Major Inspections Conducted by RDS

Large Classification	Small Classification	
Soil	- Grain Size Analysis Test - Specific Gravity Test - Atterberg's Limit Test	- Proctor Compaction Test - Unified Soil Classification System - California Bearing Ratio CBR Test
Cement	- Setting Time - Soundness Test	- Motor Cube Compressive Strength - Fineness Test
Aggregate	- Specific Gravity Test - Clay Lump Test	- Bulk Density Test - Fineness Modulus
Asphalt	- Softening point (Ring & Ball) (°C) - Solubility in Trichloroethylene (%) - Specific Gravity at 25°C - Ductility at 25°C (cm)	- Loss on Heating by Weight (%) - Flash Point (°C) - Presentation After Loss on Heating at 25°C (0.1mm) (% of Original)

Source: JICA Study Team in reference to the report of "Needs Survey on Enforcement of CTC Function (Technical Assistance) (March 2018)"

2) Quality Control Section（QCS）

Role / Function:

- Soil quality surveys and tests of bridges, retaining walls and buildings planned by the five departments of MOC;
- Concrete and material quality control for bridge construction site; and
- Non-Destructive Test (NDT), loading test, and cable tensile test on cable-stayed bridges.

Inspection Work:

The following tests are mainly conducted:

Table 1-5 Major Inspections Conducted by QCS

Large Classification	Small Classification	
	- Visual Classification Test - Moisture Content Test - Wet & Dry Density - Unconfined Compressive Strength Test	- Grain Size Distribution Test - Atterberg's Limit Test - Direct Shear Test - Consolidation
Cement	- Vicat apparatus set - 70mm mortar cube mold - 100ml measuring cylinder - Mortar mixer - Sieve no.18 & 25	- Compressive machine (for mortar cube) - Le chatelier apparatus - Sieve no.170
Fine Aggregate	- Volumetric Flask bottle - San absorption cone & tamper - Bulk density and voids measure 5 lit cap - Sieve 3/8, no. 4, 8, 16 - Sieve 3/8, no. 4, pan & cove	- Balance (2,610gm) - Balance (311mg) - Balance (6,000gm) - Balance (21gm) - Oen - Adam nimbus precision balances
Compression Test	- Cylinder mold - Cube mold - Tamping rod (cube) - Tamping rod (cylinder) - Slump cone - Compression machine	- Scoop (stainless steel) - Pan type mixer - Capper for cylinder - Neoprene - Rebound hammer - Heavy duty balance 20kg
Bentonite Test for bored pile works	- 60kg balance - 30kg balance	- Bentonite apparatus

Source: JICA Study Team in reference to the report of "Needs Survey on Enforcement of CTC Function (Technical Assistance) (March 2018)"

(4) Private Agencies

Below is an introduction of two private companies with an infrastructure-related inspection function.

1) Myanmar Hydro Power Development Co., Ltd.

Established:

It was officially established as a private company in September 2013 under the "Myanmar Companies Act 1914". It is located in the Ottarathiri Township of Naypyidaw. Certificate of Incorporation is shown in Figure 1-5.

Vision:

"Promote, develop, and manage renewable energy projects especially in remote area, particularly small hydropower, in an efficient, responsible and sustainable manner, and to maximize benefit and revenues to the nation".


Certificate of Incorporation
MYANMA HYDRO POWER DEVELOPMENT COMPANY LIMITED
Company Registration No. 101265315
MYANMA HYDRO POWER DEVELOPMENT COMPANY LIMITED
This is to certify that
MYANMA HYDRO POWER DEVELOPMENT COMPANY LIMITED
was incorporated under the Myanmar Companies Act 1914 on 19 September 2013 as a Private Company Limited by Shares.
Registrar of Companies
Directorate of Investment and Company Administration
DICA

Figure 1-5 Certificate of Incorporation for Myanmar Hydro Power Development Co., Ltd.

Mission:

- Effectively and efficiently manage hydropower schemes, and maximize returns to the shareholders;
- Take a lead role in accelerating small hydropower development in the Myanmar by developing new hydropower projects independently through joint ventures or through any other arrangements with domestic and international partners;
- Be a responsible, proactive and progressive company with a highly motivated and innovative team of professionals; and
- Dedication to the highest quality of customer service delivered with a sense of warmth, friendliness, individual pride, and company spirit.

Contents of Operations:

Provides three services shown below:

- Investigation
- Construction
- Laboratory and Testing Construction Material

Of the above-mentioned work contents, inspection work is included in "Laboratory and Testing Construction Material" work. The fields covered in this content are as follows:

Table 1-6 Major Inspections Conducted by Myanmar Hydro Power Development Co., Ltd.

Large Classification	Small Classification	
Cement Test	- Normal Consistency, Setting Time Test - Specific Gravity Test - Fineness Test	- Soundness Test - Compressive Strength of Motor Test - Sieving Standard Sand for Test - Fineness Test (Blain Test)
Aggregate (Coarse)	- Grading Test - Specific Gravity Test - Absorption Test - Loose Density Test - Rodded Density Test - Flakiness and Elongation Index Test	- Material Finer than #200 Sieve - Clay Lump & Frible Particles Test - Crushing Value Test - Impact Value Test - Abrasion Value Test - Soundness Test
Aggregate (Fine)	- Grading Test - Specific Gravity Test - Absorption Test - Loose Density Test	- Rodded Density Test - Material Finer than #200 Sieve - Organic Impurities Test - Clay Lump & Frible Particles Test
Compressive Strength Test	- Concrete Compressive Strength Cube Test - Brick Compressive Strength Test	- Timber Scantling Compressive Strength Test
Steel Tensile Strength Test		
Structure Member Test	- H and I Steel Section (Unit Weight and Thickness)	- Angle, Channel and Pipe Steel Section (Unit Weight and Thickness)
Soil Test	- Atterberg Limit Test - Compaction Test	- Grading Analysis Test

Source: http://www.mmhydropower.com/laboratory-and-testing-construction-materials/

2) GEOLAB (Myanmar) Co., Ltd.

Established:

It was officially established in December 2012 under the "Myanmar Companies Act 1914". It is a subsidiary of CSC Group led by Civil Solution Consultants Ltd.[10] It is located in the North Dagon Myothit Township of Yangon. Certificate of Incorporation is shown in Figure 1-6.


ကုမ္ပဏီမှတ်ပုံတင်လက်မှတ်
Certificate of Incorporation
ဂျီအိုလက်ဗ်(ပဲ)(မြန်မာ) ကုမ္ပဏီ လီမိတက်
GEOLAB (MYANMAR) COMPANY LIMITED
Company Registration No. 153906386
This is to certify that
GEOLAB (MYANMAR) COMPANY LIMITED
was incorporated under the Myanmar Companies Act 1914 on 14 December 2012 as a Private Company Limited by Shares.
Registrar of Companies
Directorate of Investment and Company Administration

Figure 1-6 Certificate of Incorporation for GEOLAB (Myanmar) Co., Ltd.

Contents of Operations:

Provides four services shown below:

- Soil Investigation and Testing Construction
- Geotechnical and Civil Laboratory
- Geotechnical Instrumentation and Monitoring
- Pile Load Tests such as, Static (SLT), Dynamic (PDA), Sonic Integrity (SIT)

[10] Based on the "Myanmar Companies Act 1914", it was officially established as a private company in September 1999. In May 2016, it acquired ISO90001 in the fields of design, construction supervision, inspection and surveying. It has contracted work from the MOC.

Inspection Operations:

Of the above-mentioned work contents, inspection work is included in "Geotechnical and Civil Laboratory" work. The fields covered in this content are as follows:

Table 1-7 Major Inspections Conducted at GEOLAB (Myanmar) Co., Ltd.

Large Classification	Small Classification	
Geotechnical Test	- Moisture Content Test - Specific Gravity Test - Atterberg Limit Test - Triaxle Compression Test (UU) - Consolidation Test	- Particle Size Analysis (Sieve & Hydrometer) - Consolidated Undrained Triaxle Test - Small Shear Box Test (Direct Shear Test) - Point Load Test
Civil Test	- Soil Strength & Bearing Capacity Field Test	- Concrete Strength Test

Note: Civil Test can be handled both in the test room and in the field.
Source: JICA Study Team

1.3 Organize Problems and Confirmation of Needs

1.3.1 Problems Related to Human Resource Development

(1) Issues on Human Resource Development at MOC

- The opportunities for improvement of the central government's essential roles and functions such as policymaking, formulation of land development plan, investment planning for infrastructure development, preparation of necessary laws and regulations, financial management and so on, are not sufficient. Due to this, development priority has been given towards improvement of infrastructures and skills.

- As for the whole of MOC, the management ability of officers to consider infrastructure development from the construction market and socio-economic point of view is not enough.

- In response to the training conducted at CTC, the human resource development division of each department is involved only in selecting training participants, and no opinion is reflected on the content of the training program.

- Both CTC and MTC offices have severely deteriorated and there is also lack of facilities and equipment.

- Since instructors are selected from the staff of each department, it is difficult to secure high-quality instructors.

(2) Issues on Human Resource Development in Higher Education Institutions

According to the National Development Plan, particularly under the "Science Technology Human Resource Development Plan (2011 / 12-2030 / 31), "YTU and MTU have both been designated as core universities (COEs) which lead national engineering education and research. Their goal is to achieve an ASEAN level university by 2020. However, before the democratization in 2011, universities had limited contact with private companies, thus university education did not suit the level of skills and technology that private companies required.

1.3.2 Problems Related to Research and Laboratory Activities

- Public organizations (i.e. administrative organizations, higher education institutions, etc.) are expected by the industry to provide various research and inspection services that use inspection / measuring equipment which are difficult for companies to procure individually. In any case, facilities and equipment need to be maintained to meet the service requirements.

- The inspection equipment in RDS (under DOH, research and development office) developed by ADB are not used due to lack of space in the facility and non-conformity.

- Research and inspection agencies under MOC lack the knowledge and experience to obtain ISO9001 certification. In addition, after acquiring the ISO, it is necessary to develop a function to determine the conformity of materials and related products in Myanmar with the ASEAN standard (MRA: Mutual Recognition Arrangement).

- There is a shortage of national budget for research and inspection.

1.3.3 Confirmation of the Necessity of the Loan Project

As mentioned above, with the change in the economic and social environment guided by the democratization policy of the Thein Sein regime – which began following the transfer of power to civilian administration in March 2011 – a mature society was required in response. Until recently, administrative functions have been focused on the development of infrastructure that contributes to the development of the nation. Parallel to the development of infrastructure, the completion of planning, executing and managing policies and plans for the future is also desired moving forward. Moreover, maintaining legal system and assuring quality with the same level as international standards are also being considered.

In order to cope with requirements of the infrastructure-related field, it is necessary to strengthen MOC's organization, capacity of staff, and maintenance of facilities and equipment that can strengthen the organization and its capacity.

2. Outline of the Thuwunna Central Training Center and Research Laboratories

2.1 Facilities on Target Site

The target site of the project is located in Thingangyun Township, north east of the central area of Yangon. The total area of the site is about 0.37 km^2 and its north eastern boundary line is along the main road called Kamar Kyi Rd. An aerial photograph of the target site is as shown below:

Source: JICA Study Team

Figure 2-1 Aerial Photograph of the Target Site

The target site includes the research laboratories of the Department of Highways (DOH), the Department of Bridge (DOB), the Department of Building (DOBi), the Department of Rural Road Development (DRRD), and the facilities of the Thuwunna Central Training Center (CTC) which are all under the Ministry of Construction (MOC). The current status of each existing facility is described in 2.1.1 to 2.1.5 hereinafter:

2.1.1 Current Situation of Thuwunna CTC

2.1.1.1 Function, Role and Training Programs

CTC was established in 1966 as a technical training center for the Ministry of Construction (MOC) staff. Recognizing that MOC has the responsibility to skill up engineers and skilled laborers, CTC has been conducting technical training for the MOC staff (both engineers and administrative staff), as well as vocational training and assessments for skilled laborers. The administration office in CTC takes care of the financial matters and management of training.

Technical training for the MOC staff is planned by the Director General (DG) of MOC and is being held at three locations: Thuwunna Central Training Center (CTC), Mechanical Training Center (MTC) in Yangon, and MTC in Mandalay.

CTC provides management training and basic construction skills training (i.e. road, bridge and building construction) for MOC officers and junior class.

MTC provides construction equipment operation and maintenance training (practical training and lectures) for MOC mechanical engineers.

Table 2-1 MOC Staff Technical Training Courses in CTC (2017-2018)

No	Name of Training	Time	Quantity	Week
1	Staff Officer (Finance) & Accountant Refresher Training Course	1	142	4
2	Junior Engineer (4) Civil Entry Training Course	3	114	6
3	Defense Services Technology Academy(Cadet)	1	20	2
4	Middle Rank officer Training Course for DD & AD	1	20	4
5	Building, Road and Bridge Quality Control Training Course	2	40	4
6	Junior Engineer (3) Civil Refresher Training Course	2	31	6
7	Road materials Quality Control Training Course Mini Lab	1	34	4
8	Workshop for Financial (Building)	1	39	1
9	Officer Training Course for Staff Officer (civil)	1	40	6
10	Clerical Training Course for superintendent & Branch Clark	1	19	2
11	Junior Engineer (1) Civil Refresher Training Course	1	44	4
12	Junior Engineer (2) Civil Refresher Training Course	2	59	4
13	Accountant (2) Refresher Training Course	1	66	4
14	Asphalt Concrete Road Construction Training Course	1	61	2
15	Housing Management Training Course	1	20	4
16	Road materials Quality Control Training Course (Assistant Reserve)	1	50	4
17	Clerical Training Course for UD & LD	1	40	4
18	Rural Roads & Bridge Construction Training Course	1	43	6
19	Rural Roads & Bridge Construction Training Course	1	49	4
20	Survey Course	1	80	6
21	Concrete Course	1	50	6

Source: CTC

Table 2-2 Annual Training Schedule of MOC Staff Technical Training in CTC (2019-2020)

No	Name of Training	Time	Quantity	weeks	2018 Oct	2018 Nov	2018 Dec	2019 Jan	2019 Feb	2019 March	2019 April	2019 May	2019 June	2019 July	2019 Aug	2019 Sept
1	Asphalt Concrete Road Construction Training Course	1	50	2	1----12											
2	Staff Officer civil Refresher Training Course	1	70	6	1--------9											
3	Accountant (2) Refresher Training Course	1	70	5		29---30										
4	Towns and Housing Management Training Course	1	20	4			3------28									
5	Basic Survey Training Course	2	60	6				14---------22								
6	Rural Roads and bridges ConstructionTraining Course	1	60	4				28----22								
7	Accounting (4) Refresher Training Course	1	60	4				28---22								
8	Basic Computer Training	1	30	4						11------5						
	(Accunting (4),Junior clerk)															
9	Staff officer Civil Refresher Training Course	1	70	6								6----------14				
10	Accountant (3) Refresher Training Course	1	60	4								6---31				
11	Junior Engineer (4) Civil Refresher Training Course	1	70	6								6----------14				
12	Road and Bridges,Building quality Control Training Course			4									10------5			
13	Junior Engineer (1) Civil Refresher Training Course	1	50	4									10 ----5			
14	Deputy Director (Civil) Refresher Training Course	1	50	2										22---2		
15	Asphalt Concrete Road Construction Training Course	1	50	2										22---2		
16	Assistant Director Civil Refresher Training Course	1	50	2											12--23	
17	Junior Engineer (2) Civil Refresher Training Course	1	50	4											12------6	

Source: CTC

(2) Technical Training and Assessment of Skilled Laborers

CTC conducts technical training and assessment of skilled laborers in accordance with the standards set by the National Skill Standards Authority (NSSA). There are 19 types of construction-related skills in the NSSA standards. CTC has been conducting technical training and issuing training participation certificates for 5 construction worker types: (1) Concrete Worker, (2) Carpenter, (3) Bricklayer, (4) Tiler, and (5) Road Worker. CTC performs skills assessments and issues the national

certificate of occupational competency on 8 worker types: (1) Concrete Worker, (2) Carpenter, (3) Brick layer, (4) Painter, (5) Tiler, (6) Scaffolder, (7) Plumber, and (8) Bar Bender. In addition, CTC carries out a one-day safety management classes for all training and assessments of any type of competency held in the facilities. In the future, CTC hopes to provide technical trainings and assessment for a total of 16 out of 19 construction-related occupational competencies following the NSSA standards. The remaining 3 competencies will be covered by MTC (Table 2-3).

Private enterprises and general households recognize the national certificate of occupational competency; hence, it is possible for certificate holders to get involved in better job opportunities. Some private enterprises perform assessments independently. For example, Myanmar Kaido Co., Ltd (Magway) and Irrigation Training Center (Mayangone) perform assessment of hydraulic excavator operator qualification, while Myanmar Kaido Co., Ltd performs assessment of forklift qualification. On top of that, each private enterprise also conducts safety management training.

NSSA categorizes skills standard into four levels according to the degree of difficulty. In the future, CTC hopes to prioritize training programs for lower difficulty levels. Levels 1 and 2 aim to increase the number of skilled laborers, while Levels 3 and 4 are assumed to be prioritized by technical schools, universities, and private companies.

Table 2-3 NSSA Construction-Related Occupational Competency, CTC Technical Training, Assessment and Future Plans

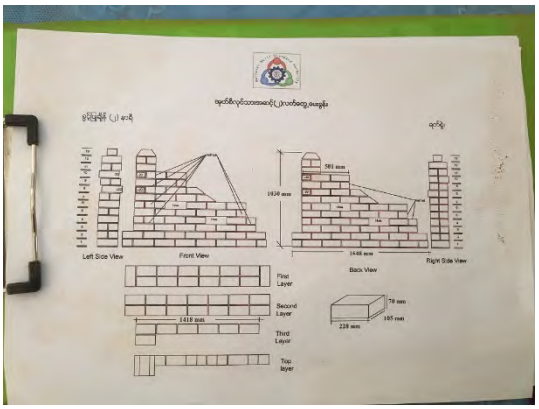
No	Field	Current Situation		Future Plan	
		Technical Training	Assessments	Technical Training	Assessments
1	Concrete	✔	✔	✔	✔
2	Carpenter	✔	✔	✔	✔
3	Brick Layer	✔	✔	✔	✔
4	Painter	Will be held soon	✔	✔	✔
5	Tiler	✔	✔	✔	✔
6	Steel Structure		✔	✔	✔
7	Scaffolder	Will be held soon	✔	✔	✔
8	Plumber		✔	✔	✔
9	Roofer			✔	✔
10	Care Taker			✔	✔
11	Landscape Gardener			✔	✔
12	Construction Machine Maintenance			(MTC)	(MTC)
13	Well Digger			✔	✔
14	Toll Collector			✔	✔
15	Bar Bender	Will be held soon	✔	✔	✔
16	Road Worker	✔		✔	✔
17	Plasterer			✔	✔
18	Hydraulic Excavator Operator			(MTC)	(MTC)
19	Forklift Operator			(MTC)	(MTC)
	19 types	5 types	8 types	16 types	16 types

Source: JICA Study Team

1) Technical Assessments

For example, the process of brick layer assessment is summarized below:

- The brick layer assessment is mainly performed by the Ministry of Labor, the Ministry of Education and the Ministry of Industry.
- One assessment session has about 30 participants divided into several groups. It takes 5 days for all groups to take the examination, and each group is required to participate for 3 days. One day out of the 3-day session is allocated for a lecture on safety management. Each group alternately participates in a written examination in the morning and a two-hour practical examination in the afternoon.
- Each practical examination is taken by a maximum of 10 people, and is supervised by 5 examiners.
- The passing grade is about 50 to 70 percent.

	
Brick Layer Assessments	Assignment of Brick Layer Assessments Level 2

Source: JICA Study Team

Figure 2-2 Situation of Assessments

Situation of Existing Buildings

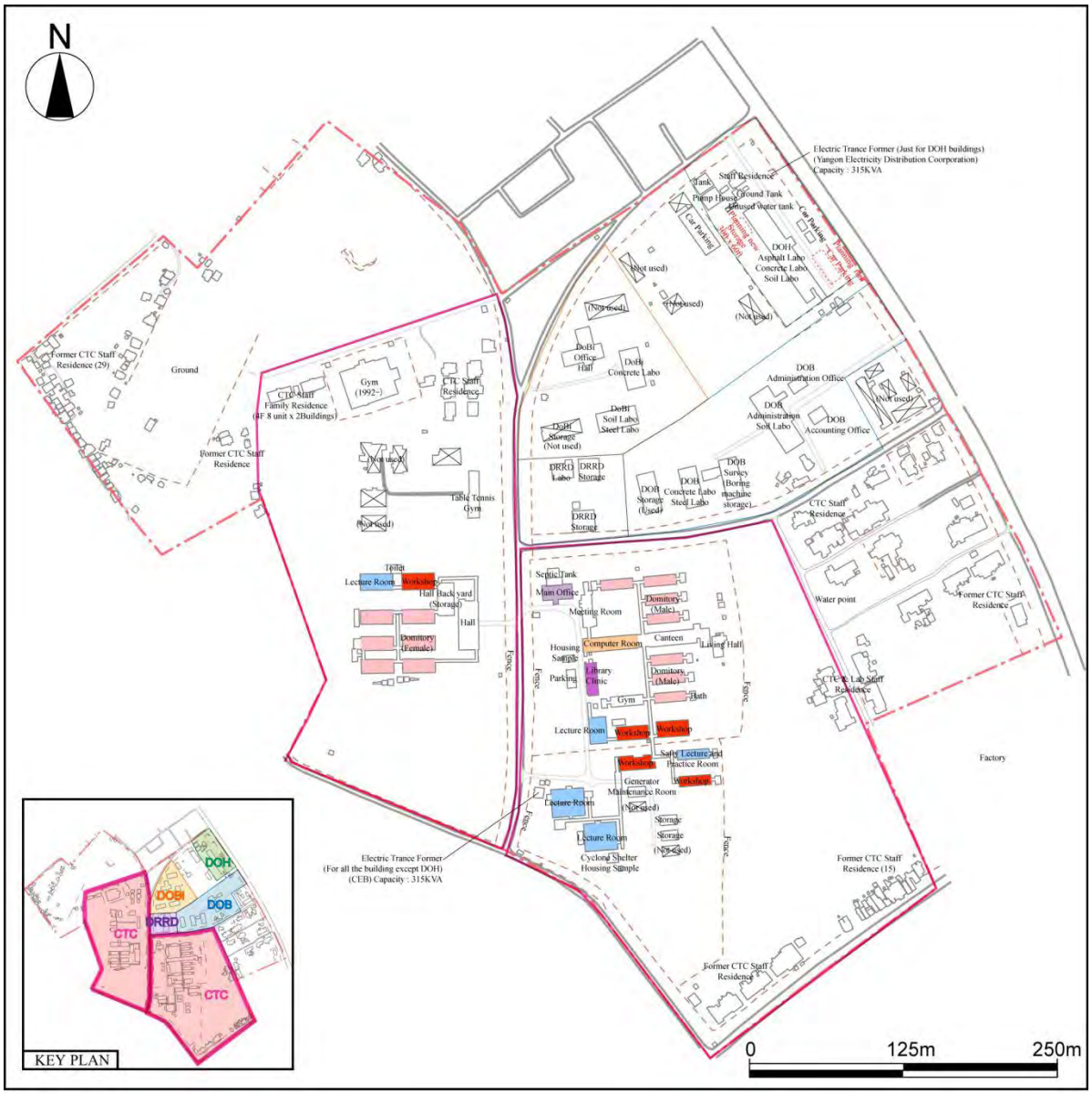
CTC facilities are roughly divided into training buildings, trainee dormitories, office, common areas and staff residence. Technical training for MOC staff as well as technical training and assessment of skilled laborers are all held in the same facilities on site. Because the location of CTC facilities has a particularly high level of water, there are buildings which suffer from severe deterioration, where the walls are likely to come off from structural frames. Such buildings are currently used as warehouses where unused equipment items are piled up. The procedure to discard such unused equipment would take a quite long time, so even the equipment which had been broken for years had to be kept on site, i.e. in existing deteriorated buildings. On the other hand, many rooms in existing training buildings are kept clean and tidy.

On site, there are two wells of approximately 200 m deep which are purified by the water treatment facilities provided on site. There are toilets and rainwater storage tanks made of concrete in several locations on site which are utilized during training and for daily use such as cleaning. The sewage on the site is not connected to the public sewerage system; thus, all sewerages are infiltrated after treatment in septic tanks. Although a request for drainage improvement has been sent to the Yangon City Development Committee (YCDC), YCDC representatives only came to conduct a field survey, and there has been no answer regarding the matter since then.

	
Situation of the Location with High Water Level	Aging Wall
	
Lecture Room Buildings Constructed by JICA	Well

Source: JICA Study Team

Figure 2-3 Situation of Existing Buildings on Site



Source: JICA Study Team

Figure 2-4 Layout Drawing of Existing CTC Buildings

Table 2-4 Area of Each Room in CTC Facilities

Room Name	Area (m2)
CTC	
Classroom and Practice Room	2,684
Meeting room	223
Computer Room	223
Hall	391
Library ・ Nurse Room	186
Administration	265
Canteen	307
Others	0
Total	**4,279**
Dormitory	
Dormitory for Manager class & Ladies	1,859
Dormitory for Skilled Labor	372
Kitchen	93
Storage	372
Storage (Not Using)	0
Total	**2,696**

Source: JICA Study Team

(1) Training Buildings

The training buildings consist of 8 lecture rooms, 5 workshops, an auditorium, a computer room, a canteen, a library, and a clinic.

At the southern part of the site, there are two lecture room buildings constructed by JICA in 1980. The buildings have a total of 5 lecture rooms with a capacity of 50 to 80 people and fully equipped with air conditioning, a lecturer's waiting room, a reception room and a toilet. Among the lecture rooms, there are rooms equipped with large work desks which can be used during technical drawing exercises. The large work desks are also used when taking the written test during the assessment. The other lecture rooms are equipped with tablet arm chairs.

The workshops consist of exercise rooms where 8 to 10 skilled workers can work at one time as well as a place for the lecturer or for storing equipment. There are rooms where posters used in lectures and exercises are displayed on the wall. During exercises, dust from bricks and woods are floating around, in addition to loud noises generated by electrical equipment and tool works. Since the storage space is not enough, building materials used in the exercises are left outside. When cement is used in exercises, an electric cement mixer runs in the outdoor corridor next to the workshop. New building materials are purchased and used for every exercise. After the exercises, the materials are then used as paving materials on the site, or are dumped on the site.

The auditorium consists of 256 seats including 32 seats for guests of honor and a stage at the front. The computer room is used for MOC staff technical training. There are about 50 desktop computers installed, but there is no internet connection. The canteen can accommodate about 200 people and is

located next to a kitchen. On the wall, there are numerous photographs and pictures of bridges constructed by the MOC. In the library, MOC-related books are arranged on the shelves and one large self-study desk is placed in the center. One doctor is stationed at the clinic.

	
Lecture Room (capacity of 50 to 80 people) 〈 〉	Carpenter Workshop
	
Situation of Lecture of Skilled Labor Training (capacity of 30 people)	Computer Room
	
Canteen	Library

Source: JICA Study Team

Figure 2-5 Situation of Training Buildings

(2) Trainee Dormitories

There are two locations of accommodation facilities on site for trainees. The one on the east side consists of 7 buildings for male skilled workers. The one on the west side consists of 6 buildings for females and MOC staff. There are only around 15 wooden beds in each building, and only a limited number of rooms are equipped with fans. Therefore, when entering the facilities, trainees bring in all their daily necessities, including beddings from their homes. Since there are no partitions between the beds, trainees live together in one big space for an extended period of time. There are no curtains on windows in the female dormitories. There is a source of water next to each dormitory building which is used for bathing and washing.

	
Inside of the Male's Accommodation	Water Source

Source: JICA Study Team

Figure 2-6 Situation of Trainee Dormitories

(3) Office

The office building consists of office and meeting rooms. The office takes care of the financial matters and management of training. Staff members work inside the facilities on weekdays.

	
Outer Appearance	Inner Appearance
	
Director General's Office	Meeting Room

Source: JICA Study Team

Figure 2-7 Situation of the Office

(4) Common Areas

Each building is connected with a roofed outdoor corridor, with flooring of about 0.1 m to 1 m higher than the ground surface to allow mobility in the facilities even in the rainy season. As the existing paint layers in outdoor corridors are constantly painted over, there are places where parts of the ceiling are extremely low and where the floor is uneven.

Near the workshop buildings, there is a generator maintenance building and 4 warehouses, 2 of which are used as semi-outdoor storage areas.

	
Outdoor Corridor Connecting Each Building	Semi-outdoor Warehouse

Source: JICA Study Team

Figure 2-8 Situation of Common Areas

(5) Staff Residence and Sports Gym

There are residence buildings for CTC staff on the north and east side of the site. One is for families and the other one is for singles. There is also a sports gym constructed in 1992.

	
CTC Staff Residence (for Family)	Sports Gym

Source: JICA Study Team

Figure 2-9 Situation of Staff Residence

2.1.1.3 Situation of Existing Equipment

As its function, CTC conducts technical/vocational training and technical skills test. The technical/vocational training consists of lectures and practical training courses. Besides furniture, the lecture room is equipped with audio-visual equipment such as projectors and personal computers, and the practical training room is provided with some equipment such as electrical planer and electrical saw – which were procured through JICA Technical Cooperation implemented in 2016 – for carpentry course for the building section.

Table 2-5 Major Equipment Owned by CTC

No.	Functions	Major Items
1	Training (Lecturing)	Projectors, Lap-top computers, Desk-top computers and so on
2	Practical Training and Skill Testing	Survey Equipment, Electric meters, and Tools for Carpenters, Wood fittings, Steel works, Electricians, Bricks and Tile works and so on

Source: JICA Study Team

2.1.1.4 Organization and Staff

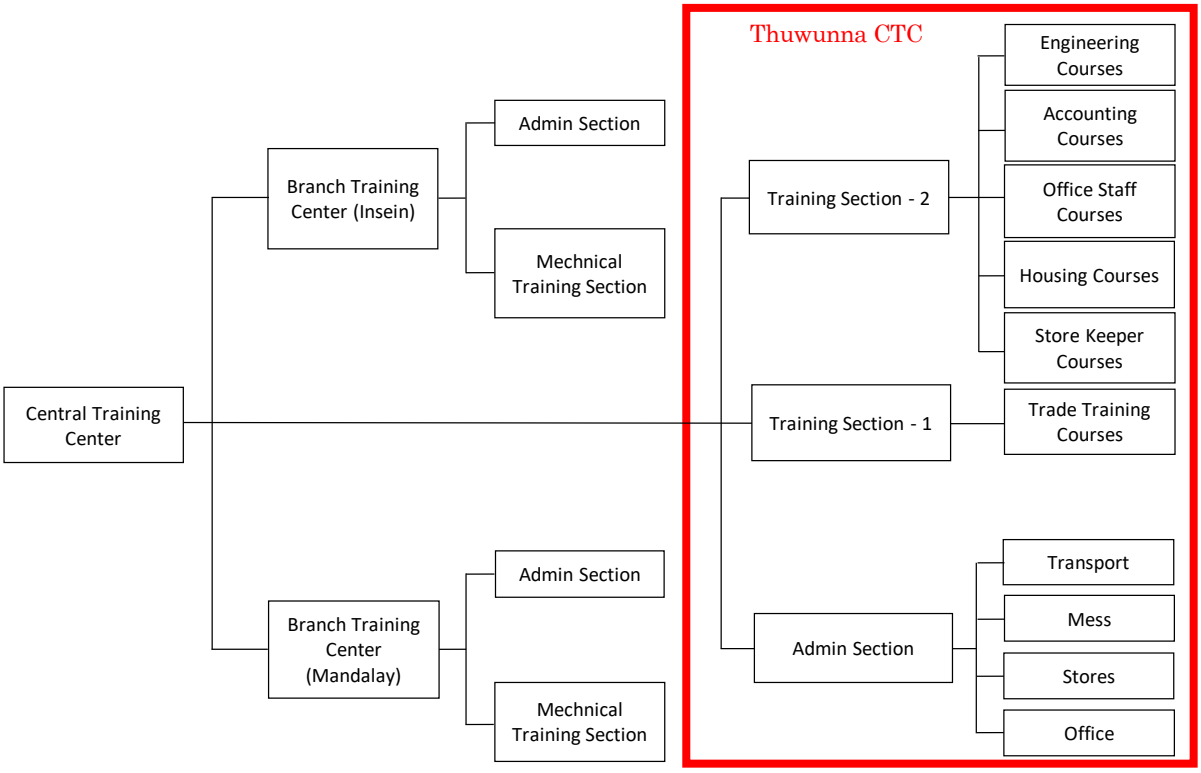
CTC conducts technical training and assessments under the Human Resources Development of the Department of Highways (DOH). Under Thuwunna CTC, MTC was established as a training facility for construction machinery with 2 branch locations: Yangon Region (Insein Township) and Mandalay Region.

As of April 2019, 76 staff are employed at the Thuwunna CTC. Among them are 11 MOC staff and 65 non-regular workers (operator, unskilled worker, security guard, etc.).

Table 2-6 Current Number of CTC Staff

Position	Number of people
Deputy Director General	0
Director	1
Deputy Director	1
Assistant Director	1
Staff Officer	2
Junior Engineer	6
Accountant	2
Typist	5
Cleaner	6
Driver	4
Guard	6
Staff	10
Cook	8
Nurse	1
Gardener	7
Deputy supervisor	4
Water supplier	5
Library	1
Staff help	3
Electrician	3
Grand Total	**76**

Source: CTC



Source: Needs Survey on Enforcement of CTC Function (Technical Assistance) Summary Report, March 2018

Figure 2-10 CTC Organizational Chart

2.1.2 Current Situation of DOH Research Laboratory

The Road Research Laboratories (RRL), which changed its name to the Research and Development Section (RDS), was established in 1974 as a sand and aggregate testing laboratory. With the purpose to expand and reinforce domestic road networks, the government of Myanmar – together with the UN – carried out a Road Research and Development Project in 1986 which lasted for 3 years, and the current RDS facilities were built in Yangon Region and Mandalay Region. In this Project, trainings courses for researchers were conducted. When the organization was restructured in 2015, RRL became known as RDS.

2.1.2.1 Function, Role and Research Activities and Laboratory Tests

Under the umbrella of the Construction Department of DOH, RDS is responsible for general road material testing, road pavement design, etc. The facilities are located in Thuwunna of Yangon Region – which is the target site of the Project – and in Mandalay Region, and the bitumen plant is located in Mingaladon Township. The main roles of RDS are as follows.

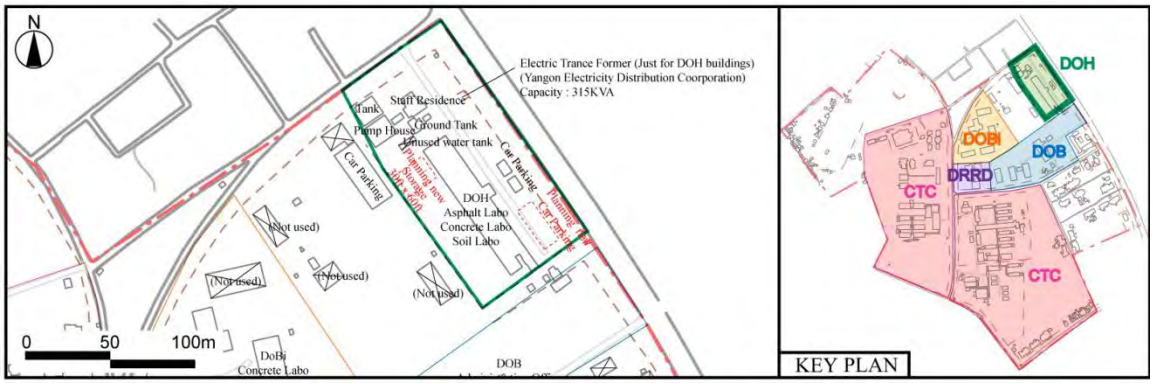
- Strength testing of airport runway and road pavement surface as well as soil quality testing
- Material testing of roads within jurisdiction (i.e. crushed stone, sand, bitumen, sealant, cement, concrete block)

- Various designs of asphalt concrete and concrete
- Implementation of cement stabilization treatment method, lime stabilization treatment method as well as cement and granular asphalt treatment method
- Design of pavement and road retaining wall
- Production of asphalt mix emulsion
- Annual lectures on road materials and quality control in CTC training courses
- Implementation of research projects regarding on site material utilization as well as road pavement and slope collapse repair
- Collaboration with international technology groups for sustainable development in the road sector

Currently, RDS carries out all the inspections of the roads that MOC will construct. Therefore, when the field survey was conducted in January 2019, RDS in Thuwunna was the busiest research and testing section among the facilities. The staff members work in the facilities from 6 am to 7 pm.

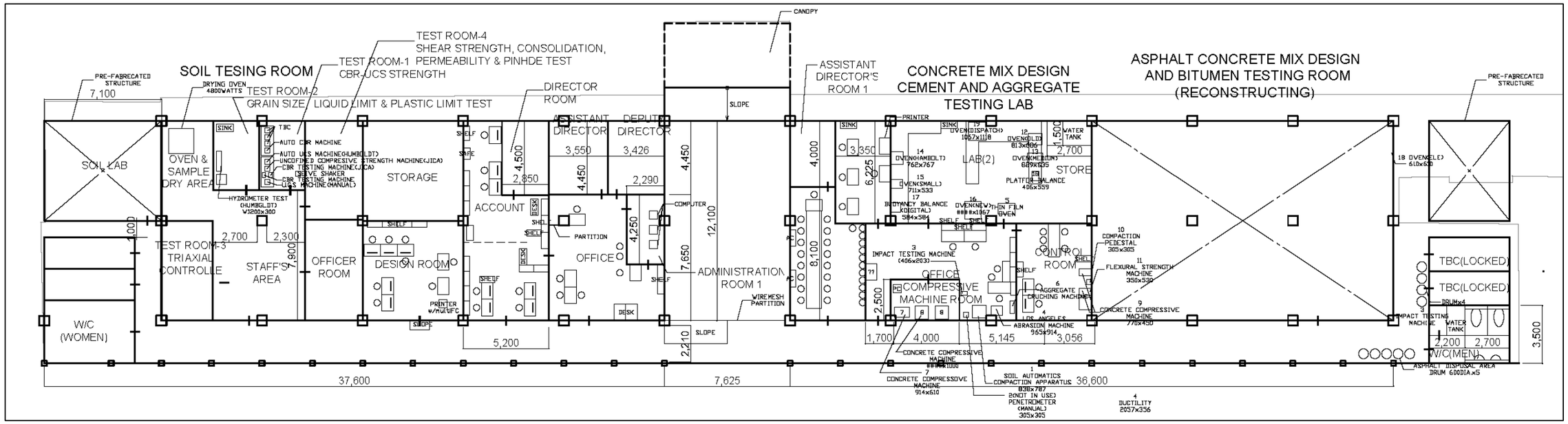
2.1.2.2 Situation of Existing Buildings

The RDS's research and testing facility is comprised of only one building consisting of a management office, four research and testing laboratories (asphalt, concrete, sand, and aggregate), and a meeting room. On the north side of the site, there is a well and a water treatment facility. The water from the well is used for testing. As of April 2019, new parking lots and warehouses are being planned to be constructed on site. (Refer to Figure 2-11 below).



Source: JICA Study Team

Figure 2-11 RDS Layout Drawing



Source: JICA Study Team

Figure 2-12 Survey Drawing of Existing Building of RDS Research and Testing Facilities

Table 2-7 Area of Each Room in RDS Facilities

Room Name	Area (m2)
Laboratory	
Asphalt lab	163
Concrete Laboratory	157
Soil Laboratory	170
Office	
Director's room	13
Deputy Director's room	15
Assistant Director's room 1	16
Assistant Director's room 2	11
Administration office	54
Accountant Office	50
Asphalt office	40
Concrete office	21
Soil office	21
Design room	37
Storage	
Common Storage (Next to toilets)	41
Common Storage (Next to Design room)	37
Asphalt lab Storage	18
Others	
Meeting room	33
Entrance	92
Toilet	38
Corridor	226
Total	**1,253**

Source: JICA Study Team

(1) Administration Office

The administration office is made up of the Director General's office, Deputy Director General's office, head of assistant office, management office, accounting office, management staff office and a meeting room. Each of these rooms is divided by a simple partition.

	
Management Office	Meeting Room

Source: JICA Study Team

Figure 2-13 Situation of the Administration Office Building

(2) Asphalt Research and Testing Laboratory

Asphalt research and testing laboratory has testing rooms (asphalt testing, asphalt concrete testing, and asphalt concrete mix testing), an office and a warehouse. Compared to other laboratories, this laboratory has more sand and aggregate samples needed for testing. Since the warehouse space is relatively quite small, the samples in the container are placed and spread all over the floor or stacked at the corridor or outdoors. However, it is required that storage space should be able to prevent rainwater intrusion. In other words, sand and aggregate samples should not be exposed to rainwater. Asphalt samples are put inside plastic containers and stored indoors or at the corridor. Sand and aggregate samples cannot be stored together with asphalt samples, but this is made possible by providing movable partitions. Samples used in testing should be kept inside the facilities for 1 to 2 months. After the storage period is over, the samples will be used for on-site pavements or donated to monasteries and nearby residents.

Asphalt is melted indoors with an electric stove and a charcoal brazier. Because the indoor space is limited, such tools/equipment are placed in an ineffective layout. There is an exhaust pipe duct above the electric stove, but there is no exhaust equipment dedicated for the charcoal brazier, creating a very dangerous testing environment.

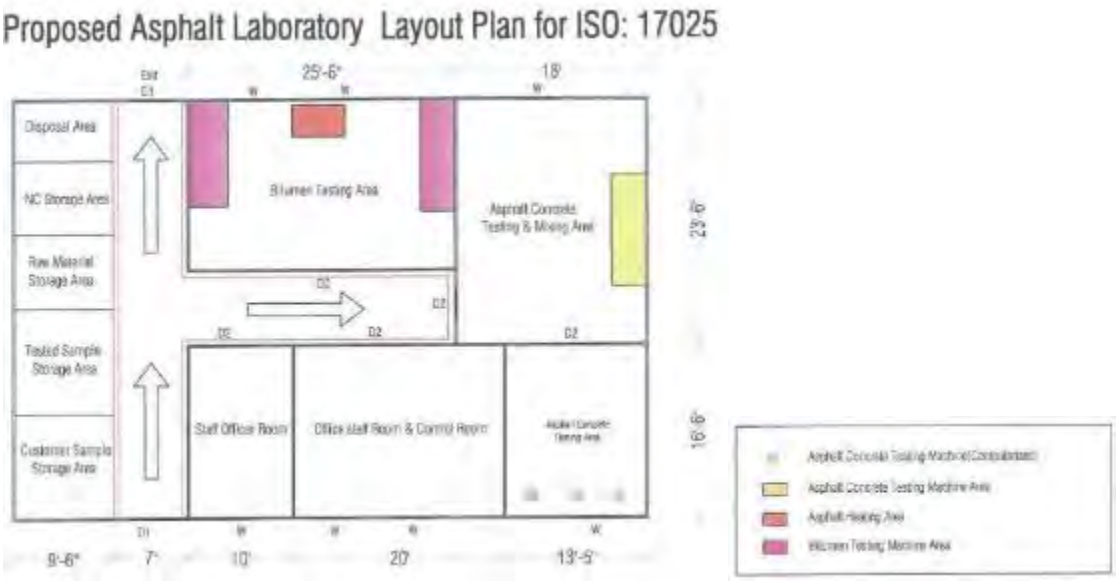
	
Samples that cannot fit in the warehouse and left outdoors	Condition when asphalt is melted indoors
	
Sand and Aggregate Samples placed all over the floor	Asphalt Sample

Source: JICA Study Team

Figure 2-14 Situation in the Asphalt Research and Testing Laboratory Building

1) Proposed Renovation Plan

The asphalt research and testing laboratory is drafting a renovation plan to acquire ISO certification within this fiscal year (September 2019) (Refer to Figure 2-15 below). As the plan is limited to interior renovation of the existing buildings, the required space area for each room is not fulfilled. Each testing room (i.e. asphalt testing, asphalt concrete testing, and asphalt concrete mix testing) is related to each other. The room positioning should be in the following order: (1) asphalt testing, (2) asphalt concrete testing, and (3) asphalt concrete mix testing. Ideally, all the testing rooms should located close to each other for convenience. To ensure security, the office is planned to be placed close to the entrance of the sample warehouse.



Source: RDS asphalt research and testing laboratory
Note: NC storage area is a place to store samples that did not meet the testing standards after inspection.

Figure 2-15 Proposed Renovation Plan for the Asphalt Research and Testing Laboratory

(3) Concrete Research and Testing Laboratory

The concrete research and testing laboratory is comprised of testing rooms (i.e. material testing, asphalt concrete testing and asphalt concrete mix testing), an office and a warehouse. Nine samples are made in one concrete mix, and 3 to 4 concrete mixes are performed daily. An underwater curing tank for the samples is installed inside the testing room. The corner area where the water tank is placed looks like a warehouse.

	
Testing Room	Samples Stored Inside the Testing Room

Source: JICA Study Team

Figure 2-16 Situation of the Concrete Research and Testing Laboratory Building

(4) Sand and Aggregate Research and Testing Laboratory

The sand and aggregate laboratory is made up of triaxial compression testing room, an oven and sample drying room, g, a granularity and liquidity limit testing room, an automatic machinery room, and an office. Three to four mixing tests are conducted daily. The entire process of one mixing test takes 3 days.

	
Testing Laboratory	Situation of Materials Breaking in the Outdoors

Source: JICA Study Team

Figure 2-17 Situation of the Sand and Aggregate Research and Testing Laboratory Building

2.1.2.3 Situation of Existing Equipment

Many of the existing equipment items still works fine; however, some existing equipment that no longer work due to malfunction and deterioration are seen here and there. In recent years, ADB funded a project for the procurement of advanced testing equipment such as Hamburg Wheel Tracker and JICA Technical Cooperation procured Automatic Triaxial Testing Machine in 2016. The major items of each lab are as shown in Table 2-8 below:

Table 2-8 Main Equipment Items Owned by the Department of Highways

No.	Test/Lab/Functions	Test Material	Major items
1	Lab-1 Asphalt/Bitumen Testing	Asphalt	Penetrometer, Hot Plate (Ring and Ball), Ductility, Flash Point and so on
		Emulsion	Viscometer
		Asphalt Concrete	Marshall Testing Machin, Centrifuge Extractor, Roller Compactor, Hamburg Wheel Tracker and so on
2	Lab-2 Concrete Mix Design Cement Aggregates Testing	Concrete, Cement, and Aggregates	Los Angeles Abrasion machine, California Bearing Ratio Testing Machine, Concrete Compressive Machine, Soil Automatic Compaction Apparatus and so on
3	Lab-3 Soil Testing	Soil	Soil Automatic Compaction Apparatus, Direct Shear Machin, Balances, Triaxial Machine Test Set and so on

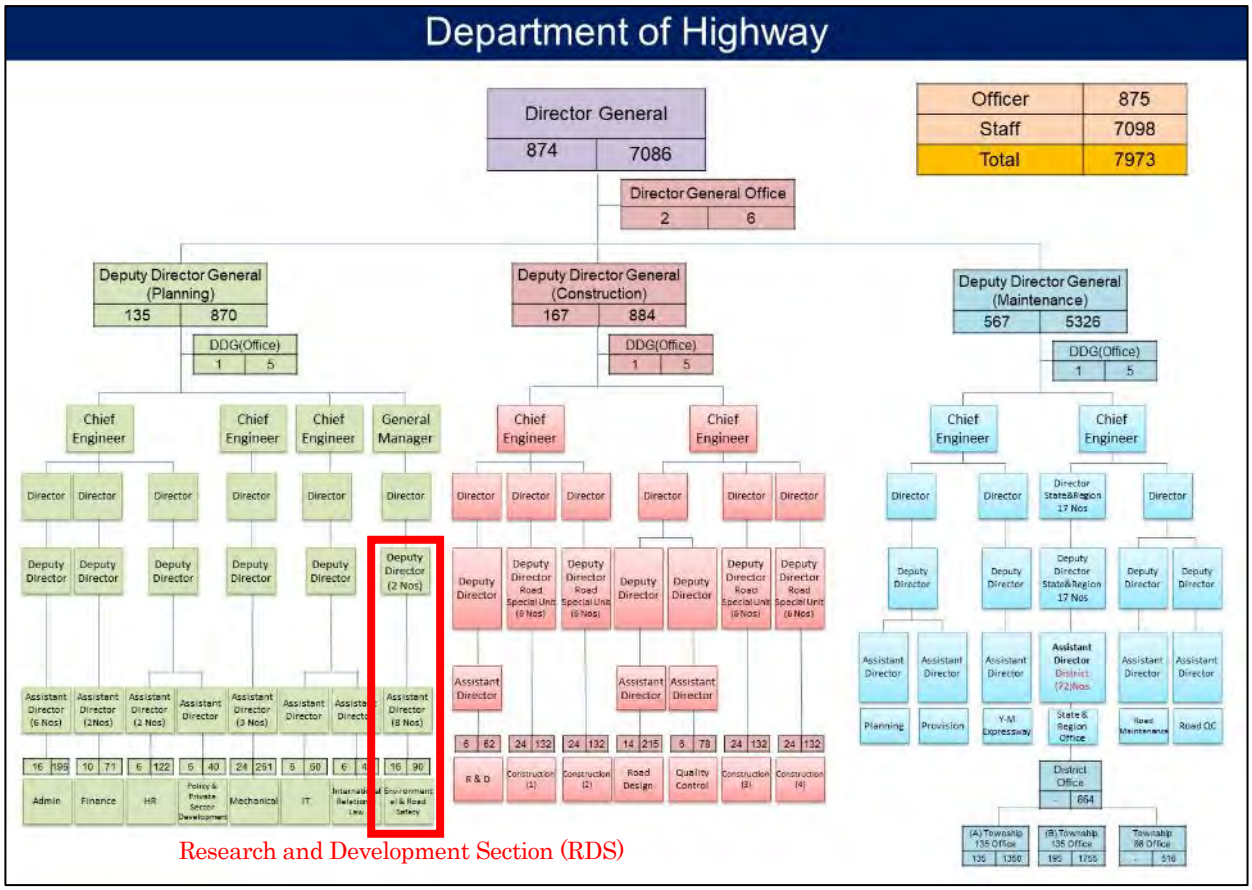
Source: JICA Study Team

When a new testing equipment is required, the department applies for a budget claim – prepared based on the price quotation of local agents – to the upper-level department of the Ministry of Construction for approval. For the next step, the MOC solicits the bidding among registered local agents to determine the supplier for the equipment items applied for. The awarded local agents are responsible for operation and maintenance training of officers of testing labs. The department has no staff members that handle maintenance works. The officer-in-charge (OIC) of the department contacts a local agent to inspect the items that are not working. Whenever repair services are required, the OIC submits the necessary application to the upper-level department of the MOC to secure the budget. For the calibration of testing equipment to maintain accuracy, the department has been implementing it regularly as specified in the service manuals of the relevant equipment and has been keeping the records of the calibrations. Other departments also have been taking the same procedures with the assistance of local agents.

2.1.2.4 Organization and Staff

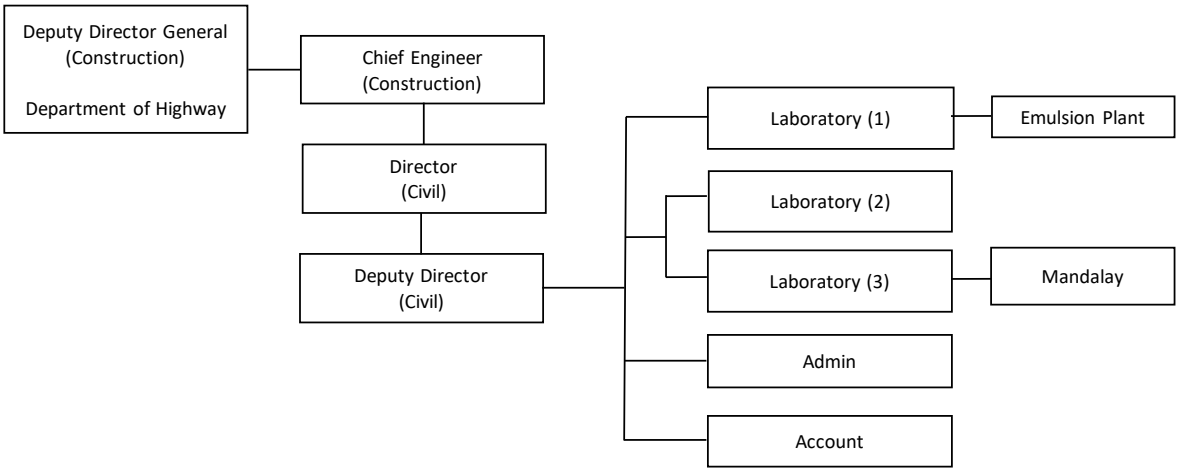
The Department of Highways (DOH) is headed by the Director General (DG) and divided into three divisions: Planning, Construction and Maintenance. Each division is led by a Deputy Director General (DDG). DOH staff includes 875 official staff (staff officer and above) and 7,098 general staff.

RDS belongs to the Construction Division, and staff members under the Deputy Director are stationed in Thuwunna. As of April 2019, a total of 87 employees are working in Thuwunna consisting of 27 MOC staff members and 60 other non-regular workers (e.g. training instructor, cleaning staff, security guard, etc.).



Source: Addition to MOC Documents by JICA Study Team

Figure 2-18 DOH Organizational Chart



Source: Needs Survey on Enforcement of CTC Function (Technical Assistance) Summary Report, March 2018

Figure 2-19 RDS Organizational Chart

Table 2-9 RDS Staff Composition

Department	Position	Number of People							Total
		General	Concrete / Cement Test	Soil Test	Asphalt Test	Re-bar Test	Research Inspection	Design	
DOH			✔	✔	✔			✔	
	Deputy Director General	0							0
	Director	1							1
	Deputy Director	1							1
	Assistant Director	2							2
	Staff Officer	0	2	1	1			1	5
	Junior Engineer	4	3	4	3			4	18
	Accountant	2	0	0	0			0	2
	Typist	1	1	1	0			0	3
	Trainers form MOC	14	1	1	7			0	23
	Trainers from Private sector	3	6	6	5			3	23
	Cleaner	1	1	1	0			0	3
	Driver	0	0	0	0			0	0
	Gurd	6	0	0	0			0	6
								TOTAL	87

Source: JICA Study Team

2.1.3 Current Situation of DOB Research Laboratory

2.1.3.1 Function, Role and Research Activities and Laboratory Tests

The Bridge Law, which was enacted in 2017, regulates the Department of Bridge (DOB) to be in charge of bridge planning, design, construction, maintenance, as well as coordination with related agencies. In addition to independently designing and constructing bridges with a length of more than 180 feet (about 54 m), the department also constructs small-scale bridges on local roads under the supervision of the local government and bridges under the supervision of the Ministry of Railways upon request. The design department is located in Yangon and Naypyidaw. The department in Yangon is mainly in charge of large-scale bridges, while the one in Naypyidaw is responsible for bridges of relatively smaller scale. The construction department owns 16 Special Construction Units in each region or state under 4 Bridge Construction Units. Each unit is in charge of bridge construction and maintenance in each region or state.

The Quality Control Section (QCS) is under the umbrella of the DOB's management department. Mandalay Quality Control Section (MQCS) is responsible for quality management of bridges on the north side of the country, while Yangon Quality Control Section (YQCS) is responsible for bridges on the south side.

The roles and activities of QCS mainly cover the quality control of on-site soil, concrete, and deformed rebar of bridges. The functions of the section are as follows:

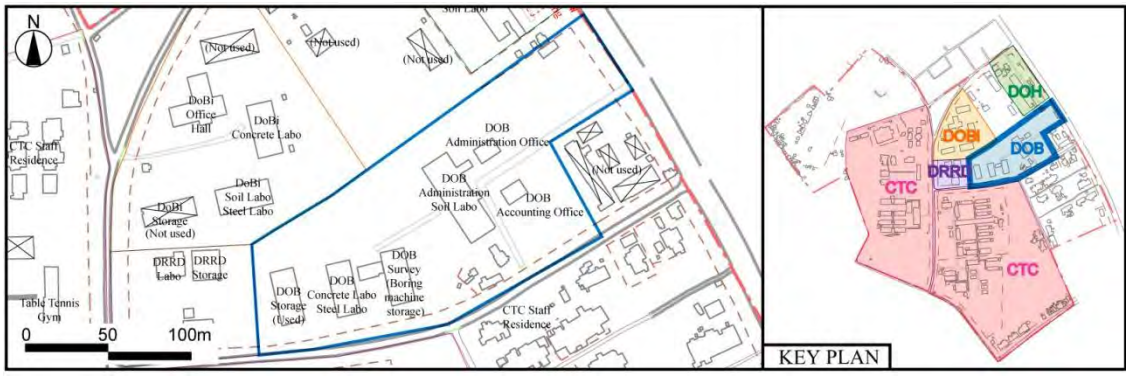
- To conduct soil quality surveys and tests of bridges, retaining walls and buildings planned by the five departments of MOC
- To establish a construction quality control team and conduct on-site concrete and material quality control, for bridge quality control; and

- To conduct Non-Destructive Test (NDT), loading test, and cable tensile test on cable-stayed bridges. (All cable-stayed bridges are inspected once a year.)

The difference between the sand and coarse aggregate research and testing laboratory in the DOB and DOH is that DOB carries out deep soil surveys, while DOH carries out shallow soil surveys. However, both departments share the same equipment for testing.

2.1.3.2 Situation of Existing Buildings

The YQCS facilities are roughly divided into administration office; concrete and steel research and testing laboratory; sand and aggregate research and testing laboratory; and soil survey laboratory.



Source: JICA survey team

Figure 2-20 Yangon Quality Control Section (YQCS) Layout Drawing

(1) Administration Office

The administration office is comprised of management and accounting office in the sand and coarse aggregate research and testing building as well as in a separate building. Located in the sand and coarse aggregate research and testing building are the office of the Director General, office of the Deputy Director General-cum-general staff (6 computers), and computer room-cum-staff office (10 people). The separate building consists of management and accounting office.

	
Office for Director General, Office for Deputy Director General-cum-general Staff	Accounting Office (separate building)

Source: JICA Study Team

Figure 2-21 Situation of YQCS Management Office

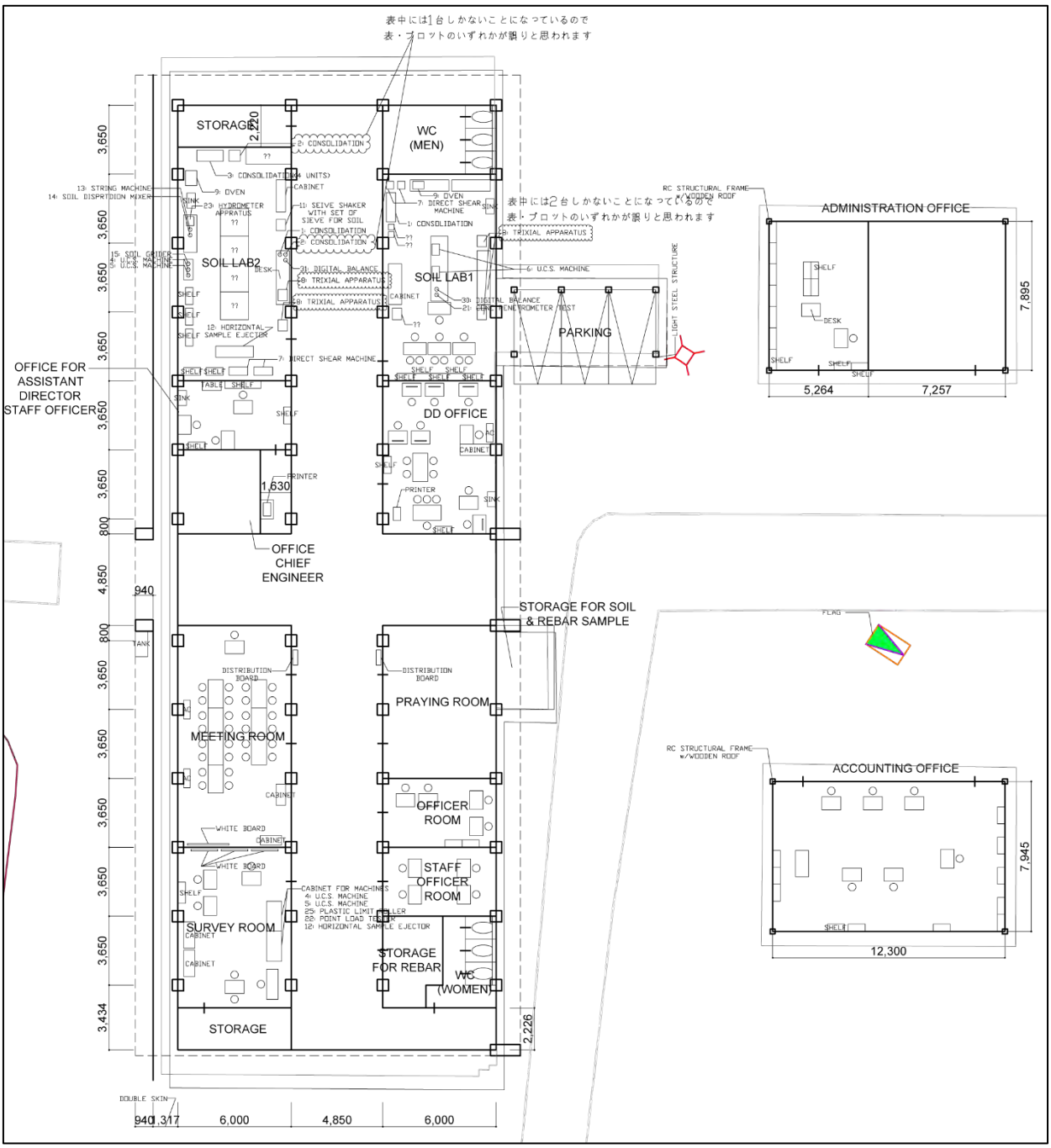
(2) Sand and Aggregate Research and Testing Laboratory

Located in the sand and aggregate testing building is the administration management office. This includes the Director General's office, Deputy Director General's office, a meeting room, a computer room, as well as two sand and aggregate testing laboratories and bridge testing laboratories including testing equipment storage. Two groups are made, and testing are conducted separately for each project. The sand and aggregate testing includes 7 tests which are (1) moisture content test; (2) grain size test; (3) confined compressive strength test; (4) Atterberg limit test; (5) direct shear test or triaxial test; (6) density test; and (7) consolidation test. According to MOC guidelines, the sample used in testing should be kept in the facilities for 1 year, and test result documents should be kept for 3 to 5 years. Ten projects are carried out monthly. The samples sent in from the sites to the laboratory are put inside a single tube pipe of nearly a meter long. Before the water evaporates, the samples must be extruded from the pipe and cut into pieces of 2-inch diameter and 1 foot in height.

	
Testing Laboratory	Sand and Aggregate Samples

Source: JICA Study Team

Figure 2-22 Situation of YQCS Sand and Aggregate Testing Building



Source: JICA Study Team

Figure 2-23 Survey Drawing of Existing Buildings of YQCS Sand and Aggregate Testing and Administration Office Facilities

Table 2-10 Area of Each Room in YQCS Facilities

Room Name	Area (m2)
Laboratory	
Steel	29
Concrete Laboratory (Including curing tank area)	158
Soil Laboratory	140
Survey room	64
Office	
Director's room	-
Deputy Director and staff's room	49
Assistant Director and staff's room	22
Chief Engineer's office	27
Officer room	44
Administration Office	99
Accountant Office	98
Concrete Lab Senior Assistant Engineer	29
Concrete Lab1 office staff room	29
Concrete Lab2 office staff room	29
Soil office	
Staff room (Inside Drilling machine storage)	31
Storage	
Common Storage (Next to soil lab)	13
Common Storage (Rebar)	15
Common Storage (Material)	120
Drilling Machine Storage	187
Concrete Lab Storage	57
Others	
Meeting room	71
Printing room (Inside Drilling machine storage)	31
Toilet	36
Praying room	49
Corridor (main building)	314
Corridor (Inside Drilling machine storage)	28
Corridor (Inside Concrete lab)	45
Total	**1,814**

Source: JICA Study Team

(3) Concrete and Steel Research and Testing Laboratory

The concrete and steel research and testing laboratory building is comprised of concrete testing laboratory and steel testing laboratory. There is also one room each for equipment storage and material storage.

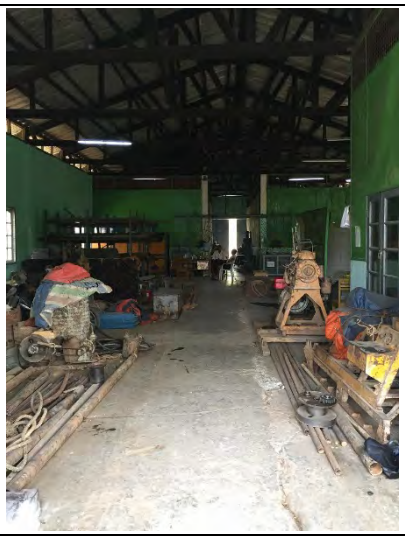
	
Concrete Testing Laboratory	Steel Testing Laboratory

Source: JICA Study Team

Figure 2-24 Situation of YQCS Concrete and Steel Research and Testing Laboratory Facilities

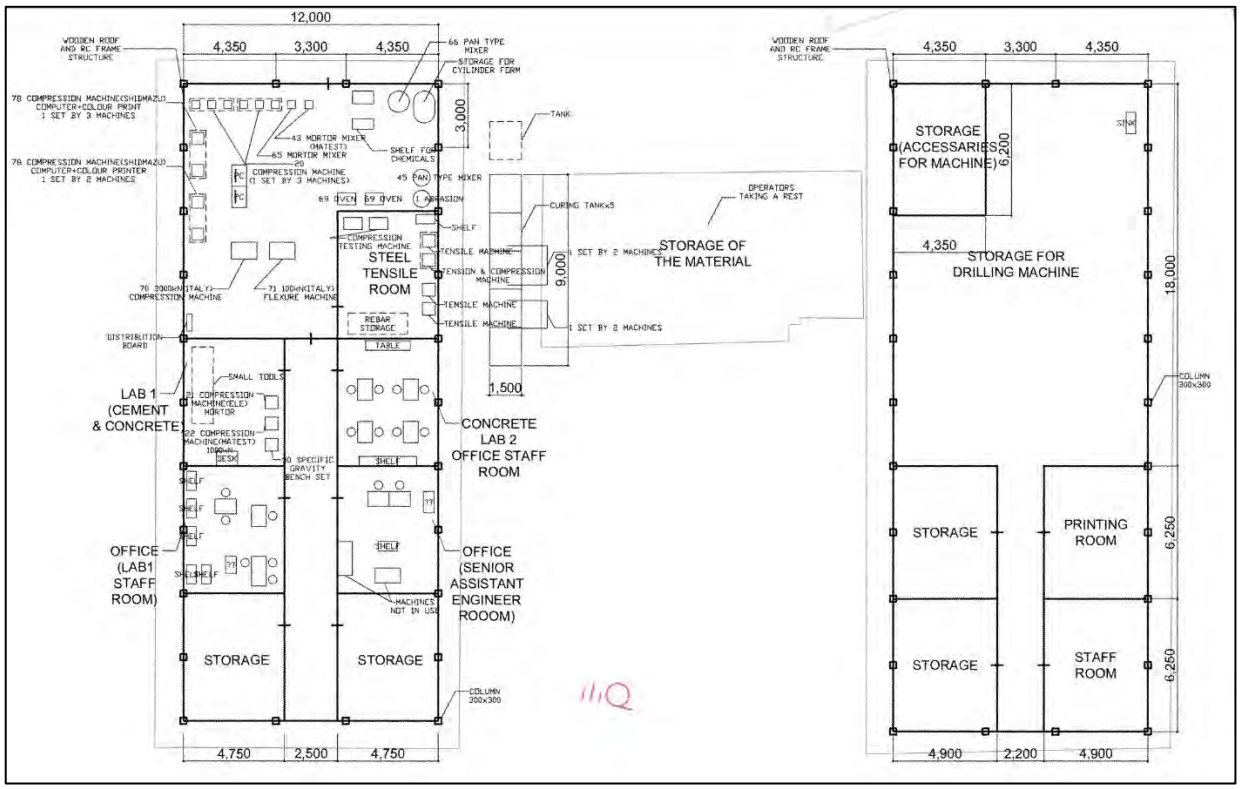
(4) Soil Testing Laboratory Building

In the soil testing laboratory building, 17 boring machines are stored, while the remaining electronic equipment are stored in the bridge testing laboratory (testing equipment storage) inside the sand and aggregate testing building. The building entrance is made large for ease of entry and exit of boring machines. In the bridge testing laboratory inside the sand and aggregate testing building, a few number of electronic testing equipment are stored.

	
Soil Testing Laboratory Building	Boring Machine
	
Bridge Testing Laboratory (sand and aggregate testing building)	Electronic Testing Equipment

Source: JICA Study Team

Figure 2-25 Situation of YQCS Testing Laboratory Building



Source: JICA Study Team

Figure 2-26 Survey Drawing of Existing YQCS Concrete and Steel Research and Testing Building and Testing Laboratory Building

2.1.3.3 Situation of Existing Equipment

The DOB undertakes the measurement of the settlement characteristics of the supporting ground and soil bearing characteristics. It also conducts underground exploration by core drilling and collects and examines the sample soil to facilitate evaluation for appropriate and economical designs. Furthermore, the department performs quality control of the concrete and the field quality control team combines materials of the concrete of the bridge under construction during investigation. As part of bridge maintenance in operation, the department performs a Non-Destructive Test, a load examination and the strain measurement of the cable of cable-stayed bridge.

From 2015 to 2017, the department has procured equipment for inspecting bridges in operation and most of equipment of approximately 90 items for the concrete test during the past five years. The department has secured budget from the annual development budget, and recruited machine parts, and ten more several items such as compressive testing equipment and load cell and spare parts through the assistance of ADB and JICA. The soil testing equipment has also been procured within the past five years.

In the latter years, the background where equipment procurement was carried out depended on the testing standard of the country concerned, having switched over from BS to ASTM. The equipment products made in United States and Italy have been mainly introduced in substitutes for equipment products made in the U.K. The following table shows the main equipment items in existence.

The major equipment items of the Department of Bridge are shown in Table 2-11 below:

Table 2-11 Main Equipment Items Owned by the Department of Bridge

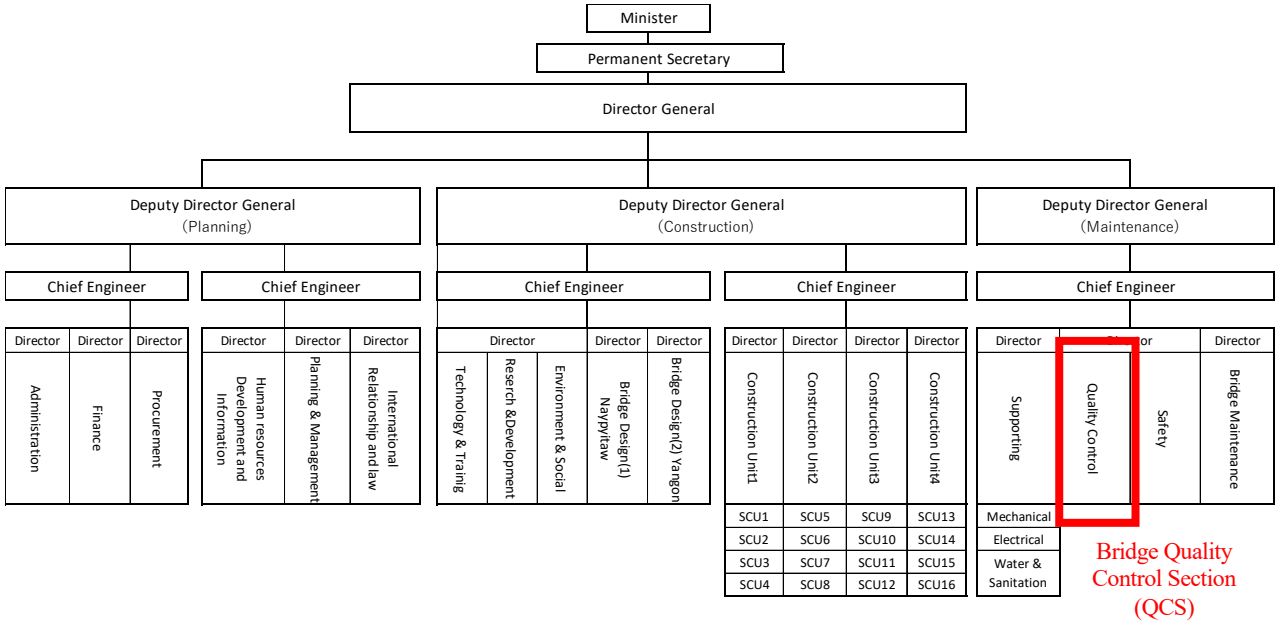
No.	Testing Room	Testing Material	Major Items
1	Rebar	Steel	Tensile Machine, Tensile Machine with Extensometer and so on
2	Non-destructive Test (NDT)	Survey of Completed Bridges	NDT Machine (Profoscope, Pundit Ultrasonic Pulse Velocity, Endoscopic and so on
3	Soil testing	Soil (Core sample)	Consolidation, Direct Shear Machine, Triaxial Apparatus so on
4	Concrete Testing	Cement, Aggregates, and Concrete	Los Angeles Abrasion machine, Sieve Shaker, Concrete Mixer, Compressive Machine and so on

Source: JICA Study Team

2.1.3.4 Organization and Staff

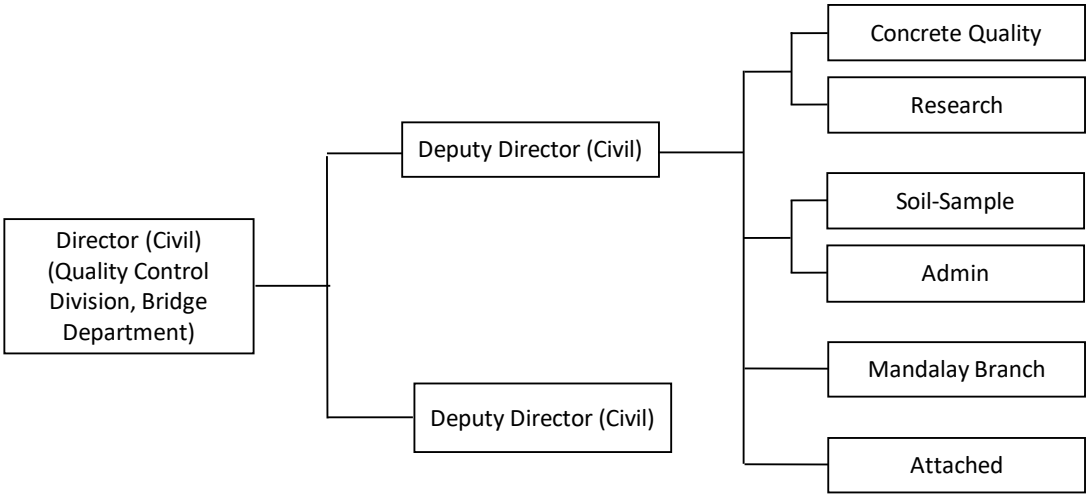
The Department of Bridge (DOB) is headed by the Director General (DG) and is made up of three divisions under the office of the Deputy Director Generals (DDG): Planning, Construction, and Maintenance. The staff body includes 352 official staff (staff officer and above) and 1,578 general staff.

As of April 2019, there are 60 staff members working in Thuwunna. Among them are 10 MOC staff members and 50 other non-regular workers (e.g. testing assistant, accountant, security guard, etc.).



Source: Needs Survey on Enforcement of CTC Function (Technical Assistance) Summary Report, March 2018

Figure 2-27 DOB Organizational Chart



Source: Needs Survey on Enforcement of CTC Function (Technical Assistance) Summary Report, March 2018

Figure 2-28 QCD Organizational Chart

Table 2-12 YQCD Staff Composition

Department	Position	Number of People							Total
		General	Concrete / Cement Test	Soil Test	QC at field	Re-bar Test	Research Inspection	Design	
DOB			✔	✔	✔	✔	✔		
	Deputy Director General	1							1
	Director	1							1
	Deputy Director	1							1
	Assistant Director	3							3
	Staff Officer	4							4
	Junior Engineer	4							4
	Research Assistant	6							6
	Laboratory Technician	0	1	13	3	0	0		17
	Accountant	4							4
	Typist	3							3
	Gurd	3							3
	Clerk	2							2
	Lower Division Clerk	0	1	1	2	1	1		6
	Worker	0	1	1	0	0	0		2
	Helper	0	0	3	0	0	0		3
								TOTAL	60

Source: JICA Study Team

2.1.4 Current Situation of DOBi Research Laboratory

The Department of Building (DOBi) performs design, construction and maintenance of public buildings owned by the ministries such as hospitals, schools and government offices (including local government offices). The central design department is in charge of design, and the construction department is responsible for construction and maintenance.

The Building Research Laboratory (BiRL), which is under the umbrella of the Design, Estimate and Research Department of DOBi, was established in 1968 in Yankin Township (Yangon) as the Office of Building Research. In 1987, Researches and Quality Control of Building was constructed in Thuwunna. In November 2014, the building was renamed Building Research Laboratory (BiRL).

2.1.4.1 Function, Role and Research Activities and Laboratory Tests

BiRL conduct supervision, confirmation and evaluation of building materials quality as indicated in the special specifications. The department has the following responsibilities:

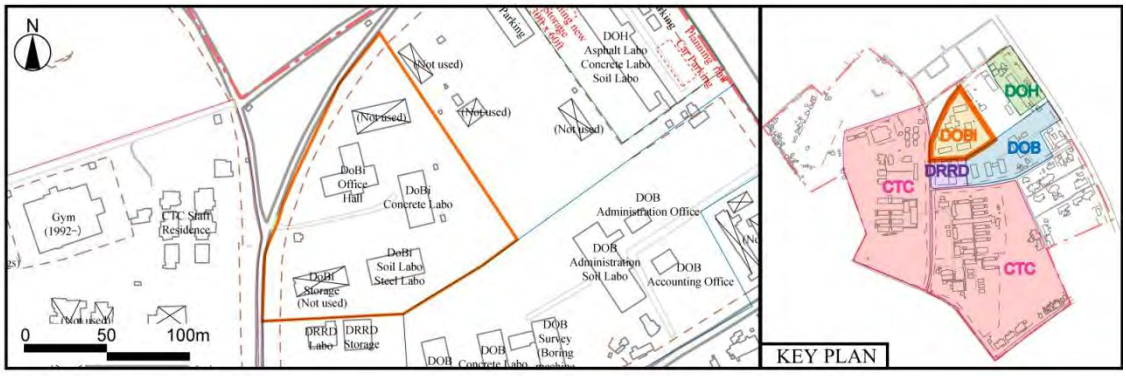
- Building of materials testing
- Formation and dispatch of quality control teams
- Quality inspection of concrete and rebar

In order to achieve the above responsibilities, DOBi specifically conducts the following activities:

- Physical properties testing of building materials such as cement, crushed stone, bricks, and deformed rebar
- Concrete mix design and concrete compressive strength test
- Supervision and management of concrete quality control at construction sites
- On-site inspection of deformed rebar structures according to the special specifications
- On-site inspection of building materials according to the design and the special specifications

- Concrete testing of existing buildings (non-destructive structure testing (UPV, Rebound) and destructive testing (core drill machine testing))
- Inspection of quantity and positioning of rebar and steel frames in existing buildings

2.1.4.2 Situation of Existing Buildings



Source: JICA Study Team

Figure 2-29 BiRL Research and Testing Laboratory Layout Drawing

(1) Administration Office

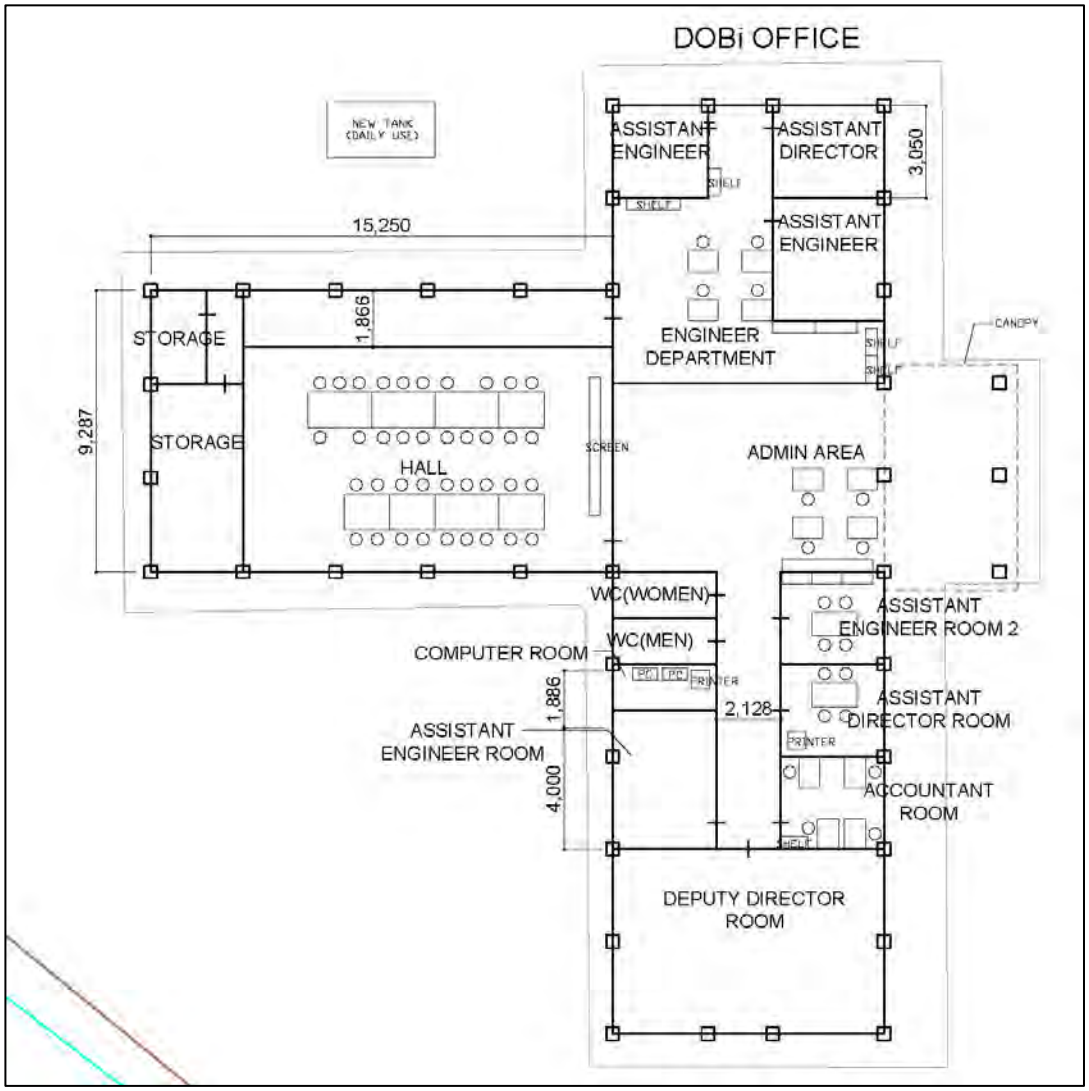
The administration office building is comprised of Deputy Director General's office, head of assistant office, management office, accounting office, management staff area, engineer room and meeting room.

Engineer Room

Meeting Room

Source: JICA Study Team

Figure 2-30 Situation of BiRL Administration Office Facilities



Source: JICA Study Team

Figure 2-31 Survey Drawing of Existing Building of BiRL Research and Testing Facilities (Administration Office)

Table 2-13 Area of Each Room in BiRL Facilities

Room Name	Area (m2)
Laboratory	
Concrete Laboratory	324
Soil Laboratory	110
Steel Laboratory	147
Office	
Director's room	-
Deputy Director's room	55
Assistant Director's room 1	10
Assistant Director's room 2	11
Assistant Engineer's room 1	16
Assistant Engineer's room 2	10
Assistant Engineer's room 3	15
Assistant Engineer's room 4	10
Engineer Department	46
Administration area	21
Accountant Office	10
Computer Room	5
Concrete Laboratory office (+control room)	46
Soil Laboratory office	-
Steel Laboratory office	-
Quality Control office	38
Storage	
Machine storage (In Soil and Steel Lab)	68
Storage (Not used)	-
Others	
Meeting room	91
Toilet	10
Corridor (Office)	77
Total	**1,120**

Source: JICA Study Team

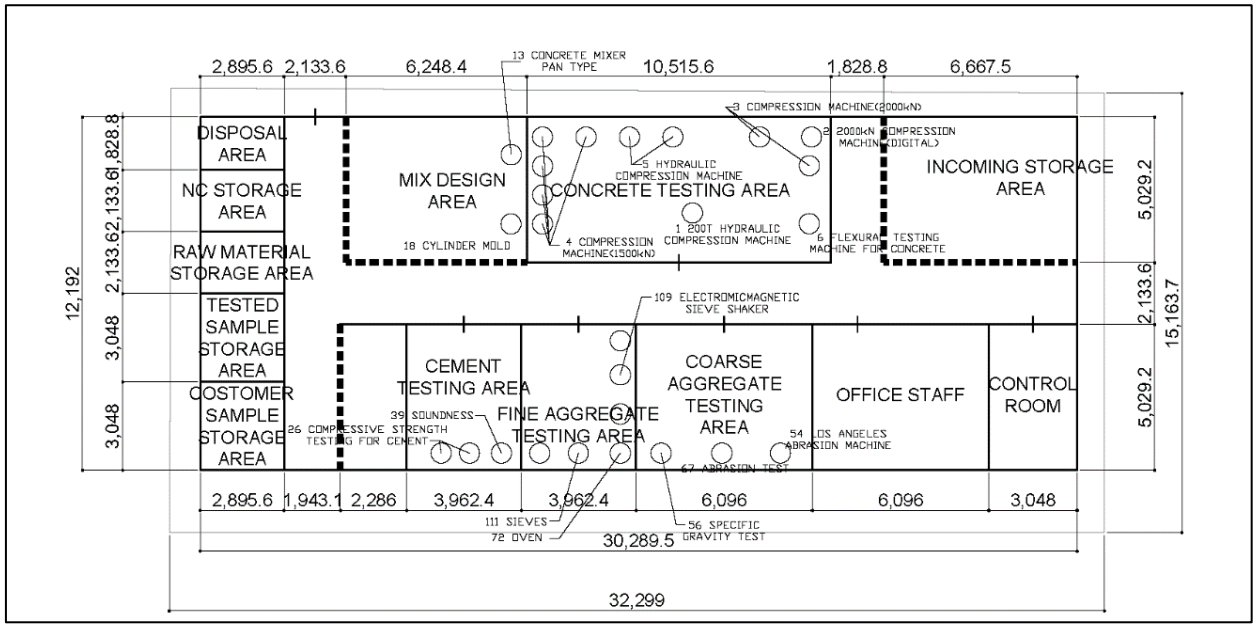
(2) Concrete Research and Testing Laboratory

The concrete research and testing laboratory building was renovated in order to obtain ISO17025 certification. The building consists of mixing laboratory, concrete compression testing laboratory, materials (cement, sand, and aggregate) testing laboratory, office, control room (document storage), sample storage and sample reception desk. The building is inspected for ISO certification on May 19, 2019.

	
Overlook View from Sample Reception Counter to All Other Rooms	Material Examination Room

Source: JICA Study Team

Figure 2-32 Situation of BiRL Concrete Laboratory Facilities



Source: JICA Study Team

Figure 2-33 Survey Drawing of Existing Building of BiRL Research and Testing Facilities

(3) Sand and Aggregate Research and Testing Laboratory

Since there are many private companies in the building sector, there has not been much work in DOBi's sand and aggregate research and testing laboratory. The private companies carry out researches for renovation projects of MOC buildings. There is a quality control office which is used only for one or two months a year.

	
Laboratory	Storage for Tested Deep Soil Sample

Source: JICA Study Team

Figure 2-34 Situation of BiRL Steel and Soil Laboratory Facilities

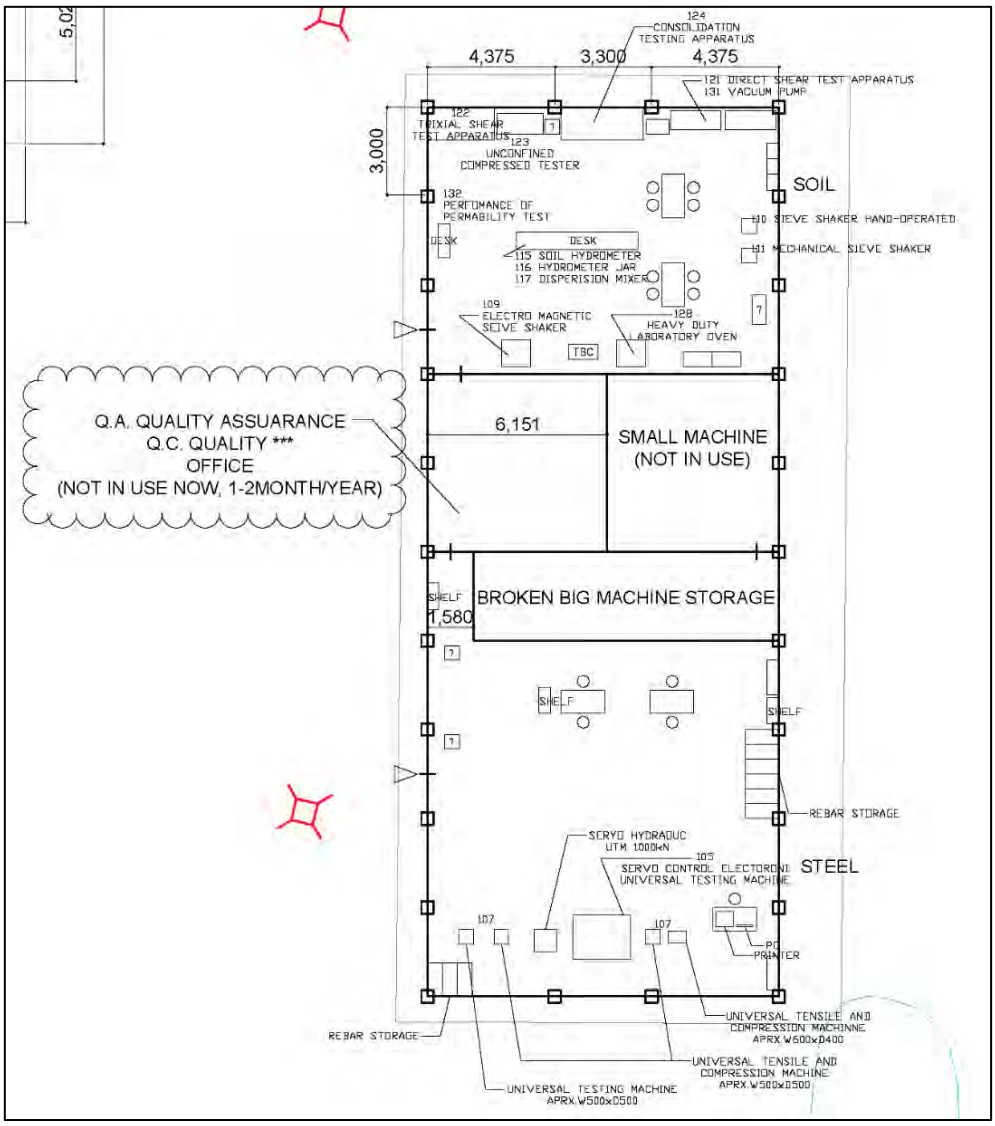
(4) Steel Research and Testing Laboratory

The steel research and testing laboratory conducts a maximum of 21 tests daily.

	
Laboratory	Storage for Tested Steel Sample

Source: JICA Study Team

Figure 2-35 Situation of BiRL Steel Laboratory Facilities



Source: JICA Study Team

Figure 2-36 Survey Drawing of Existing Building of BiRL Research and Testing Facilities (Sand and Aggregate Testing Laboratory, Steel and Soil Testing Laboratory)

2.1.4.3 Situation of Existing Equipment

DOBi has procured testing machines and parts such as compressive machines and load cells in cooperation with ADB and JICA, because the testing specifications have shifted from BS to ASTM similar to other departments. Since DOBi is still in transition period, there are BS testing machines in existence which are still being used continuously. The department has implemented modifications of the facility as well as procurement of testing equipment. It has been accredited as an ISO-certified research and testing facility and has been ahead of other departments in recent years. The major equipment items are as shown in Table 2-14 below:

Table 2-14 Main Equipment Items Owned by the Department of Building

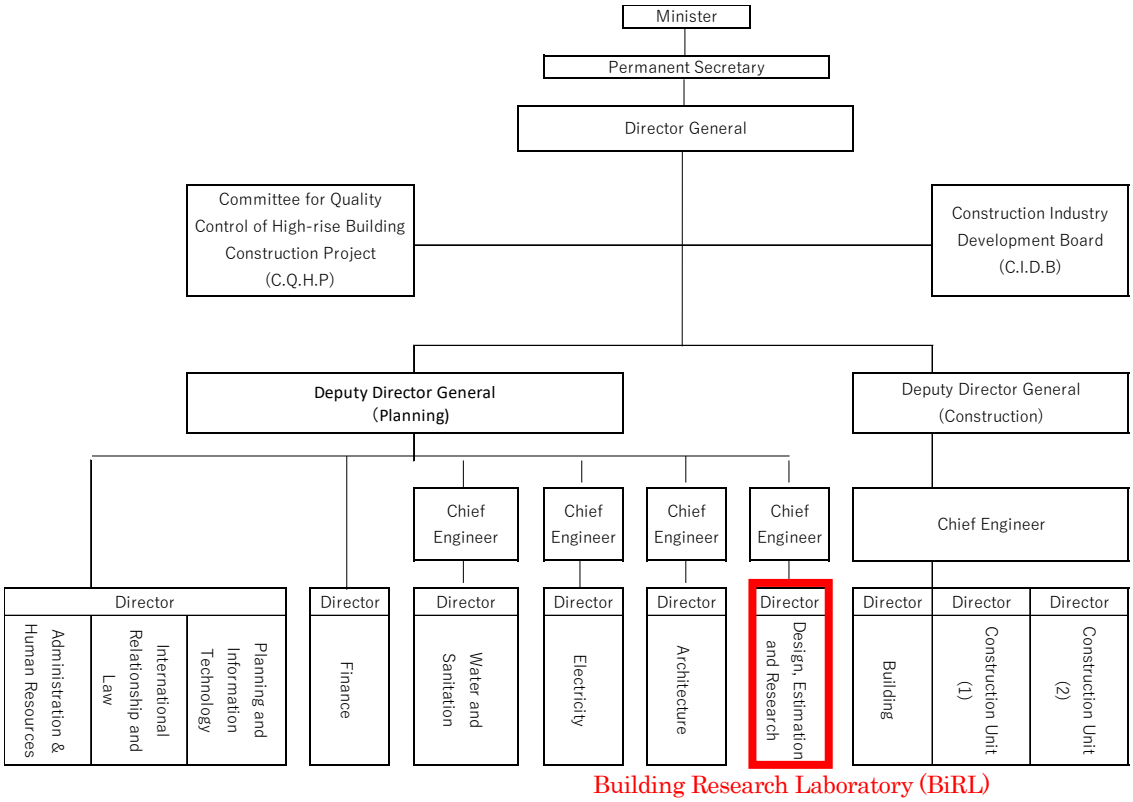
No.	Testing Room	Testing Material	Major Equipment
1	Concrete test	Coarse and fine aggregates, Cement, Concrete, and bricks	Los Angeles abrasion machine, Concrete mixer, Compressive machines and so on
2	Soil test	Soil (Core sample)	Core Drilling Machine, Direct shear strength machine and so on
3	Re-bar test	Deformed bars	Tensile testing machine, Compression /Bending machine and so on
4	Non-destructive Test (NDT)	Survey of existing buildings	Ultrasonic Pulse Echo, Pundit Ultrasonic Pulse Velocity, Profoscope and so on

Source: JICA Study Team

2.1.4.4 Organization and Staff

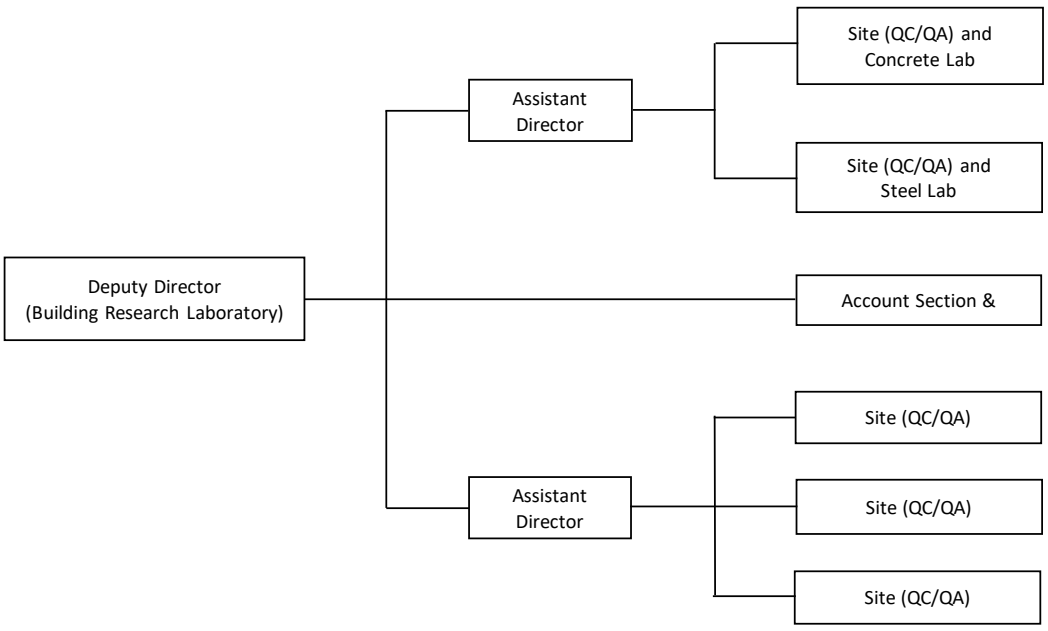
The staff body of the DOBi includes 286 official staff (staff officer and above) and 2,286 other staff members. DOBi is in charge of the design, construction, and maintenance of public buildings, while local authorities are responsible for construction permit of private buildings. The committee of Myanmar Engineering Society (MES) takes care of the quality control of high-rise buildings.

The BiRL belongs to the Design, Estimate and Research Department and employs 25 staff as of April 2019. The number of staff members includes 8 MOC staff and other 17 non-regular workers (e.g. junior engineer, accountant, typist, etc.).



Source: Needs Survey on Enforcement of CTC Function (Technical Assistance) Summary Report, March 2018

Figure 2-37 DOBi Organizational Chart



Source: Needs Survey on Enforcement of CTC Function (Technical Assistance) Summary Report, March 2018

Figure 2-38 BiRL Organizational Chart

Table 2-15 BiRL Staff Composition

Department	Position	Number of People							Total
		General	Concrete / Cement Test	Soil Test	Asphalt Test	Re-bar Test	Program	Quality	
DOBi			✔	✔		✔	✔	✔	
	Deputy Director General	0							0
	Director	0							0
	Deputy Director	1							1
	Assistant Director	2							2
	Staff Officer	0	1	1		1	1	1	5
	Junior Engineer	0	5	1		2	2	2	12
	Accountant	3							3
	Typist	2							2
								TOTAL	**25**

Source: JICA Study Team

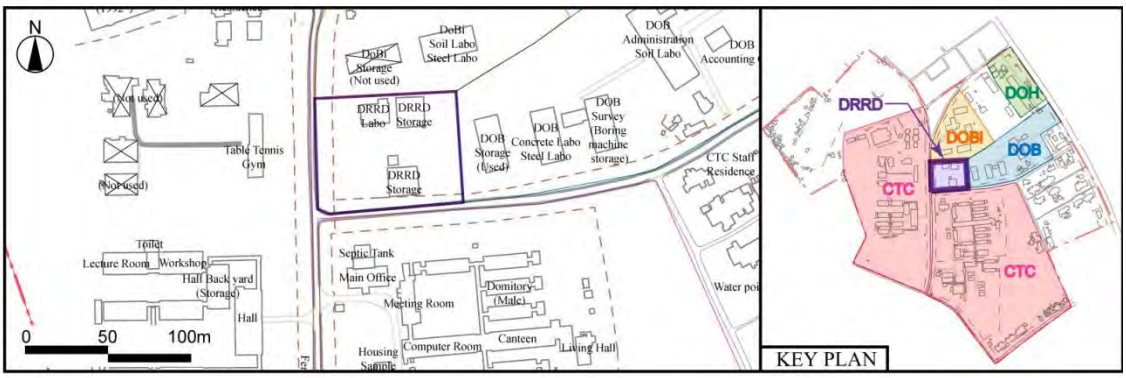
2.1.5 Current Situation of DRRD Research Laboratory

The Department of Rural Road Development (DRRD) was established in August 2017 when the road and bridge division was transferred from the Department of Rural Development (DRD) under the Ministry of Agriculture, Livestock and Irrigation (MOALI) to MOC.

2.1.5.1 Function, Role and Research Activities and Laboratory Tests

The main activities of DRRD include material testing and soil testing of aggregate, cement and concrete materials for the purpose of quality control of local paved roads. The department recently became independent from the DOH and has procured basic testing equipment using the annual development budget. However, it is difficult to say that the facilities are sufficiently equipped with on-site survey equipment. The department is planning to equip the facilities with sufficient equipment in consideration of the requirements specified in ASTM test specifications.

2.1.5.2 Situation of Existing Buildings



Source: JICA Study Team

Figure 2-39 DRRD Research and Testing Laboratory Layout Drawing

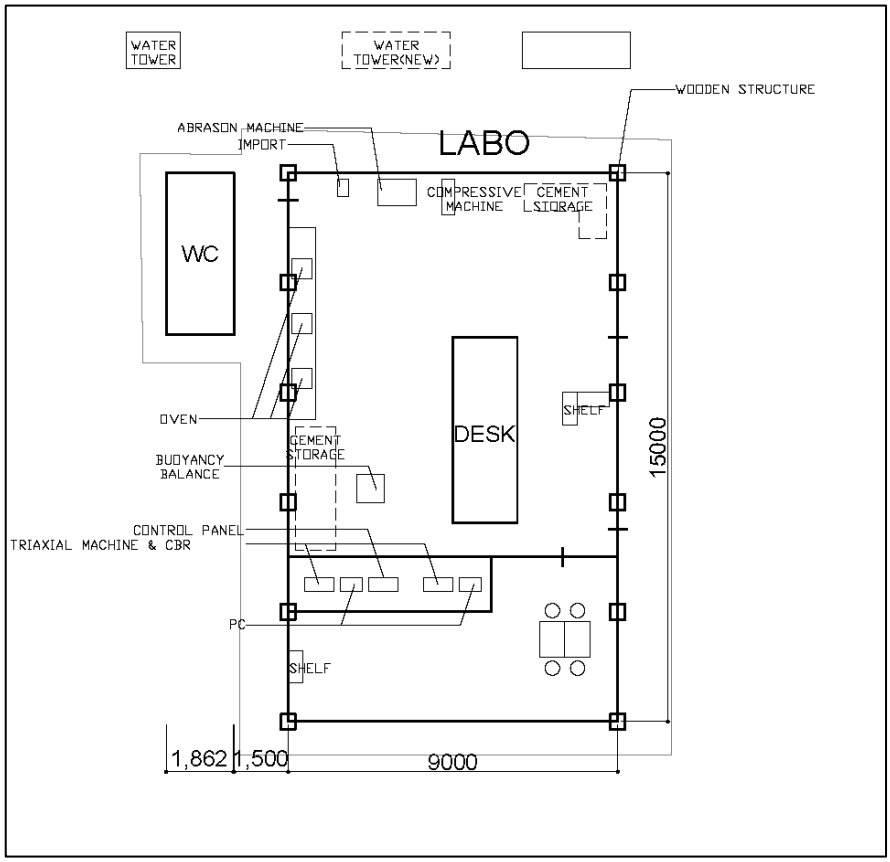
(1) Research Building

DRRD research building conducts concrete testing, sand and aggregate testing, and rebar testing.

	
Meeting room Doubled as Laboratory	Testing Table

Source: JICA Study Team

Figure 2-40 Situation of the Facilities



Source: JICA Study Team

Figure 2-41 Survey Drawing of Existing Building of DRRD Research and Testing Facilities

Table 2-16 Area of Each Room in DRRD Facilities

Room Name	Area (m2)
Concrete and Soil Lab	98
Office	42
Storage (Under construction)	230
Storage (Not using)	-
Toilet	8
Total	**378**

Source: JICA Study Team

2.1.5.3 Situation of Existing Equipment

The following table shows the main equipment items in existence.

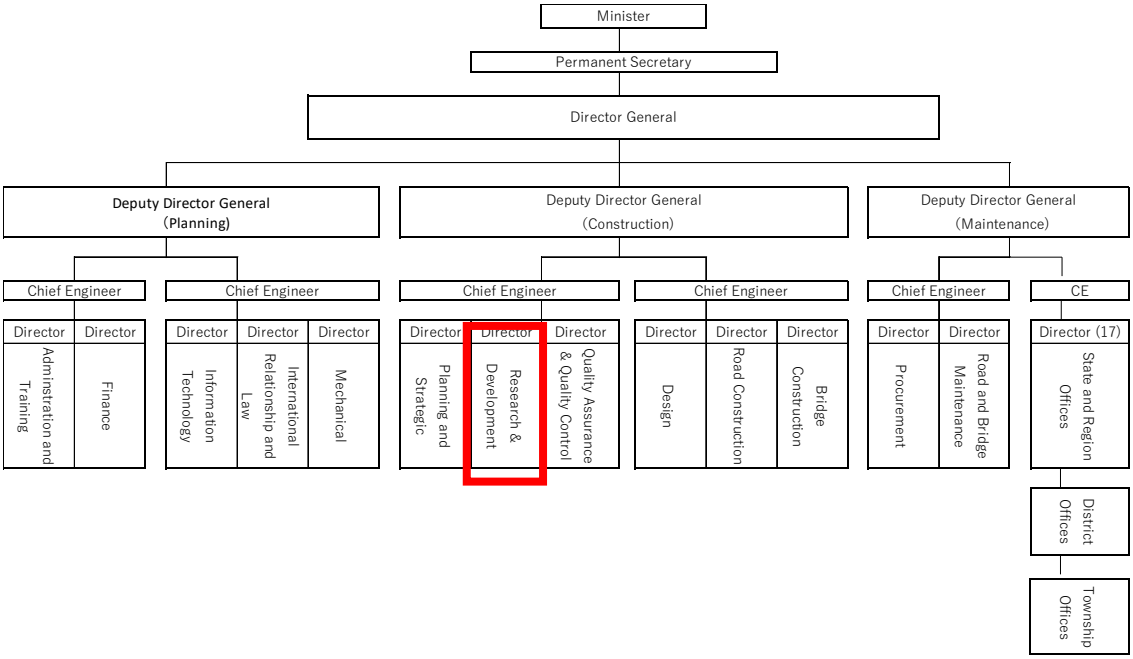
Table 2-17 Main Equipment Items Owned by the Department of Rural Road Development

No.	Testing Room	Testing Material	Major Equipment
1	Concrete Test	Aggregates, Cement and Concrete	Los Angeles Abrasion Machine, Concrete Mixer, and Compressive machine and so on
2	Soil Test	Soil	CBR Machine, Triaxial Testing Machine and so on

Note: Please refer to Appendix-1. Existing Equipment attached to the end of this report, for the details regarding the existing equipment and its current status.
Source: JICA Study Team

2.1.5.4 Organization and Staff

The number of staff employed in DRRD includes 563 official staff (above staff officer) and 2,437 other staff. As of April 2019, the number of staff employed in DRRD of Thuwunna is 12 people. They consist of 2 MOC staff and 10 other non-regular workers (e.g. junior engineer, assistant engineer, accountant, etc.).



Source: Needs Survey on Enforcement of CTC Function (Technical Assistance) Summary Report, March 2018

Figure 2-42 DRRD Organizational Chart

Table 2-18 DRRD (Thuwunna) Staff Composition

Department	Position	Number of People							Total
		General	Concrete / Cement Test	Soil Test	Asphalt Test	Re-bar Test	Research Inspection	Design	
DRRD			✔	✔					
	Chief Enginer	1							1
	Director	1							1
	Junior Engineer	2							2
	Assistant Junior Engineer	6							6
	Accountant	1							1
	Gurd	1							1
								TOTAL	12

Source: JICA Study Team

2.2 Current Infrastructure Surrounding the Project Site

2.2.1 Water Supply

The city water main pipe managed by YCDC (Yangon City Development Committee) is laid under the road traversing south to north of the Project site. However, the amount of current water source is mostly well water lifted from two boreholes which are located at the south-east corner of the CTC compound. The well water lifted from No.1 and No.2 boreholes is treated by a primitive gravel filtration system with no chlorine sterilization and is stored in a concrete underground tank. The treated water is distributed by pumps to each elevated tank which is located next to toilet huts. The toilets and other taps are supplied with water by gravity. Only the DOBi is fed in with the main city water.

(1) Existing Boreholes

The specifications of the existing borehole are shown below;

No.1 Borehole：	
Casing diameter：150mmφ Casing depth 550 feet (165m) Lift up pipe：75mmφ Depth 185feet (55m)	Deep well pump; 3HP
No.2 Borehole ：Same as No.1	
Casing diameter：150mmφ Casing depth 550 feet (165m) Lift up pipe：75mmφ Depth 185feet (55m)	Deep well pump; 3HP

(2) Water Quality of Yangon City Water and Well Water

The results of water quality test in August in 2018 conducted by a certified inspection institute are shown below:

Table 2-19 Water Quality Test Result of City Water and Well Water (August 2018)

Water quality index	City water	Borehole No.1	Borehole No.2	WHO drinking water standards (Geneva-1993)
PH	7.3	6.7	6.3	6.5 – 8.5
Color	Nil TCU	60 TCU	80 TCU	15TCU
Turbidity	2 NTU	96 NTU	110 NTU	5NTU
Conductivity	372 mS/cm	1317 mS/cm	3639mS/cm	
Total Hardness	78 mg/l as $CaCO_3$	408 mg/l as $CaCO_3$	1270 mg/l as $CaCO_3$	500 mg/l as CaCO3
Magnesium Hardness	54 mg/l as CaCO3	134 mg/l as $CaCO_3$	422 mg/l as $CaCO_3$	
Iron	0.24 mg/l	5.1 mg/l	6.9 mg/l	0.3 mg/l
Chloride	66 mg/l	355 mg/l	1250 mg/l	250 mg/l
Sulphate as SO_4	20 mg/l	88 mg/l	186 mg/l	500 mg/l
Total Solids	189 mg/l	768 mg/l	1944 mg/l	1500 mg/l
Dissolved Solids	186 mg/l	659 mg/l	1821 mg/l	1000 mg/l
Manganese	Nil mg/l	0.02 mg/l	0.05 mg/l	0.05 mg/l

Source: JICA Study Team

Every index of Yangon city water sufficiently meets WHO drinking water standards according to the result of water quality test. Meanwhile, the well water substantially exceeds some index of

WHO standards such as Color, Turbidity, Total Hardness, Iron and Chloride. The well water is treated by a primitive gravel filtration system and distributed to elevated tanks scattered in the CTC compound by supply pumps. The day water consumption of the CTC is unclear because the existing water meter is out of order.

	
No.1 Borehole and Water Meter (Broken)	Primitive Gravel Filtration System

Source: JICA Study Team

Figure 2-43 Situation of Water Supply

Elevated Tank Beside the Filtration System

Source: JICA Study Team

Figure 2-44 Situation of Elevated Tank

2.2.2 Waste Water Drainage and Sewer

No main city sewer surrounding the Project site is available. Thus, wastewater drain and sewer from toilet and wash rooms in each building is collected by waste drainage pipe and currently drained outside the building through septic tanks located in nearby toilets, and treated water by septic tank is infiltrated into the ground through soaked well.

2.2.3 Power Supply

Currently, two medium voltage power lines of 11 kV, 3-phase, 3 –wire system are taken into the site of the existing Thuwunna CTC from the 11 kV overhead high tension distribution line supplied around the site by Yangon Electricity Supply Cooperation (hereinafter referred to as "YESC") which is affiliated with the Ministry of Electricity and Energy (hereinafter referred to as "MOEE"). Tapped power service lines are connected to the indoor cubicle type switchboard equipment provided in the Substation Room. Low voltage power of 380/220V, 3-phase, 4-wire system stepped down with the transformers provided in the cubicle will be distributed to each building on site.

- No.1 Substation (Construction Year: Unclear)

  Serving for CTC, Department of Bridge, Regional Road and staff housing
  Transformer capacity: 11KV/380V/220V 3 Phase 4 Wires 315KVA
  Low voltage primary breaker: 1000A 4P

- No.2 Substation (Construction Year: Unclear but relatively new)

  Serving for Department of Highway
  Transformer capacity: 11KV/380V/220V 3 Phase 4 Wires 315KVA
  Low voltage primary breaker: 1000A 4P

Low voltage power distribution systems are as follows:

- Main Feeder Line: 380/220 V, 3-phase, 4-wire
- Earthing type: TTS
- Feeder for lighting and receptacles: 220 V, single phase, 2-wire
- Power line for motors: 380 V, 3-phase, 3-wire

Table 2-20 No.1 Substation: Low Voltage Power Feeders and Breaker Size

Feeders	Main breaker (A)	Size of power feeder	Remarks
Department of Bridge and Building (DOB, DOBi)	4P250A	Unclear	
CTC Staff Housings, East	3P200A	Unclear	
CTC Staff Housings, West	3P200A	Unclear	
CTC	3P160A	Unclear	Via AVR 200KVA

Source: JICA Study Team

	
	Transformer (315KVA)
	
High Tension Service Entrance (CTC and others)	Autmatic Voltage Regulator (AVR)

Source: JICA Study Team

Figure 2-45 No.1 Substation Serving for CTC and Others

	
High Tension Service Entrance and Transformer of 315KVA (for DOH)	High Tension Receiving Panel and Metering Panel (for DOH)

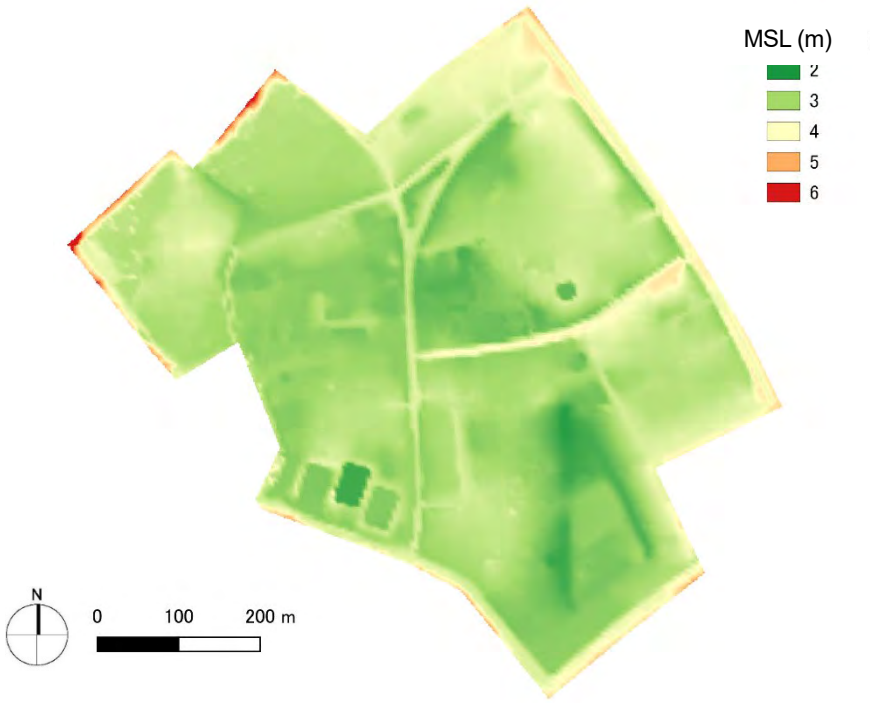
Source: JICA Study Team

Figure 2-46 No.1 No.2 Substation Serving for the Department of Highways

2.3 Natural Conditions

2.3.1 Geographical Features

Topographical survey was conducted during the field survey. The survey report from the subcontractor is attached in Appendix-4. The survey investigated the site boundary lines, ground level of the target site of the Project, locations of existing buildings, locations of major trees, etc. Although the site is having a relatively flat ground level, the lack of drainage systems at some places with low ground level creates ponds. A Digital Terrain Model (DTM) of the site is shown in Figure 2-47 below:



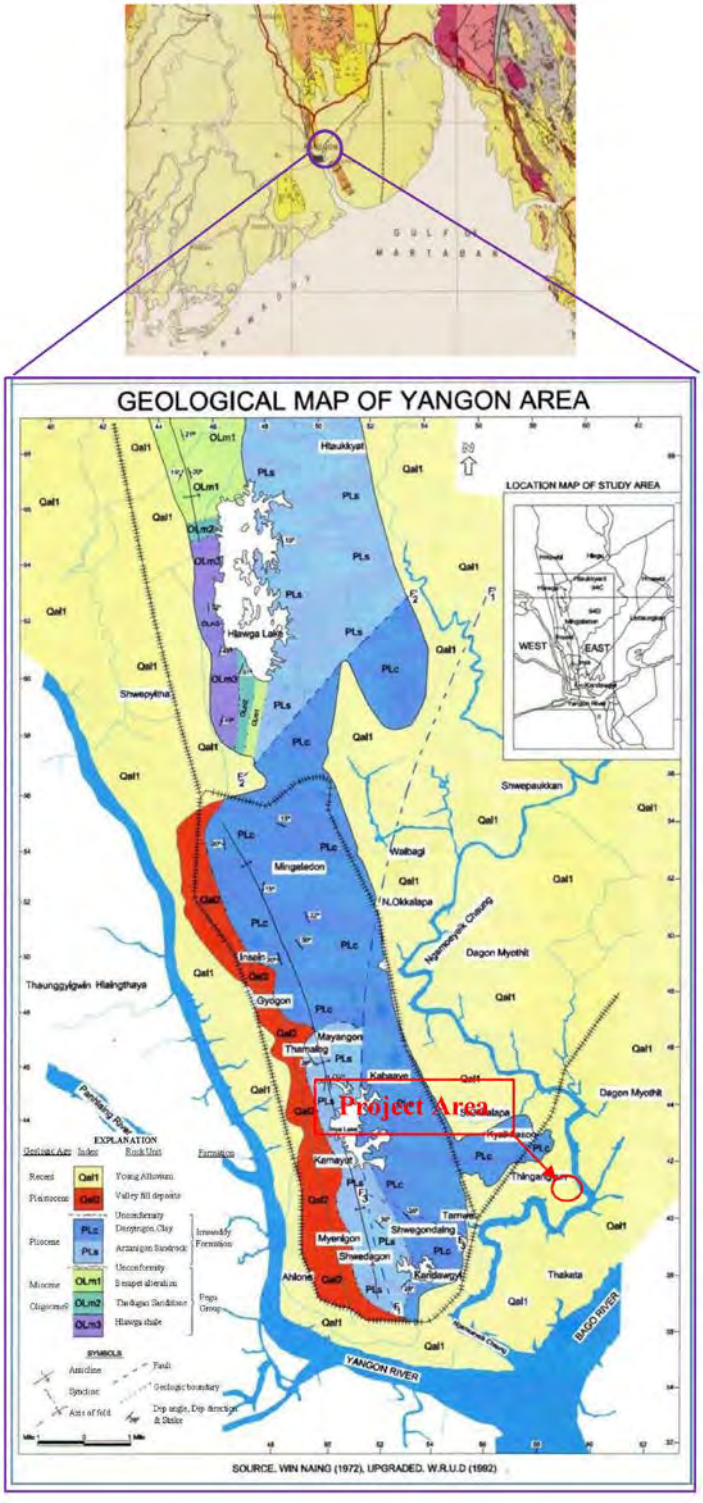
Source: Report on Topographical Survey for the Preparatory Survey for the East-West Economic Corridor Highway Development Project (New Bago-Kyaikto Highway Section) (Data Collection Survey for Thuwunna CTC Project)

Figure 2-47 Digital Terrain Model (DTM)

2.3.2 Geological Features

As the target site of the Project area is located at the western flank of Bago Yoma Range, the original topography of the area is undulated flat low-lying land, small hills and small valleys. The proposed site areas are covered with existing buildings, short grass, small bushes and medium trees. The topography of the project area has been modified several times along with past developments of urbanization of Yangon City. The drainage pattern has also been modified from its original position to urban drain. The survey report from the subcontractor is attached in Appendix-5.

The project site and surrounding area lie on the southwest end of Inner-Burma Tertiary Basin located in the back arc basin. In this basin, the sediments are of Miocene, Oligocene, Eocene and a small amount of Paleocene. The overburden soil layer of the project site is Quaternary Alluvial deposit (Q2). Based on the boring results of soil investigation, the project area is made up of alluvial deposit of CLAY and Silty SAND.



Source: Report on Geological Survey for the Preparatory Survey for the East-West Economic Corridor Highway Development Project (New Bago-Kyaikto Highway Section) (Data Collection Survey for Thuwunna CTC Project)

Figure 2-48 Geological Map of Project Area

(1) Alluvium

The top soil layer is composed of clayey soil layers, and the colors of these layers are brownish gray to gray. The minimum thickness of these clayey soil layers is 6.0m, and the maximum is 14.0m with medium plasticity. A yellowish brown color and a gray color of fine to medium grained sandy soil layer are well observed in this project area.

(2) Irrawaddy Formation

This formation is yellowish fine sandstone or sandrock of the Irrawaddian group. The outcropping areas can be seen in the left bank of Yangon-Thanlyin crossing of Pegu River. It is characterized by loosely cemented sandstone with trace grit.

(3) Pegu Group

This formation is mainly composed of sand and shale interbeds. The outcropping area is found along the anticlinal ridge of the Thanlyin area. The upper part of Peguan sandstone is altered by weathering as reddish brown oxidized lateritic soil.

(4) Geological Structure

In the northeast part of the project site, the anticlinal ridge is located in the Danyin Gone area. In the eastern part of this area, there is a fault called Danyin Gone Fault which is positioned in parallel with the anticline axis.

2.3.3 Metrological Conditions

The target site is located in the southeastern part of Yangon and has tropical monsoon climate. The region has high precipitation and humidity throughout the year, and rainy season spans from May to October. In June to August, the region often takes direct hits from cyclones. In 2008, Cyclone Nargis landed on the southern coast of Myanmar, causing heavy rain, flooding, and strong winds which resulted in the largest damage ever occurred in the country. Dry season spans from November to February, and the hottest time of the year is from March to May.

Yangon's weather data in the past 3 years from 2016 to 2018 is as shown in Table 2-21 below:

Table 2-21 Yangon's Weather Data 2016-2018

Year	Month	Monthly Average Temperature (℃)	Monthly Average Highest Temperature (℃)	Monthly Average Lowest Temperature (℃)	Monthly Rainfall (mm)
2016	1	23.7	31.7	15.7	23
	2	26.6	34.4	18.8	0
	3	29.4	36.7	22.1	0
	4	31.3	38.6	24.1	1
	5	30.7	37.2	24.2	288
	6	27.4	31.6	23.2	379
	7	27.4	31.9	22.9	559
	8	26.9	31.3	22.5	526
	9	27.9	32	23.9	543
	10	28.2	32.4	24	240
	11	28.1	33.4	22.8	1
	12	27.5	33.5	21.4	
2017	1	26.5	33	19.9	1
	2	26.9	34.8	19.6	0
	3	29.2	36.7	21.7	0
	4	30.2	36.1	24.3	81
	5	30.2	35.1	25.2	449
	6	27.7	31.4	24	650
	7	27.4	30	24.8	802
	8	26.9	30.7	23	382
	9	27.7	32.3	23.1	401
	10	27	31.8	22.2	460
	11	27.4	33.1	21.7	125
	12	25	32	18.1	0
2018	1	24.9	32.4	17.3	0
	2		34.4	17.4	0
	3	28.4	36.5	20.4	0
	4				
	5	29.2	35.2	23.2	229
	6	26.3	30.9	21.6	627
	7	25.7	30.1	21.4	796
	8	25.6	30.1	21	579
	9	26.5	31.8	21.2	472
	10	26.7	32.9	20.5	229
	11	26.2	33.7	18.7	66
	12	25.4	33.2	17.6	61

Source: Japan Meteorological Agency, Ministry of Land, Infrastructure, Transport and Tourism (Point-Based Data Graph (World Weather Data Tool))

3. Outline of the Proposed Project

3.1 Outline of the Proposed Project

3.1.1 Objective of the Project

(1) Objectives

MOC plans to establish a new department called "Thuwunna Research Laboratory and Training Department" which will be responsible for all research and laboratory functions, and training functions provided by CTC and 4 Research Laboratories under DOH, DOB, DOBi and DRRD. The name of the target facility for this project is currently under consideration in the MOC, and the new facility is tentatively named "Thuwunna Research Laboratory and Training Center (Thuwunna RLTC)." This project aims to strengthen high quality human resource development and quality control in the construction sector in Myanmar, and the center will have a research and development functions in the future.

In consideration of the abovementioned plan, this project aims to strengthen the functions of Thuwunna RLTC by reconstructing the Training Facility and Research Laboratories, Hostels and procuring the necessary training and laboratory equipment for these facilities.

(2) Function of Thuwunna RLTC

Thuwunna RLTC will have two major functions: a) as Training Center; and b) as Research Laboratories. The objectives of each planned function are summarized as follows:

1) Training

- To provide **appropriate training programs** for MOC staff: theoretical and practical training to reformation of MOC
- To provide **vocational training programs** : according to NSSA and MOC
- To provide **assessment** for skilled workers : NSSA and VSDP programs
- To be **a comprehensive knowledge & learning center** for construction technology in Myanmar : promote exchange of knowledge

2) Research Laboratory

- To conduct material tests and issue certificates (for procurement, manufacturing and plant): with linkage to Standards and Certification System
- To conduct material tests for bidders/ contractors: to be linked to Standards and Certification System for materials
- To conduct material testing for quality control of construction works
- To provide testing to meet the requirement of ASTM/AASHTO in compliance with ISO standards
- To conduct research for new materials and technical development
- To be a center for research activities for construction-related technologies

3) Hostels

- To provide hostel and dining hall for the trainees

3.1.2 Contents of the Project

The scope of the Project is described hereinafter:

(1) Building Development

As shown below in Table 3-1, facilities which are necessary for achieving the abovementioned objectives are being planned:

Table 3-1 Summary of the Facilities

Block	Facilities	Story and Floor Area
MOC Training Center	Lecture room, training room, survey/quality management room, veranda, terrace/deck, exhibition space, hall/waiting room, staff meeting room, library, computer room, staff office, instructor room, maintenance staff room, support staff room, health room	3 stories, 6,100m^2
Vocational Training Center	Lecture room, training room, warehouse, veranda, terrace/deck, staff office, instructor room, reception desk	2 stories, 6,180m^2
Research Laboratory	Inspection room, warehouse, veranda, terrace, staff office, locker, support staff room	2 stories, 7,620 m^2
Hostel (3buildings)	• Hostel for MOC staff (male-only wing, with dining hall for MOC staff): 80 people • Hostel for MOC staff (female-only wing): 120 people • Hostel for skilled labors with dining hall: 100 people	3 stories, total 7,280 m^2
Outdoor Exhibition	Environmental roadway pavement field experiment, Life-size full-scale model (cross section sample of bridge, bridge pier sample and shield etc.), barrier-free experience corner	750 m^2
Road on the Premises	Paved Road, Main Gate, Sidewalk, Bridge	20,400 m^2
Adjustment Pond	Overflow Pipe, Flap Gate	28,250 m^2

Source: JICA Study Team

(2) Procurement of Equipment

The main equipment items which are required for CTC and each research laboratory of other departments are shown in Table 3-2:

Table 3-2 Main Equipment Items

Department	Main items of Equipment
CTC	Concrete Cutter, Total Station, Concrete Mixer, Level, Office Equipment for Text Preparation, etc.
DOB	Compressive Testing Machine, Soundness (Autoclave), Consolidation Testing Machine, Core Barrel, etc.
DOH	Los Angeles Abrasion Machine, Cement Autoclave, Automatic Digital Mortar Mixer, and Temperature and Humidity Controlled Cabinet, Pan-type Mixer, Triaxial Compression Test, Gyratory Compactor, Automatic Asphalt Extraction Apparatus, etc.
DOBi	Concrete Curing Specimen Tank, SIT (Sonic Integrity Test), Direct Shear Test Apparatus, Moist Cabinet, Universal Tensile Testing Machine, Floor-standing Optical Emission Spectrometer, etc.
DRRD	CBR Apparatus, Consolidation Test Equipment, Compressive Testing Machine, Los Angeles Abrasion Testing Machine, SIT (Sonic Integrity Testing), etc.

Source: JICA Study Team

3.2 Outline of the Conceptual Design

3.2.1 Design Policy

The Thuwunna Research Laboratory and Training Center (Thuwunna RLTC), which is planned to be built under this Project, is a center that integrates the current CTC, DOH Laboratory, DOB Laboratory, DoBi Laboratory, and DRRD Laboratory. It aims to centralize the currently scattered facilities and take the following factors into account: (1) functionality and effectiveness of the training centers and research laboratories; (2) natural and social conditions of Thuwunna; (3) construction and procurement conditions; (4) maintenance and management ability of the implementing agency; (5) construction period; etc. The design policy shall be determined in consideration of the following:

- As a training and laboratory facility responsible for human resource development and quality control in the field of construction in Myanmar, the facility is planned to further enhance research and human resource development.
- MOC is in the process of strengthening the organization of CTC. In this project, the minimum necessary facilities and equipment shall be designed that can be respond to the new organization.
- To establish a proper facility which contributes to construction-related technology development and quality control as well as facilitate research and development, the facility shall be designed in consideration of the possibility of building expansion in the future.
- Laboratories shall be designed to provide exhibition facilities and libraries to allow more diverse training and for easy access of trainees to acquire more knowledge.

- The Research Laboratory shall be aimed to provide quality control under the ASEAN, and facilities and provision of equipment shall be planned to adapt to ASTM standards. Since there is a possibility to restructure the laboratories in the future, flexibility of the building plan to respond to layout changes will be taken into consideration.
- In regard to the equipment, sharing and unified management of common equipment will be considered.
- In order to reduce the burden of maintenance and management in the future, the design shall be prepared in consideration of securing natural lighting and ventilation, ease of maintenance, and reduction of utility costs. In addition, the concept of green building design shall be adopted, and the facility itself shall be an example in which the trainees can learn from.
- To be a suitable environment as training center and research laboratory, the design shall be prepared following the current trends (i.e. universal design, green building, etc.).

3.2.2 Design Conditions

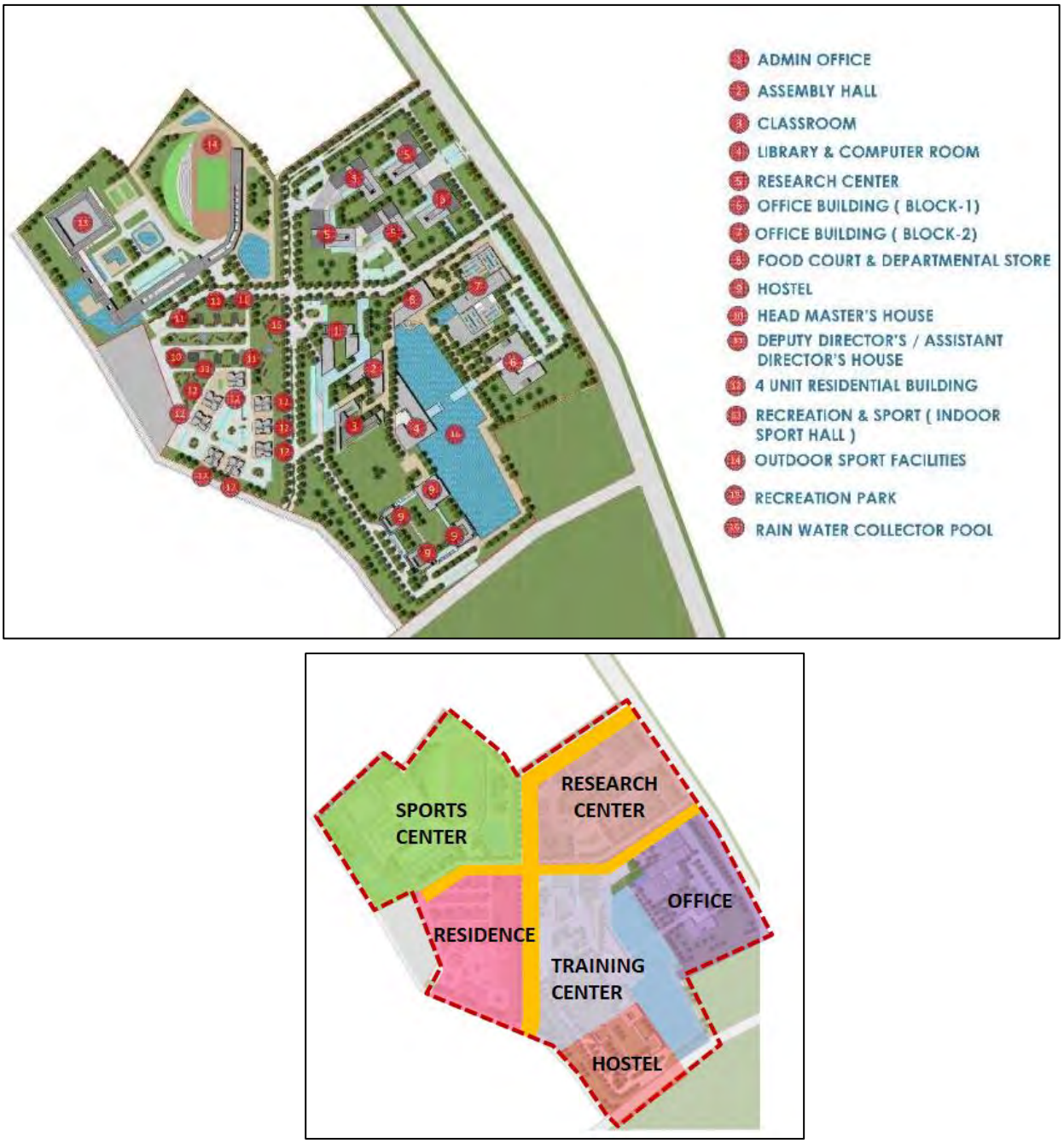
(1) The Project Site

In September 2015, DOBi of MOC developed a master plan for Thuwunna CTC (Figure 3-1). Based on this Master Plan and the current situation, the zoning plan was prepared through discussions with relevant authorities (Figure 3-2).

The project site area is proposed as shown in Figure 3-2. Due to the new bridge at the north side of the project site, the traffic volume of the center road from northeast to south is expected to increase. The main entrance from the east side road is planned in between the Research Center and the office zone.

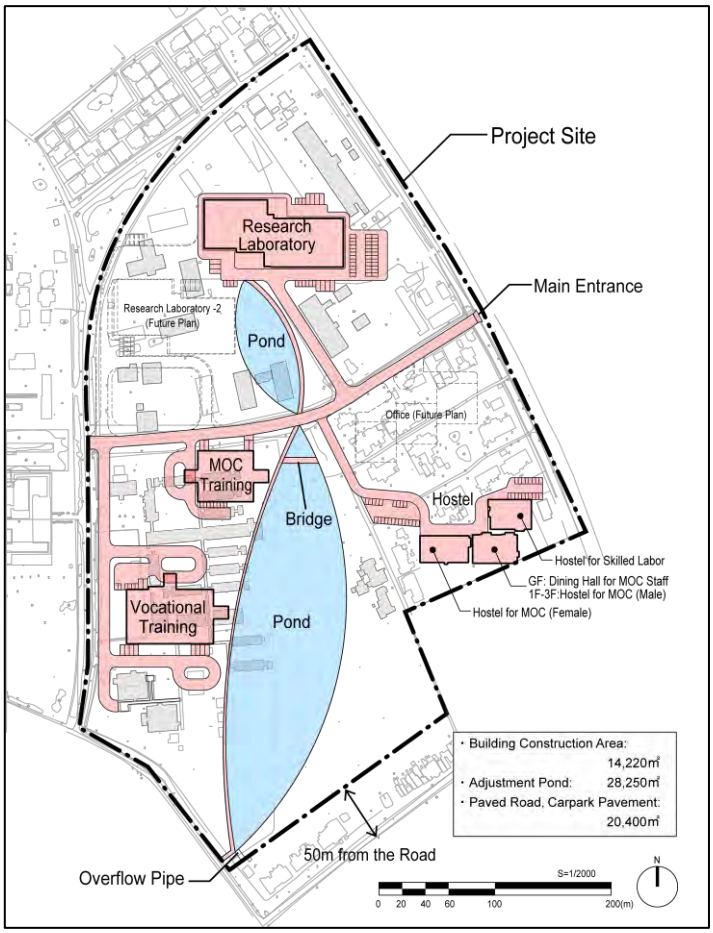
In the original MP, the hostel is planned to be located at the east side of the site as a part of the office zone. The existing staff residences are planned to be relocated to the western part of the site as shown in the zoning plan with MOC's budget next year.

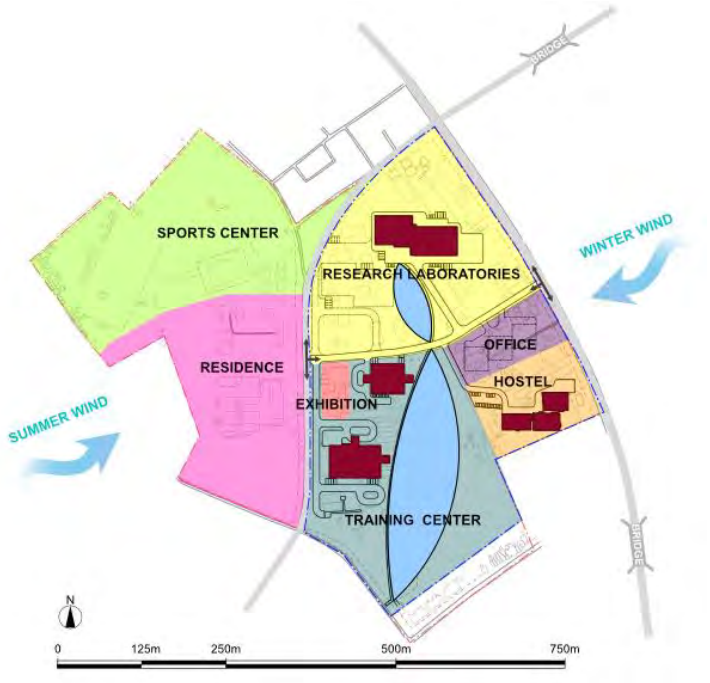
The project site boundary is shown in Figure 3-2. The 50m wide area of the southernmost part of the CTC where the families of ex-staff members live is excluded from the project site.



Source: Thuwunna CTC

Figure 3-1 Original Master Plan (above: Overall Plan, below: Zoning)





Source: JICA Study Team

Figure 3-2 Current Master Plan and Project Site (above: Overall Plan, below: Zoning)

(2) Consideration of the Facilities Scale and Details

1) Facilities Location Planning

- The target facilities of this project are six buildings, namely: MOC Training Center, Vocational Training Center, Research Laboratory, MOC Staff Hostel (Male, including Dining hall for both male and female), MOC Staff Hostel (Female), and Skilled Labor Hostel. In addition, the adjustment pond, on-site access roads and entrance gates shall be included.
- These buildings are upgrades of the existing buildings, and this project targets not only space expansion, but also functional improvement including circulation, safety and efficiency. The facility as a whole shall be designed as a functional and efficient research and testing facility.
- Currently, each laboratory and the CTC have their own entrance gates, but there is no main gate for the area. The new main entrance shall be located at the T-junction on the eastern side, and access to the Research Laboratory and the Training Center will be from this center road from the east to the center road.
- The layout design shall be made in consideration of future space expansion.
- Considering the natural sunlight, the buildings shall be arranged in the east-west axis basically.
- The two existing buildings constructed by JICA shall remain and be used, new facilities will be positioned where the old ones will not be affected.
- New buildings for research laboratories will be placed away from existing laboratory buildings so that laboratory tests will still be possible during construction of new buildings.
- Proposed laboratory building will cover only the minimum and major functions of each laboratory. Existing buildings can be continuously used as additional buildings, such as storage for drilling rigs, warehouse for unused equipment, etc.
- Each building shall be planned with internal road access for loading and unloading of materials.
- In consideration of security control, the research and testing facility is designed to have separate flow lines for insiders including researchers, and outsiders including visitors.

2) Drainage on the Premises

Currently, there is no drainage system in and around the Project site, but only a water supply system. YCDC (Yangon City Development Committee) conducted a field survey for new draining system, but there has not been any development. In this project, as measures against flooding, the ground floor level of the building is planned to be raised 1 m above the ground, storm water drainage ditches shall be constructed and storm water shall be discharged to and collected in the adjustment pond. Because the groundwater level at the site is high and the effectivity is low even if the pond is quite deep, the pond shall have a depth of 2 m or more and shall be as large as practically possible.

In addition, a flap gate will be installed on the south side of the adjustment pond in preparation for future storm water drainage system extension outside the premises. This pond is a general measure against rain during rainy seasons, and not against big floods that occur every other year. To prevent such big flood, it is necessary to have storm water drainage system for the entire town in which the target area will be expanded extremely large, so this project will not target such expanded areas.

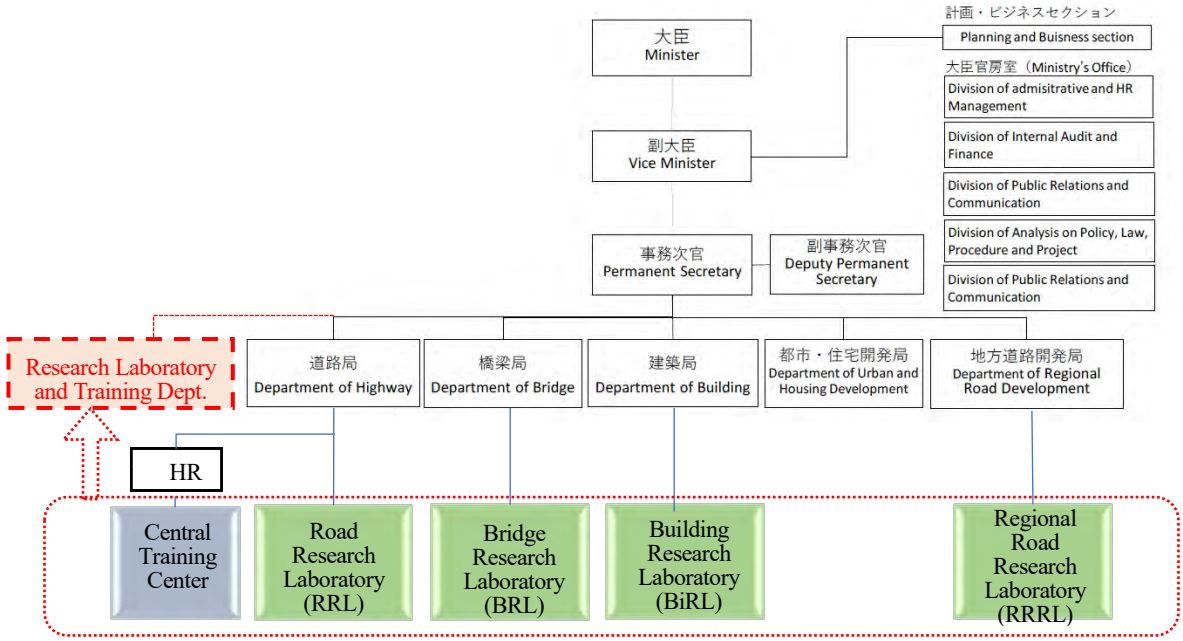
(3) Considerable Laws and Regulations

The facilities are designed according to Myanmar National Building Code (MNBC), basically.

3.2.3 Architectural Plan

In the future, MOC plans to integrate the research laboratories under the four departments and the CTC into the Research Laboratory and a Training Department. Figure 3-3 shows the organization proposed by MOC. The research laboratory is planned to consolidate the 4 laboratory buildings. However, since it will take time for MOC to establish a comprehensive and appropriate laboratory and training center, the building plan will be prepared based on the existing organization (4 research laboratories). However, flexibility of layout can be considered based on the functional integration of laboratories in the future.

The survey team conducted a survey on similar facilities in Japan and used it as a reference when planning the construction for this project (see Appendix-2).



Source: JICA Study Team

Figure 3-3 New Organization

(1) Floor Plan

The floor plan is designed based on the layout plan and function or standard calculation for each necessary room. The main design policies are the following. The schematic design drawing of the floor plan of each floor design is shown in Appendix-6.

- Practice rooms and laboratories where much loading and unloading of materials happen are placed on the ground floor, while office rooms and lecture rooms are on the first floor.
- In order to avoid the huge burden of operation and maintenance costs, the design is made in consideration of securing natural lighting and ventilation, easy maintenance and reduction of utility costs.
- The exterior wall is made double-skinned to prevent direct sunlight from entering the building and increase the room temperature and to enable outdoor works while ensuring security.
- Veranda for outdoor works and air conditioning outdoor unit storage are placed.
- The design will provide evacuation routes properly and carry out floor plans and furniture layout plans.
- The MOC staff hostels include hostels for men and women, and hostel for skilled labors. If there are women trainees for vocational training courses, the female-only building for MOC staff will be used as hostel.
- Required functions and activity plans of CTC and laboratories will be considered when formulating the facility plans. Thus, the detailed design will be decided based on discussions with related parties.

1) Lecture Room

- The MOC Training Center will provide classrooms that can accommodate 54 people in each room (98 m^2) which will be shared with each course. The area per person is 1.96 m^2, which is the standard size for educational facilities. With the target to train 2,000 people annually, it has been decided that there will be a total number of 8 classrooms (Table 3-3).
- The Vocational Training Center will provide classrooms that can accommodate 32 people per room (72 m^2). Lecture rooms can be shared by two different courses by planning a program in which classroom lectures do not overlap or take place at the same time. The area per person is 2.25 m^2, which is the standard size for educational facilities. With the target to provide classrooms for 16 work types, it has been determined that there will be a total number of 9 classrooms (Table 3-3).
- The Vocational Training Center conducts training classes for each work type using a lecture room, a practice room and a storage area. However, classes for road worker, well digger, toll collector, caretaker and landscape work types only need a lecture room without a practice room. The classrooms will be equipped with a teaching desk, white board, projector screen, as well as desks and chairs for trainees. Trainees will be provided with individual desks and

chairs so that the furniture can be arranged flexibly, i.e. the desks can function as work tables in the practice room.

Table 3-3 Calculation of Room Numbers

Trainings	Calculation	Rooms
MOC Staff Training	● Target 2,000 persons ● 50 pers./course >> 40 courses ● 40rooms x 6weeks/course = 240 room*weeks ● One year 44 weeks (8 weeks break) ● 240 room*weeks /44weeks = 5.45 rooms ● Occupancy Rate 70% → 7.79 rooms	8 Lecture Rooms
Vocational Training	● 16 trainings in CTC (out of 19 under NSSA) ● Training (per course) [Level 1] 6 weeks x 3 times + [Level 2] 4 weeks x 3 times = 30 weeks/ year Assessment (per course) [Level 1] 1 week x 6 times + [Level 2] 1 week x 6 times = 12 weeks/ year ● [11 courses] Lecture room (for 30 persons) + Practice room (10 persons x 3 groups) + Storage ● [5 courses] Lecture rooms + storage and exhibition spaces	9 Lecture Rooms + 11 Practice Rooms (4 rooms with terrace) + Storages

Source: JICA Study Team

Currently, CTC has a long vacation period of ten days from the first week of April, and construction site operations stop during the rainy season. Hence, during this period, the number of trainees increase and the number of training courses are double than usual. Myanmar's school year stars from October.

2) Practice Room and Storage for Skilled Labor

- The Vocational Training Center conducts training classes for each work type using a lecture room, a practice room and a storage area. However, classes for well digger, toll collector, caretaker and landscape work types only need a lecture room without a practice room.
- A practice room can be shared for concrete and plaster work training classes.
- An area for a maximum of 10 people working at a time will be ensured. The area per person is 10.8 m2, similar to the existing buildings.
- Training and qualification examination will be done in the same room for each type of work.
- The storage area is where dedicated equipment for training will be stored.
- The storage area is arranged in between practice rooms to avoid noise, vibration and dust generated from the practice rooms that could disturb training activities in different practice rooms.

Table 3-4 Contents of Each Work Type of Skilled Labor Training

Concrete Worker	Training on concrete material mixing and concrete kneading based on the mix design prepared by the engineer
Carpenter	Training on wooden framework using electric planer, electric saw, etc.
Brick Layer	Training on stacking and cutting bricks, joint construction
Painter	Training of steel painter for bridges and of building painter
Tiler	Training on tile construction
Steel Structure Worker	Training on bolt fitting (not welding)
Scaffolder	Training on scaffold assembly work
Plumber	Training on piping work
Roofer	Training on terracotta roofing and locally used tin roofing
Caretaker	Training on building security, management after building construction (not for construction management)
Landscape Gardener	Lectures on gardening, lawn mowing, and fertilizer (not landscape designing)
Well Digger	Lectures on wells and technical training on well digging
Toll Collector	Lectures on road toll collection, guidance of ECT system introduction and vehicle types
Bar Bender	Training on bending and binding of RC reinforcement (not welding)
Road Worker	Training on road maintenance work assistance / Support training of unskilled labor such as gravel spreading and asphalt concrete construction
Plasterer	Training on plaster work

Source: JICA Study Team

3) Labor Practice Room for MOC Staff

The practice rooms are planned to be used for concrete compounding, quality control (flat plate loading test, inspection with Schmidt hammer) and as lecture venues for junior engineers.

4) Laboratories

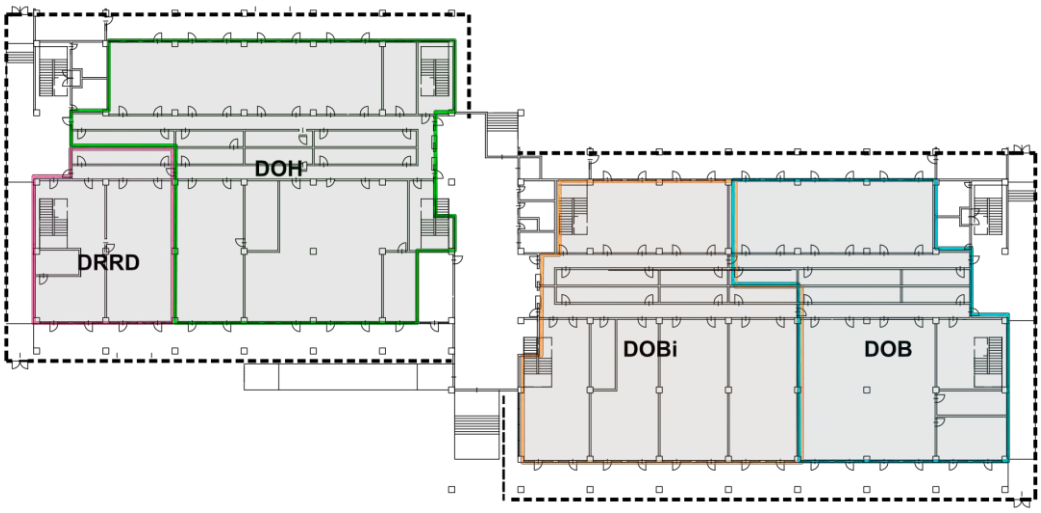
The laboratories are designed to be a proper research environment as the first research and testing laboratories in Myanmar that fulfill ISO17025 standards. In addition to securing the floor area of the existing laboratories (excluding office, corridors, and storages), the floor plan is being designed in which flexibility is considered based on the functional integration of laboratories in the future. Table 3-5 shows the tests which are conducted by each department.

Table 3-5 Tests Conducted by Each Department

	Concrete / Cement Test	Soil Test	Asphalt Test	Re-bar Test	Research Inspection	Design
DOH	✓	✓	✓			✓
DOB	✓	✓		✓	✓	
DOBi	✓	✓		✓		✓
DRRD	✓	✓				

Source: JICA Study Team

Layout of the Laboratories is shown Figure below.



Source: JICA Study Team

Figure 3-4 Layout of Laboratories

5) Storage for Laboratory

The storage for laboratory samples is divided into the following five sections according to the experimental stage. By locating the storage in the middle of the laboratories, effective work flow lines are secured.

- Customer Sample Storage Area
- Tested Sample Storage Area
- Raw Material Storage Area
- NC Storage Area (for samples found to be unsuitable after inspection)
- Disposal Area

6) Veranda for Research, Laboratories, and Training Center

- The area is used for outdoor work and air conditioning outdoor unit storage. The area is also used as a place to operate cement mixer when working on bricks or tiles. It will be used as a temporary material storage as well.
- Basically, the materials used in the training will be newly purchased every time, but materials which are still good after dismantling will be reused and can be temporarily stored on the veranda.

	
Outdoor Work (Cement Mixer)	Materials Temporary Storage in Existing Building

Source: JICA Study Team

Figure 3-5 Current Usage of CTC Existing Facilities

7) Terrace and Deck

Terraces and decks are provided as resting spaces and to encourage interactions among facility users. The deck is placed for users to comfortably spend time while overlooking the pond and open space.

8) Exhibition Space

An exhibition space is provided on the third floor of the MOC Training Center to spread information about MOC's history and new projects. This space is used as a center for public relations activities of local centers and construction industries (i.e. for training information, research and inspection information, photo exhibition of MOC's latest constructions, etc.).

9) Outdoor Exhibition Space

To allow hands-on learning experience, the training facilities display the environment roadway pavement field experiment, life-size full-scale models (i.e. bridge cross-sectional samples, bridge pier samples and shields, etc.), with a barrier-free experience corner. Since it is necessary for Myanmar to increase the number of sidewalks and facilities which consider universal design, the barrier-free experience corner is very important. However, there is currently no competent lecturer on this subject, so the facilities will need support from experts in technical support projects or volunteers.

10) Hall

The hall in the MOC Training Center building accommodates about 300 people, which is equivalent to the capacity of the existing building. The area for each person is 1.63 m^2, a standard size for a hall. To allow furniture rearrangement according to lecture style, movable desks and chairs are placed in the hall.

11) MOC Staff Meeting Room

An MOC staff meeting room with a capacity of 70 people will be established in the MOC Training Center building. The area for each person is 2.8 m^2, a standard size for a meeting room. With a movable partition, the room can be used for multiple purposes.

12) Library

The library is currently located on the ground floor of MOC Training Center building, which stands in the middle among the three new buildings. The library is also used as Vocational Training Center and Research Laboratory. Tables for individual works are placed in the library, where trainees can study before or after lectures.

13) Computer Room

There is one computer room in the MOC Training Center building with a capacity of 50 people similar to the existing building. The area per person is 3.92 m^2, a standard size for a computer room.

14) Management Office

a) Reception

- The reception will be placed at the side or at the front of the entrance to control the flow of people who enter the facilities.
- The training facilities accept payments and administrative documents from trainees.
- At the Research Laboratory, reception is established for each material. In each reception, customers hand in test samples, make payments, and do administrative procedures. When a testing is complete, reports on the testing results will be delivered through the reception.

b) Office

- The area of the executive offices range from 10 m^2 to 24.5 m^2 depending on the position.
- The offices at the MOC Training Center facilities are designed based on the number of staff – which is 29 – working in the existing buildings. The area per person (including meeting space, personal computer room, and document storage) is 10.98 m^2, a standard size for an office.

Table 3-6 Room Allocation for the Number of Staff in Existing CTC Buildings and New Buildings

Position	Executive (Private Room)	Office Staff	Supporting Staff	Special Staff
Deputy Director General	-	-	-	-
Director	1	-	-	-
Deputy Director	1	-	-	-
Assistant Director	1	-	-	-
Staff Officer	-	2	-	-
Junior Engineer	-	6	-	-
Accountant	-	2	-	-
Typist	-	5	-	-
Cleaner	-	-	6	-
Driver	-	-	4	-
Gard	-	-	6	-
Staff	-	10	-	-
Cook	-	-	-	8
Nurse	-	-	-	1
Gardener	-	-	7	-
Deputy supervisor	-	4	-	-
Water supplier	-	-	5	-
Library	-	-	-	1
Staff help	-	-	3	-
Electrician	-	-	3	-
Sub Total	**3**	**29**	**34**	**10**
Grand Total	**76**			

Source: JICA Study Team

- The offices at the Vocational Training Center are designed based on the number of temporary staff – which is 11 – currently working at the facilities. The information is obtained from an interview survey. The area per person is 11.16 m^2, a standard size for an office.

Table 3-7 Room Allocation for the Number of Staff in Existing Vocational Training Center Buildings and New Buildings

Position	Executive (Private Room)	Office Staff
Deputy Director General	-	-
Director	1	-
Deputy Director	1	-
Assistant Director	-	2
Staff Officer	-	9
Sub Total	**2**	**11**
Grand Total	**13**	

Source: JICA Study Team

- The offices at the Research Laboratory are designed for the 144 staff currently employed in the facilities. The area per person (including meeting space and document storage) is 8.32m^2, a little small for an office. However, since it is assumed that research assistants and external lecturers spend most of their time in the laboratory, only the necessary area is secured for the offices.

Table 3-8 Room Allocation for the Number of Staff in Existing Research Laboratory Buildings and New Buildings

Department	Position	Executive (Private Room)	Office Staff	Supporting Staff
DOH				
	Director	1	-	-
	Deputy Director	1	-	-
	Assistant Director	2	-	-
	Staff Officer	-	5	
	Junior Engineer	-	18	-
	Accountant	-	2	-
	Typist	-	3	-
	Trainers form MOC	-	23	-
	Trainers from Private sector	-	23	-
	Cleaner	-	-	3
	Driver	-	-	0
	Guard	-	-	6
SUB TOTAL		**4**	**74**	**9**
Department	Position	Executive (Private Room)	Office Staff	Supporting Staff
DOB				
	Deputy Director General	1	-	-
	Director	1	-	-
	Deputy Director	1	-	-
	Assistant Director	3	-	-
	Staff Officer	-	4	-
	Junior Engineer	-	4	-
	Research Assistant	-	6	-
	Laboratory Technician	-	17	-
	Accountant	-	4	-
	Typist	-	3	-
	Guard	-	3	3
	Clerk	-	-	2
	Lower Division Clerk	-	-	6
	Worker	-	-	2
	Helper	-	-	3
SUB TOTAL		**6**	**38**	**16**
Department	Position	Executive (Private Room)	Office Staff	Supporting Staff
DOBi				
	Deputy Director General	-	-	-
	Director	-	-	-
	Deputy Director	1	-	-
	Assistant Director	2	-	-
	Staff Officer	-	5	-
	Junior Engineer	-	12	-
	Accountant	-	3	-
	Typist	-	2	-
SUB TOTAL		**3**	**22**	-

Department	Position	Executive (Private Room)	Office Staff	Supporting Staff
DRRD				
	Chief Engineer	-	1	1
	Director	1	-	-
	Junior Engineer	-	2	-
	Assistant Junior Engineer	-	6	-
	Accountant	-	1	-
	Guard	-	-	1
SUB TOTAL		**1**	**10**	**1**
GRAND TOTAL		**Executive (Private Room)**	**Office Staff**	**Supporting Staff**
		14	**144**	**26**

Source: JICA Study Team

c) Lecturer's Rooms (Only as Training Facilities)

Since external lecturers are often invited based on the lecture schedule, a room for lecturers is established separately from the general staff office.

- The lecturer's room in the MOC Training Center is designed to accommodate 11 lecturers in consideration of the number of rooms (8 lecture rooms, 2 practice rooms, 1 computer room). The area per person is 8.91 m^2, a standard size for a lecturer's room.
- The lecturer's room in the Vocational Training Center is designed to accommodate 9 lecturers. The area per person is 8.33 m^2, which is relatively small for a lecturer's room. However, since it is assumed that external lecturers spend most of their time in the practice rooms, only the necessary area is secured.

d) Waiting Room for Supporting Staff and Maintenance Staff (i.e. Security Guard, Cleaning Service Worker, Driver, Electrician, etc.)

A waiting room for supporting staff personnel who clean and maintain the facilities is provided. Since it is assumed that the supporting staff will spend a relatively short time in the room, the area per person is set to be smaller than half of the area per person in the staff office.

- The supporting staff room in the MOC Training Center is designed to accommodate 13 staff currently employed. The area per person – which is 3.42 m^2 – is less than half of the office area per person. The maintenance staff room is designed to accommodate 21 current staff.
- Since the Vocational Training Center carries out more training classes than the MOC Training Center, it is assumed that it needs more cleaning staff and equipment. Thus, the area of the waiting room is set to be 1.6 times larger than the supporting staff room in the MOC Training Center.
- There are currently 26 supporting staff at the Research Laboratory. Since the current research buildings will be integrated into 1 building, the number of supporting staff is expected to be

greatly reduced. Thus, the area per person of the common locker room is set to be 1.37 m^2 and the necessary minimum area is secured.

e) Nurse Room

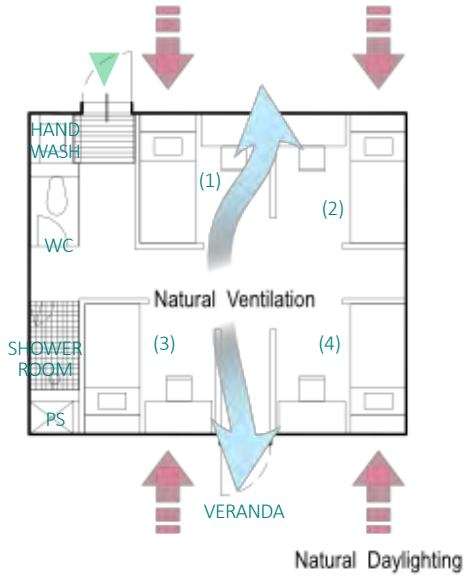
A clinic for trainees who are injured or sick during experiments or training classes will be provided. A doctor is stationed in this room. This room is planned to have a space for a desk, a chair for the doctor, a bed for the patient, and a sink.

15) Hostels

A male-only MOC staff hostel, a female-only MOC staff hostel and a skilled labor hostel are planned separately in the hostel area.

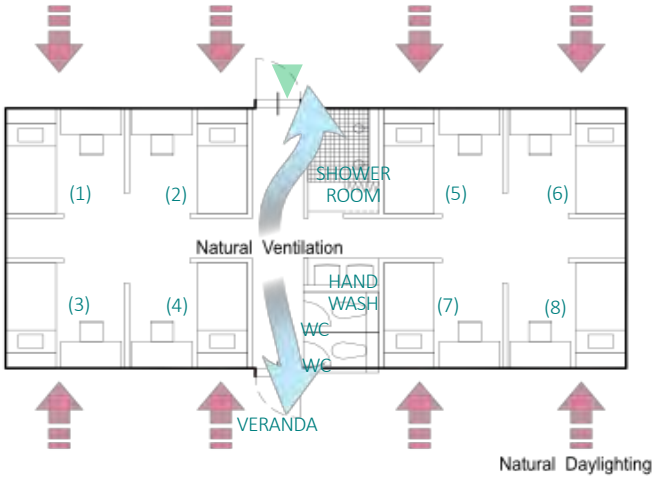
a) MOC Staff Hostel

- Divide the building into male-only wing and female-only wing.
- Provide a dining room and kitchen for MOC staff on the ground floor. The kitchen is shared with skilled labor hostel.
- Provide a laundry room for trainees on each floor where the accommodation rooms are located.
- Two types of rooms – one with 4 beds and one with 8 beds – are planned. Each bedroom has a toilet and a shower. In addition, a common toilet and a shower room is planned for 8-bed rooms. A 2-bed room is planned for future expansion by the Myanmar side.
- The area per person is 9.38 m^2 to 10.50 m^2. Figure 3-6 and Figure 3-7 show the plans for the rooms. Each bed is laid out with window for natural ventilation and lighting.



Source: JICA Study Team

Figure 3-6 Layout of 4-Beds Room for MOC Staff

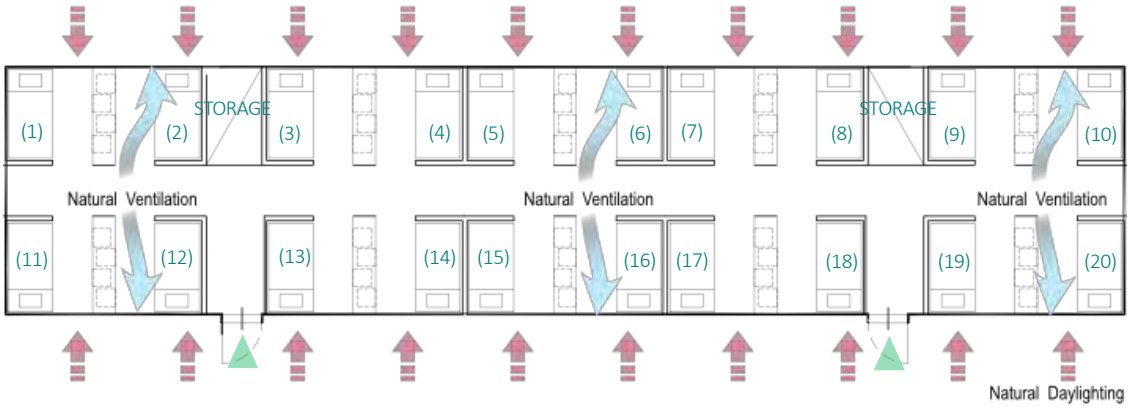


Source: JICA Study Team

Figure 3-7 Layout of 8-Beds Room for MOC Staff

b) Skilled Labor Hostel

- In cases where there are women training participants, use the room in female-only buildings at the MOC staff hostel.
- The room can accommodate 20 people, and the toilet and bath will be shared.
- The dining room will be planned on the ground floor. The kitchen will be shared by the MOC staff hostel, and meal will be delivered in a trolley.
- Laundry room for trainees will be planned on the ground floor.
- The area per person is 8.06 m^2. Figure 3-8 shows the plan for the room. Each bed is laid out with window for natural ventilation and lighting.



Source: JICA Study Team

Figure 3-8 Layout of 20-Bed Room for Skilled Labor

(2) Floor Area

The floor area of each building is shown in the tables below.

Table 3-9 Area of Each Room in MOC Training Center

Room Name	Room Use	Plan			Unit Area
		Capacity	Number of Rooms	Area (m^2)	(m^2/ person)
Lecture Room	Classroom lecture	54	8	784.00	1.81
Practice Room	Concrete mixing training	-	2	196.00	-
Survey and Quality Control Room	Surveying equipment storage	-	1	49.00	-
Library	Double as study room	-	1	98.00	-
Computer Room		50	1	196.00	3.92
Exhibition Space	Exhibition to display information	-	1	94.50	-
Hall		300	1	490.00	1.63
Control Room	Preparation room	-	1	98.00	-
Executive Office		1	3	73.50	24.50
Staff Meeting Room		70	1	192.50	2.75
Staff Office	Including meeting space, personal computer room, and document storage	29	1	318.50	10.98
Lecturer's Room		11	1	98.00	8.91
Maintenance Staff Room	Waiting room for maintenance staff	21	1	96.25	4.58
Supporting Staff Room	Waiting room for security guard, cleaning service, gardener, driver, etc.	13	1	44.46	3.42
Nurse Room		-	1	49.00	-
Entrance, Corridor, Toilet, Stairways, etc. (Indoor)		-	-	1467.29	-
Veranda	Outdoor work and outdoor storage	-	-	624.20	-
Terrance and Deck	Resting space	-	-	565.74	-
Entrance, Corridor, Toilet, Stairways, etc. (Semi-outdoor)		-	-	566.80	-
Total Floor Area				**6101.74**	

Source: JICA Study Team

Table 3-10 Area of Each Room in Vocational Training Center

Room Name	Room Use	Plan			Unit Area
		Capacity	Number of Rooms	Area (m^2)	(m^2/ person)
Lecture Room	Classroom lecture	32	9	651.00	2.26
Practice Room		10	11	1203.00	10.94
Storage		-	17	504.00	-
Exhibition Space	Exhibition to display information	-	1	72.00	-
Executive Office		1	2	25.00	12.50
Staff Office		11	1	122.00	11.09
Lecturer's Room		13	1	75.00	8.33
Reception		10	1	72.00	7.20
Supporting Staff Room	Waiting room for security guard, cleaning service, gardener, driver, etc.	-	1	72.00	-
Entrance, Corridor, Toilet, Stairways, etc. (Indoor)		1	1	1549.00	-
Veranda	Outdoor work and outdoor storage	-	-	1130.18	-
Terrace and Deck	Resting space	-	-	282.00	-
Entrance, Corridor, Toilet, Stairways, etc. (Semi-outdoor)		-	-	417.80	-
Total Floor Area				**6174.98**	

Source: JICA Study Team

Table 3-11 Area of Each Room in Research Laboratory

Room Name	Room Use	Plan			Unit Area
		Capacity	Number of Rooms	Area (m^2)	(m^2/ person)
Laboratory		144	-	2409.10	16.73
Storage		-		682.15	-
Executive Office		1	20	262.58	13.13
Staff Office	Including meeting space and document storage	144	-	1197.70	8.32
Supporting Staff Room	Waiting room for security guard, cleaning service, gardener, driver, etc.	26	1	35.49	1.37
Locker		-	-	118.32	-
Entrance, Corridor, Toilet, Stairways, etc. (Indoor)		-	-	1282.24	-
Veranda		-	-	803.62	-
Terrace		-	-	127.73	-
Machinery Room		-	-	171.13	-
Entrance, Corridor, Toilet, Stairways, etc. (Semi-outdoor)				526.85	-
Total Floor Area				**7616.91**	

Source: JICA Study Team

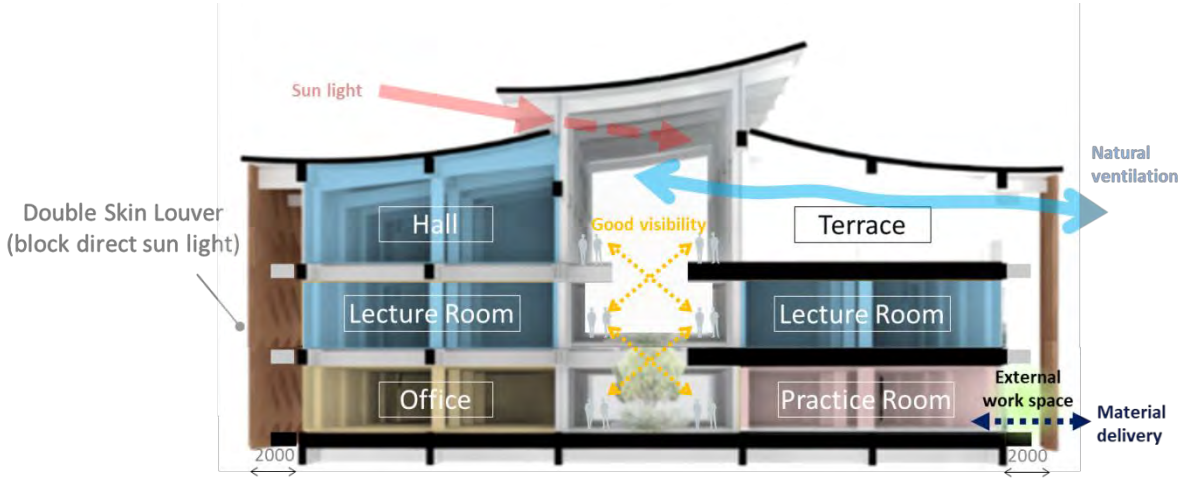
Table 3-12 Area of Each Room in Hostels

Room Name	Room Use	Plan			Unit Area
		Capacity	Number of Rooms	Area (m^2)	(m^2/ person)
MOC Staff Hostel (Male)					
4per. Room	Veranda excluded	4	6	252.00	10.5
8per. Room	Veranda excluded	8	7	525.00	9.38
Dining Hall	Kitchen included	200	1	499.00	2.50
Others		-	-	1393.34	
				Subtotal 2669.34	
MOC Staff Hostel (Female)					
4per. Room	Veranda excluded	4	10	420.00	10.5
8per. Room	Veranda excluded	8	10	750.00	9.38
Others		-	-	1377.04	
				Subtotal 2547.04	
Skilled Labor Hostel					
20per. Room		20	5	806.45	8.06
Cafeteria	Kitchen is shared by Dining Hall	100	1	167.22	1.67
Bath	Assuming 20 people This is twice the number of Japanese law for labor hostel, which prescribe 10% of user.	20	1	80.55	4.04
Others		-	-	1033.99	
				Subtotal 2058.21	
Total Floor Area				**7274.59**	

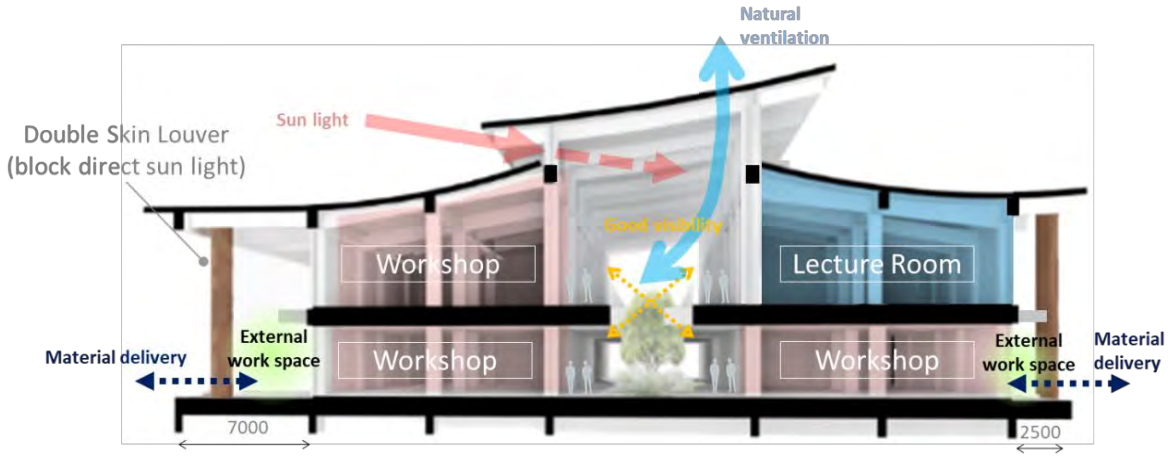
Source: JICA Study Team

(3) Cross-Sectional Plan

- By having a central corridor with open ceiling, training facilities have a cross-sectional configuration that makes it easy to visually grasp the structure of the building and easy to maintain.
- The research and testing laboratory facilities have a cross-sectional configuration that allows people in the office on the first floor to look over the laboratories on the ground floor.
- Considering the hot and humid environment, the ceilings are designed to be high (at least 3 m).
- Eaves are installed to block sunlight and allow windows to be opened even in rainy weather.
- High windows are installed in the center of the building to allow natural daylight.



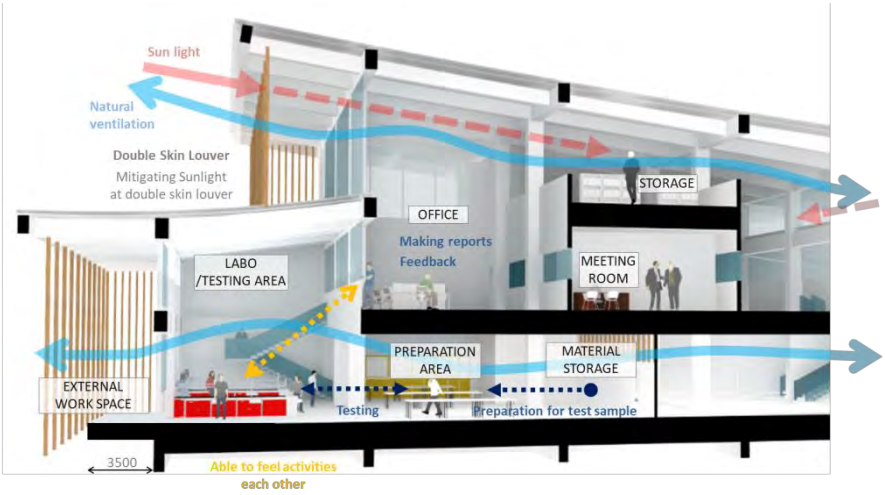
MOC Training Center



Vocational Training Center

Source: JICA Study Team

Figure 3-9 Building Design Concept Diagram (Section) of MOC Training Center and Vocational Training Center



Source: JICA Study Team

Figure 3-10 Building Design Concept Diagram (Section) of Research Laboratory

Hostel for Skilled Labor　　Hostel for MOC (Male) and Dining Hall for MOC

Source: JICA Study Team

Figure 3-11 Building Design Concept Diagram (Section) of Hostels

(4) Building Materials Plan

1) Basic Objectives

In consideration of Myanmar's climate, condition of the construction site, construction period, construction cost and maintenance, the building materials are planned based on the following objectives:

- To select building materials which are appropriate for the local climate, high in durability and easy to maintain, as well as to strive to reduce maintenance costs

- To select reasonable building materials that can accommodate the functionalities required by CTC and the laboratory facilities, which are aligned with the equipment and machinery planning and which can sufficiently exert these effects

2) Building Materials Selection

- Exterior finish: The main exterior walls, including the columns and beams, are painted over mortar base. The aluminum louver is to be used, as double skin is coated with urethane coating.
- Exterior fixtures: The openings facing outside such as windows and doors are made from aluminum sash windows or steel doors. The fixtures will be filled with weld mounting mortar to avoid leaks.
- Flooring materials: For practice rooms and laboratories, to allow easy cleaning (wiping with water, etc.) of testing materials dirt on the floor, the flooring is planned to have a mortar base with surface strengthening coating. For lecture rooms and management offices, the flooring has a mortar base finished with PVC sheet or porcelain tiles.
- Wall materials: Mainly has a mortar base finished with paint.
- Ceiling: Mainly made of decorative gypsum board.

(5) Schematic Design

Layout drawing, floor plan, elevation drawing, and sectional drawing are presented in the Appendix-6.

3.2.4 Structural Plan

(1) Design Policy

The following design policy shall be adopted for the Structural Planning of this Project.

- Safe and rational Structural Planning shall be conducted under the proper judgement of the ground conditions of the site.
- Appropriate and usable structural system shall be adopted in consideration of the deflection and vibration caused by long-term loads.
- Durability of the building shall be properly maintained against short-term loads such as strong wind, and sufficient safety shall be secured.
- Locally available materials shall be used by the structural members, and simple and durable construction methods shall be adopted for the Structural Planning.

(2) Construction Methods and Materials

The structural system of the buildings shall be a rigid frame structure made of reinforced concrete which is generally used in Myanmar, and the wall material shall be bricks which are quite common in Myanmar.

(3) Ground Conditions and Foundation

The geotechnical survey data is shown Table 3-13 below. The geotechnical survey was conducted in the project site.

Table 3-13 Geotechnical Survey Data (B No. 01)

Depth under grade	Type of Soils	N-Value
GL±0~GL－4.0m	Clay	2
GL－4.0m~GL－8.0m	Clay	2~7
GL－8.0m~GL－10.0m	Sandy clay	3
GL－10.0m~GL－12.0m	Clay	4
GL－12.0m~GL－26.0m	Sandy clay	8~22
GL－26.0m~GL－39.0m	Clay	10~22
GL－39.0m~GL－43.0m	Silty sand	37~50
GL－43.0m and below	Clay	more than 32

Source: JICA Study Team

The pile foundation system shall be made of reinforced concrete to reach the silty-sand and clay layers at the depth of -41m from the ground level. The driving method shall be done using locally available hammers. Also, giving consideration to the size of the buildings of the Project, the direct

foundation to rest on the clay layers at the depth of -2m with N-Value of 2 shall be strictly forbidden due to possible differential settlement and lack of bearing capacity of the layers.

(4) Design Loads

1) Live Load

The buildings of the Project are primarily used as testing facilities for building materials. A special equipment to measure the durability of the materials will be installed; thus, due consideration shall be given in creating the design load allowance of such equipment.

2) Wind Load

According to the Myanmar National Building Code 2016, the basic wind speed shall be 100mph (44.8m/sec). Thus, 45m/sec shall be adopted to calculate the wind loads.

Table 3.3.1, Basic Wind Speed (3 sec Gust Wind Speed in mph)

Sr	City/Town	Basic Wind Speed (mph) 1.613km/h
1	Bago	80
2	Bhamo	70
3	Bogalay	100
4	Chauk	70
5	Dawei	90
6	Falam	70
7	Hakha	90
8	Henzada	90
9	Homalin	50
10	Hpa-An	70
11	Kale	70
12	Kawthaung	90
13	Kengtung	70
14	Kyaukpyu	130
15	Lashio	70
16	Loikaw	70
17	Magwe	70
18	Mandalay	80
19	Mawlamyine	90
20	Meiktila	70
21	Monywa	70
22	Muse	70
23	Myeik	90
24	Myitkyina	70
25	Nansam	70
26	Naypyitaw	70
27	Pakokku	70
28	Pathein	100
29	Putao	70
30	Pyay	70
31	Sittwe	130
32	Taungyi	70
33	Thandwe	130
34	Yangon	100
35	Ye	90
36	Yenangyaung	70

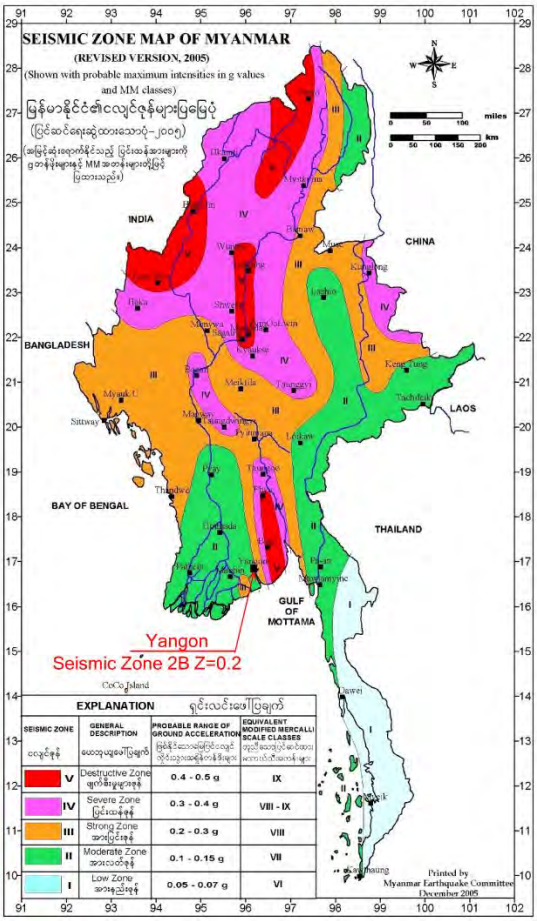
161.3km/h(44.8m/sec)

Source: Myanmar National Building Code 2016

Figure 3-12 Wind Speed Pressure in Myanmar

3) Seismic Load

According to the Myanmar National Building Code 2016, Yangon area is situated on the Seismic Zone of 2B. Thus, seismic loads shall be calculated using the seismic factor Z=0.20



Source: Myanmar National Building Code 2016

Figure 3-13 Seismic Zone Map of Myanmar

(5) Materials Used

Table 3-14 Structural Materials Used

Concrete	Foundation ~ GF Slab	24N/mm2
	GF Column ~ Roof	24N/mm2
Rebar	Round Bar	φ6～φ9
	Deformed Bar SD295	D10～D13
	Deformed Bar SD345	D16～D25
Steel Frame	Shape Steel, Steel Plate	SS400
	Lightweight Shaped Steel	SSC400

Source: JICA Study Team

3.2.5 MEP Plan

(1) Purpose

The Project for the establishment of both New Thuwunna Central Training Center and New Research Laboratory, which will accommodate various laboratories, belongs to Department of Highways, Building, Bridge and Regional Road. The purposes of the Facility Design are stated below:

1. Training Center

In order to ensure that the training of MOC engineers and private sectors skilled workers will be conducted effectively, the Building Facility Design is required to be consistent with the curriculums, the training programs and certificate programs.

Meanwhile, the facility plan will also consider the provision of healthy, hygienic and comfortable environment for the trainees.

2. Research Laboratories

The Building Facility Design aims to provide sufficient and flexible utility supplies and create ideal indoor conditions consistent with specific testing requirements so that various kinds of material tests could be precisely and effectively conducted.

3. Hostels

The hostels are designed to accommodate 300 trainees. The MEP design aims to provide healthy, hygienic and comfortable environment for trainees.

(2) Policy of Facility Design

1. Simple and reliable MEP (Mechanical, Electrical and Plumbing) systems
2. Adoption of MEP systems which are easy to operate and maintain
3. Adoption of economically rational system considering the lifecycle cost (LCC)
4. Realization of an environment-friendly academic facility
5. Adoption of training support system to make practices and training classes more effective.

(3) Mechanical and Electrical Systems in the Facility Design

List of Electrical and Mechanical Systems is shown Table 3-15 below.

Table 3-15 List of Electrical and Mechanical Systems

Electrical Systems		Vocational Training Center	MOC Training Center	Research Laboratory	Hostels 3 Buildings	Exterior
		RC 2 stories Total 6,180m^2	RC 3 stories Total 6,100m^2	RC 2 stories Total 7,620m^2	RC 3 stories Total 7,280m^2	
a.	Substation system					✓
b.	Emergency Generator system	✓	✓	✓	✓	
c.	Low Voltage Power Distribution System	✓	✓	✓	✓	
d.	Lighting and Receptacles	✓	✓	✓	✓	
e.	Telephone System	✓	✓	✓	✓	✓
f.	LAN System	✓	✓	✓	✓	✓
g.	Public Address System	✓	✓	✓	✓	
h.	Automatic Fire Detection and Alarm System	✓	✓	✓	✓	
i.	Lightning Protection System	✓	✓	✓	✓	
j.	Photovoltaic Power Generation System	✓	✓	✓		

Mechanical Systems		Vocational Training Center	MOC Training Center	Research Laboratory	Hostels 3 Buildings	Exterior
		RC 2 stories Total 6,180m^2	RC 3 stories Total 6,100m^2	RC 2 stories Total 7,620m^2	RC 3stories Total 7,280m^2	
a.	Domestic Cold Water Supply System	✓	✓	✓	✓	✓
b.	Wastewater Drainage & Vent System	✓	✓	✓	✓	✓
c.	Plumbing Fixtures	✓	✓	✓	✓	
d.	Fire Protection System	✓	✓	✓	✓	✓
e.	Liquefied Petroleum Gas Supply System			✓	✓	
f.	Wastewater Treatment Plant					✓
g.	Air-conditioning System	✓	✓	✓	✓	
h.	Mechanical Ventilation System	✓	✓	✓	✓	

Source: JICA Study Team

(4) Outline of Electrical and Mechanical Design

1) Codes and Standards

Planning, design and construction of Electrical and Mechanical Systems will be performed in compliance with International Codes and Standards and Technical Guidelines, including those in Japan as well as in Myanmar.

2) Electrical System

a) Substation System

Currently, two medium voltage power lines of 11 kV, 3 phase, 3 wires are taken into the site of the existing CTC from 11 kV overhead high tension distribution line supplied around the site by Yangon Electricity Supply Cooperation (hereinafter referred to as “YESC”), which is affiliated with the Ministry of Electricity and Energy (hereinafter referred to as “MOEE”). Tapped power service lines are connected to the indoor cubicle type switchboard equipment provided in the Substation

Room. Low voltage power of 380 / 220V, 3- phase, 4-wire stepped down with the transformers provided in the cubicle will be distributed to each building on the site.

In the Project, three new medium voltage power lines of 11 kV, 3 phase, 3 wires will be planned to be fed into the site from 11 kV overhead high tension distribution line supplied by YESC, since the expected power load of the new Thuwunna RLTC is apparently increased from one of the existing CTCs. Tapped power service lines will be connected to the indoor cubicle type switchboard equipment provided in the new Substation Rooms. Low voltage power of 380 / 220V, 3-phase, 4-wire stepped down with the transformers provided in the cubicle will be distributed to Research Laboratory, MOC Training Center and Vocational Training Center and Hostels.

The estimated power demand of the new Research Laboratory Building, MOC Training Center Building and Vocational Training Center Building are shown in the table below:

Table 3-16 Estimated Power Demand

Target Year	Research Laboratory Building	MOC Training Center Building	Vocational Training Center Building	Hostels 3 Buildings	Total kVA	Remarks
	7,620m^2	6,100m^2	6,180m^2	7,280m^2		
Year 2022 (At the start of operation)	7,620m^2 x 80VA/m^2= 609.6kVA	6,100m^2 x 40VA/m^2= 244.0kVA	6,180m^2 x 40VA/m2= 247.2kVA	7,280m^2 x 30VA/m^2= 218.4kVA	1,319.2 kVA	
Year 2032	731.5kVA	292.8kVA	296.6kVA	262.1kVA	1,583.0 kVA	Assuming by 20% increase from 2022

Source: JICA Study Team

Two new substations will be planned for the Research Laboratory Building and MOC Training Center Building + Vocational Training Center Building and Hostels, respectively.

To allow for the expected power demand of the target year, the capacity of substations will be as follows:

1. Research Laboratory Building : 630kVA x one (1) set
2. MOC Training Center Building + Vocational Training Center Building : 630kVA x one (1) set
3. MOC Staff Hostels + Skilled Labor Hostel : 300kVA x one (1) set

b) Emergency Generators

Since the primary power supply and distribution system by YSEC around the project site are considered unstable, an emergency generator set will be planned to be installed so that the training and research conducted in the facilities will proceed even in the event of power failure.

The emergency generator to be used will be a highly reliable and longtime operation type diesel generator and will be installed in the Generator Room adjacent to the Substations. The fuel for the generator will be diesel fuel and stored in the tank for about 10 hours of operation. An emergency electricity load for the operation of the generator will be considered for the operation of water supply pump, septic tank, lighting system, receptacles, etc., excluding the air conditioning system. Generator capacity will be assumed in the calculation shown below:

1. Research Laboratory Building:
   Estimated Generator Capacity = 630kVAx0.8x0.5 = 250KWx one (1) set

2. MOC Training Center Building + Vocational Training Center Building:
   Estimated Generator Capacity = 630kVAx0.8x0.5 = 250KW x one (1) set

3. Hostels:
   Estimated Generator Capacity = 300kVAx0.8x0.5 = 125KW x one (1) set

c) Low Voltage Power Supply (Feeder) System

Low Voltage Power will be distributed from the indoor type cubicle located in Substation Rooms to the Electric Room of each building through the underground cables. The cables will be made of direct buried type steel tape armored cross-linked polyethylene cable in view of reliability, safety and easy installation. Power distribution voltage will be planned as follows:

- Main feeder line: 380/220 V, 3-phase, 4-wire
- Feeder for lighting and receptacles: 220 V, single phase, 2-wire
- Power line for motors: 380 V, 3-phase, 3-wire

d) Lighting Fixtures and Receptacles

Lighting fixtures will be of LED, or light emitting diode type featuring long life and low power consumption. Design illumination level at each room will be planned according to JIS and / or Myanmar's standard requirements. Emergency lighting will be provided in the evacuation route such as stairs and corridors in each building. Receptacles will be planned for location considering usage conditions and the layout of the equipment and furniture in each room

e) Telephone System

Wired or wireless communication trunk lines will be drawn into the RLTC, and the lines will be connected to the IP PABXs, private automatic/electronic exchanger via the Main Distribution Frame (MDF). The IP Exchanger will be planned to be located in the administration offices of Research Laboratory Building and MOC Training Center Building and Hostels, respectively. IP

Telephone handsets will be provided in each office of the Administration Department and laboratories.

f) Local Area Network System (LAN)

A Local Area Network, equivalent to 1000 BASE-T, Campus LAN, will be planned for the provision of internet environment in RLTC. A router and a main switch located on the ground floor of each administration office of the new buildings and switches provided in each building will be planned to network with the connection of fiber optic cables. CAT 6 cables will be laid between each of the switches and LAN outlets provided in major rooms.

g) Public Address System

RLTC will be provided with a public address system for the purpose of announcing time signals, emergency broadcast, etc. An amplifier and a microphone will be installed in each administration office on the ground floor of Research Laboratory Building and MOC Training Center Building, respectively. Each building will be equipped with loudspeakers. A multi-purpose hall in MOC Training Center Building will be provided with local broadcasting system.

h) Automatic Fire Detection and Alarm System

Research Laboratory and the Training Center and the Hostels will be planned to provide various fire protection, detection and alarm systems in accordance with the Fire Service Low in Myanmar and Japan, and to establish a model building similar to MOC buildings equipped with disaster prevention system.

At each strategic point of the rooms and / or area in the building, a heat sensor / smoke sensor will be installed so that fire occurrence can be immediately detected by the fire alarm panel installed in each administration office on the ground floor of Research Laboratory Building and MOC Training Center Building, respectively. In case of fire, the emergency bell and lamp flickering alert warning will be triggered to notify people for evacuation. Three fire control panels will be installed in the Research Laboratory Building, training center buildings (MOC Training Center Building and Vocational Training Center Building) and hostels, respectively.

i) Lightning Protection System

To prevent lightning damage, lightning protection system consisting of arresters, lightning rods, down conductors for grounding will be installed in the buildings having two stories or more floors. In addition, surge arresters (SPD) will be installed in the distribution boards to protect electrical and electronic equipment from internal lightning damage.

j) Photovoltaic Power Generation System

To realize the remarkable reduction of carbon dioxide emission from an environment-friendly point of view, photovoltaic power generation (PV) systems using renewable energy will be provided. Each building will be equipped with solar panels installed on the roof, and the generated direct current (DC) power will be converted to useful alterative current (AC) power by power conditioners which are connected to main distribution panels in the electrical rooms. Thus, PV power will be connected to the grid of YESC.

The expected capacity of PV systems is assumed based on the allowable installation area of each building roof as shown below:

Research Laboratory Building	80 kW
MOC Training Center Building	50 kW
Vocational Training Center Building	80 kW
Hostels	80 kW
Total	290 kW

3) Building Mechanical System

a) Domestic Cold Water Supply System

The city water main pipe managed by YCDC (Yangon City Development Committee) is laid under the road traversing the Project site. Although the current water source is well water lifted from bore holes, the city water with stable water quality and reliable supply capacity will be provided for the new facilities, Research Laboratory Building, MOC Training Center Building and Vocational Training Center Building in consideration of an increase in future water demand. A water intake pipe will be connected to the city water main pipe, and the water introduced though water meter will be stored in the aboveground type, FRP-made water reservoir. Stored water in the reservoir will be distributed to each building by water supply units.

Daily water consumption will be assumed based on the number of users and several parameters as follows:

Table 3-17 Expected Number of Users

Target Year	Research Building	MOC Training Building	Vocational Training Building	Hostels	Total	Remarks
Year 2022 (At the start of operation)	184 persons	8 class x 50persons /class= 400persons	9 class x30persons /class= 270persons	300 persons	1,154 persons	Current staff nos. for Research Building Occupancy of Training Buildings including Lectures
Year 2035	220 persons	480 persons	324 persons	300 persons	1,324 persons	Assuming by 20% increase from 2022

Source: JICA Study Team

Since the data on daily demand rate per person in Myanmar is insufficient, the equivalent Japanese data will be referred to as follows:

- Mean daily water demand: 80~100 liter/person・day
- Daily water demand for hostels: 200 liter/person・day

Using the above conditions, the daily water demand in 2022 and 2035 are estimated as follows:

Year 2022

Research:	184 persons x 100L/person day	=	18,400L/day
Training facilities:	670 persons x 100L/person day	=	67,000L/day
Hostels:	300 persons x 200L/person day	=	60,000L/day

Say total 145m^3/day

Year 2035

Research:	220 persons x 100L/person day	=	22,000L/day
Training facilities:	804 persons x 100L/person day	=	80,400L/day
Hostels:	300 persons x 200L/person day	=	60,000L/day

Say total 162m^3/day

- Water Reservoir and Elevated Tank Capacity:

Water reservoir and tank will be prefabricated and aboveground FRP (fiber reinforced plastics) will be made in consideration of sanitary hygiene and will be of internal partition type dividing two (2) compartments capable of cleaning one area during use.

The capacity of the reservoir will be approx. 50% of daily demand. In addition, water reservoir is planned to be located outside. The calculation for the capacity of reservoir tanks is as follows:

1. Research Laboratory Building

Water reservoir tank：Capacity 22m^3/day × 50% = 11m^3

Dimensions 2m×4m×2.5m (Height)

2. MOC Training Center Building + Vocational Training Center Building

Water reservoir tank：Capacity $80m^3/day \times 50\% = 40m^3$
Dimensions 3m×6m×3.0m (Height)

3. Hostels

Water reservoir tank：Capacity $60m^3/day \times 50\% = 30m^3$
Dimensions 3m×4m×3.0m (Height)

Domestic hot water supply system using electric water heaters will be provided for the bathrooms in the hostels.

b) Wastewater Drainage and Vent System

No main city sewer line is available surrounding the Project site.

Thus, wastewater drain and sewer from the toilets and wash rooms in each building is collected by waste drainage pipe and currently drained outside the building to septic tanks located in nearby toilets. The treated water by septic tank is infiltrated into the ground through soaked well.

At present, it is being planned to provide the new buildings with advanced Wastewater Treatment Plants (hereinafter referred to as WWTP) to promote low environmental impact system on the ground water. Wastewater from toilets, pantry and wash basins, etc., will be treated by WWTPs, and the treated water will be soaked into the soil by soaked pit. Three WWTPs will be installed for Research Laboratory Building and the Training Center Buildings (MOC Training Center Building and Vocational Training Center Building) and Hostels, respectively.

Meanwhile, cleaning wastewater drainage from laboratories in Research Laboratory Building and Training rooms in Vocational Training Center Building will be separated from ordinary wastewater drainage and be led outside to underground sedimentation tanks in which mortar and sand possibly included in the drainage are sedimented. The supernatant water will be soaked into the soil as well as the treated water by WWTPs.

The rainwater collected by the downspout of the building and the groundwater – including rainwater from the paved surface of the site – will be discharged to the infiltration pond, dug wells or public drainage gutter laid along the west side road of the site.

c) Plumbing Fixtures

Plumbing fixtures such as water closet, urinal, washbasin, etc., will be made of vitreous china, a solid and sanitary hygienic fixture. Toilets for persons with disability will be planned on the ground floor in each building.

d) Fire Protection System

In Myanmar, Fire Service Laws and Building codes stipulating fire prevention system and equipment is now sufficiently established for the safety of the building users.

For details on fire protection system necessary for the planned building, specific discussions with relevant authorities concerned are necessary. However, at present, each type of the fire protection system and equipment will proceed and decided on in compliance with the Fire Service Laws in Japan.

- Indoor hydrant system for all building
- Fire extinguisher for all buildings
  Three fire pumps and associated fire water tanks will be installed in the Research Laboratory Building, training center buildings (MOC Training Center Building and Vocational Training Center Building) and hostels, respectively.

e) Wastewater Treatment Plant (WWTP)

The WWTPs to be provided in Research Laboratory Building and Training Center Buildings (MOC Training Center Building and Vocational Training Center Building) will be of biological treating type which assures of stable resolution ability. These will be of underground FRP tanks type as well. The capacity of the WWTPs is equivalent to 80% of domestic water demand as shown below:

- Research Laboratory Building $20m^3$/day BOD20ppm
- MOC Training Center Building + Vocational Training Center Building $80m^3$/day BOD20ppm
- Hostels $60m^3$/day BOD 20ppm

f) Air Conditioning System

According to the Handbook of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE), specifying the design conditions of air conditioning equipment in each city in the world, the outdoor air condition (cooling) for Yangon City are as follows:

Outdoor Design Temperature Condition

- Cooling Season: DB.37.1°C, WB 25.4 °C (Risk Level 1.0 %)

(Source: ASHRAE Fundamentals 2015, Yangon)

Considering such climate and the planned building use, air conditioning will be installed in various rooms that need to maintain an appropriate indoor environment and to improve the efficiency of

various rooms and operations where environmental conditions such as dust, high temperature and humidity are undesirable. The following are the rooms planned to be provided with air conditioning system:

- Research Laboratory Building.: laboratories
- MOC Training Center Building: multi-purpose hall and computer rooms
- Vocational Training Center Building: large lecture room

A split type air-cooled heat pump air conditioning system with high energy efficiency and can be easily operated individually will be planned for each room. The outdoor unit will be installed on the rooftop or on the outdoor wall of each building. In addition, ceiling fans will be installed in various rooms that provide air conditioning to enable natural ventilation and to be used in place of air conditioner to reduce utility costs.

Indoor Design Temperature Condition

- Cooling Season: DB.26.0 °C, RH: (in due course)

g) Mechanical Ventilation System

In order to remove and extract odor, heat and moisture, the following rooms will be provided with mechanical ventilation system. Based on the ASHRAE Design Guideline mentioned above and the Design Standards of the Ministry of Land, Infrastructure and Transport of Japan, the design standards for ventilation system applied in this project are listed in the table shown below:

Table 3-18 Design Conditions for Ventilation System

Room	Ventilation Fan	Ventilation Rate	Note
General Air-conditioned Rms.	Supply Air Fan	25m3/person-hour	Fresh air intake
Laboratories	Supply & Exhaust Air Fan	5 – 8 times/hr. air change	-
Large Hall	Air conditioner	25m3/person-hour	Fresh air intake
Storage	Exhaust Air Fan only	5 times/hr. air change	-
Toilet	Exhaust Air Fan only	10 times/hr. air change	Removal of odor
Elec. Rm.	Exhaust Air Fan only	10 times/hr. air change	Extraction of heat
Diesel Generator Rm.	Supply & Exhaust Air Fan	25 - 30 times/hr. air change	Fresh air intake for combustion and extraction heat

Source: JICA Study Team

3.2.6 Equipment Plan

(1) Planning of Equipment Procurement

The functions of each department and the main equipment items requested are shown in Table 3-19 below:

Table 3-19 Main Equipment Items Based on Functions of Each Department

No.	Department	Functions	Main items of Equipment
1.	Central Training Center (CTC)	➢ Vocational Training and Skills Testing ➢ Technical Training of officers of MOC	• Concrete Cutter, Total Station, Concrete mixer, Level and so on • Office Equipment for Text preparation
2.	Department of Bridge	➢ Concrete Test	• Compressive testing machine, Soundness (Autoclave) and so on
		➢ Soil Test	• Consolidation testing machine, Core barrel and so on
3.	Department of Highways	➢ Coarse and Fine Aggregates Test	• Los Angeles abrasion machine, Electric Balance and so on
		➢ Cement Test	• Cement Autoclave, Automatic Digital mortar Mixer, and Temperature and Humidity Controlled Cabinet and so on
		➢ Concrete Test	• Pan-type Mixer, Slump Cone Set and so on
		➢ Soil Test	• Los-Angeles Abrasion Test, Triaxial Compression Test, and so on
		➢ Asphalt Test	• Gyratory Compactor, Automatic Asphalt Extraction Apparatus
4.	Department of Building	➢ Concrete Test	• Concrete curing specimen tank, SIT (Sonic Integrity Test), and so on
		➢ Soil Test	• Direct Shear Test Apparatus, Consolidation Testing Apparatus
		➢ Steel Test	• Universal Tensile Testing Machine, Floor-standing Optical Emission Spectrometer
5.	Department of Rural Road Development	➢ Soil Test	• CBR Apparatus, Consolidation Test Equipment
		➢ Material Test (Aggregates)	• Compressive Testing Machine, Los Angeles Abrasion testing machine
		➢ Field Testing	• CBR Apparatus, SIT (Sonic Integrity Testing)

Source: JICA Study Team

(2) Examination of Equipment Planning Policy

1) Basic Policy Based on the Field Survey Results

As for CTC buildings which are in short supply of and / or have deteriorated equipment units, the equipment required for lecture and practical training rooms will be mainly examined in terms of provision of supplemental equipment and replacement of obsolete units with advanced ones. Through the field survey, it is found out that each laboratory has common testing function; thus, some of the equipment units are overlapping in function. Therefore, this project will aim to integrate as many overlapping equipment as possible, assuming that testing equipment will be placed according to testing material and all the research laboratories will commonly use such testing equipment in the near future.

2) Basic Policy for the Infrastructure of the Project Site

The factors that cause malfunction or damage of the equipment include the hard quality of water and power fluctuation, which includes current levels exceeding normal range caused by occasional power failure. The power supply will seriously affect the performance of the precision equipment,

as the power cable is directly drawn from the outside. Since some precision equipment items are included in the equipment requested, provision of uninterrupted power supply (UPS), in addition to an Automatic Voltage Regulator (AVR) and an Automatic Voltage Switcher (AVS), will serve as countermeasures for power fluctuation. As there are some items using water, it is desirable that the water shall be treated by filtering and / or water softener.

3) Reflection of Lessons to the Project

Table 3-20 below shows the lessons and countermeasures obtained from the survey of similar facilities:

Table 3-20 Lessons and Countermeasures

Requested Equipment	Issues	Correspondence in this Project
Asphalt Extraction Centrifuge	Gasoline is used as a solvent to abstract asphalt out of samples in open area, which would cause ignition to flammables. It takes a long time to dry the residue of abstraction.	➢ To raise the repeatability of the testing and to eliminate health risks (such as solvent absorption by an officer performing elution) by collecting the solvent and transferring it into a drying system that closes semi-automatically. ➢ To reduce the risk to health and ignition by using low toxic or non-flammable solvent such as ethylene tribromide.
Draft Chamber	The solvent is used during asphalt testing and other work such as washing of containers, which is left in an open space for natural ventilation.	➢ To prevent officers from absorbing the solvent and the foul steam generated at the time of testing/washing, and to improve safety and hygiene by properly exhausting the foul steam outdoors.
Sieve shaker	Sieving of the aggregate is manually done and time-consuming and repeatability is low. The conventional low tap sieve shaker produces loud noise and heavy dust during operation.	➢ To procure electromagnetic type of sieve shaker which does not generate too much noise and with relatively high repeatability.

Source: JICA Study Team

4) Result of Inspection of Requested Equipment

Table 3-21 Inspection of Main Equipment Items

Department	Description	Use	Justification
CTC	Concrete compression machine	To conduct compression tests of concrete	To use for practical training of MOC officers.
DOH (Lab-1: Asphalt)	Automatic Asphalt Extraction Apparatus	To determine bitumen content contained in Asphalt concrete	To procure newly to make testing more safely with higher repeatability compared to a conventional extractor.
DOH (Lab-2: Cement)	Temperature and Humidity Controlled Cabinet	To secure the environment for testing under constant temperatures and humidity with high accuracy	Essential to conduct various testing under the temperatures and humidity Specified in ASTM
DOH (Lab-3: Soil)	Triaxial Compression Test	To conduct soil testing to determine the strength constant of embankment material used for reinforced earth wall.	To enhance accuracy by replacement of obsolete existing manual testing machine with a new automatic testing machine.
DOBi	Blaine Air Permeability Apparatus	To determine the fineness of cement by measurement of the specific surface area	To procure testing equipment which complies with ASTM C204.
	Universal Tensile Strength Machine	To determine tensile strength, compression strength, bending shear strength of rebar and compression of concrete and bend strength Capacity: 1000kN	To enhance accuracy by replacement of existing obsolete testing equipment with an item complying with ASTM 4370.
DOB	Compressive machine	To determine compressive strength of cement mortar. Capacity: 1000-1300kN	To replace obsolete existing testing machine with a digitalized item to enhance accuracy of testing.
	Consolidation Test Equipment	To determine quantity of by the compaction of the viscous soil subsidence, subsidence speed, permeability.	To procure digitalized item to enhance accuracy of testing.
DRRD	SIT machine	For pile integrity test, Partial abnormal detection of the cavity, and property survey of civil engineering structure.	To procure for field testing newly.
	Consolidation Test Equipment	To determine quantity of by the compaction of the viscous soil subsidence, subsidence speed, permeability.	To procure testing equipment in shortage to meet the testing demands.

Source: JICA Study Team

The results of the examination of requested equipment items are shown in Appendix-3. The selection of equipment shall be judged based on the selection criteria and the results of the analysis will be conducted in Japan. The selection criteria of equipment procurement are as follows:

1. The prioritized items which are essential to training or performing ASTM test;
2. Should meet the technical level of engineers / technicians in the target facility;
3. Should be items where maintenance services provided by local agents could be secured;

4. Should be items of precision and of high accuracy, or items in which quantity is too many to be procured during the annual development plan; and
5. Should be supplementary items to increase the existing quantity in order to meet future usage demand.

The Draft Equipment Plan which was conceived based on the results of analysis conducted in Japan is shown in Table 3-22 below:

Table 3-22 Draft Equipment Plan

Item No.	Description	Quantity	Use
Thuwunna CTC			
1-1	Cutting machine for brick	10	Practical Training
1-2	Bending machine for rebar	8	Practical Training
1-3	Cutting machine for rebar	8	Practical Training
1-4	Tying machine for rebar	8	Practical Training
1-5	Total station	10	Practical Training
1-6	Theodolite	10	Practical Training
1-7	Level	10	Practical Training
1-8	Concrete mixer	5	Practical Training
1-9	Los Angeles abrasion machine	1	Practical Training
1-10	Concrete compression machine	1	Practical Training
1-11	Desktop computer	10	Lecturing
1-12	Laptop computer	10	Lecturing
1-13	Printer color	10	Lecturing
1-14	Copier medium	10	Lecturing
1-15	Projector	10	Lecturing
1-16	Plate Compactor	10	Practical Training
1-17	Recessed screens	10	Practical Training
DOB (Soil Testing)			
2-1	Double Tube Core Barrel Complete Assembly	5	Quality Control
2-2	Consolidation Test Apparatus	2	Quality Control
2-3	Oven	1	Quality Control
DOB (Concrete Testing)			
2-4	Flow Table Test (Flow of hydraulic cement Mortars and cement pastes) Apparatus	1	Quality Control
2-5	Turbidimeter Test Apparatus with accessories	1	Quality Control
2-6	Soundness Test (Autoclave) Apparatus with accessories	1	Quality Control
2-7	Compressive Strength Test	1	Quality Control

Item No.	Description	Quantity	Use
DOBi (Concrete Testing)			
3-1	Mortar Mixer	3	Quality Control
3-2	Automatic Blaine Fineness Apparatus	1	Quality Control
3-3	Electronic Analytical balance	3	Quality Control
3-4	Curing Bench	1	Quality Control
3-5	Flow Tables Machine	2	Quality Control
3-6	Concrete curing specimen tank	2	Quality Control
3-7	S.I.T (Sonic Integrity Test)	1	Quality Control
3-8	Ultrasonic Pulse Velocity Tester	1	Quality Control
3-9	Pulse Echo Foundation Tester	1	Quality Control
3-10	Flat Jacks	1	Quality Control
3-11	Laboratory Ovens	1	Quality Control
3-12	Electromagnetic Sieves Shaker	1	Quality Control
3-13	Rotary Automatic scales	3	Quality Control
3-14	Water Stills	2	Quality Control
3-15	Pulse Echo Foundation Tester	1	Quality Control
3-16	Cross Hole Ultrasonic Monitor	1	Quality Control
3-17	Compression Machine 3000 KN	2	Quality Control
DOBi (Soil Testing)			
3-18	Direct Shear Test Apparatus C/W All Accessories	1	Quality Control
3-19	Horizontal Sample Ejector	1	Quality Control
3-20	Moist Cabinet	1	Quality Control
DOBi (Steel Testing)			
3-21	Universal Tensile Testing Machine (1000 kN)	1	Quality Control
3-22	Cold Bend Testing Machine	1	Quality Control
3-23	Floor-standing Optical Emission Spectrometers	1	Quality Control
DOBi (Office Equipment)			
3-24	Copier	5	Data Processing
3-25	Computer (Laptop)	11	Data Processing
3-26	Printer (A3)	5	Data Processing
3-27	Computer (desktop)w/ desk	3	Data Processing
DOH (Bitumen Testing (Lab-1))			
4-1	Gyratory Compactor	1	Quality Control
4-2	Laboratory Saw	1	Quality Control
4-3	Universal Core Drill for AC	1	Quality Control
4-4	Standard Rotational Viscometer	1	Quality Control
4-5	Oven (0-120º C)	1	Quality Control
4-6	Automatic Asphalt Extraction Apparatus	1	Quality Control
4-7	Draft Chamber	3	Quality Control
4-8	Electromagnetic Sieves shaker	1	Quality Control
DOH (Fine and Coarse Aggregates Testing (Lab-2))			
4-9	Los Angeles Machine	1	Quality Control
4-10	Pilot Compact-line	1	Quality Control
4-11	Electromagnetic Sieve Shaker	1	Quality Control
DOH (Cement Testing (Lab-2))			
4-12	High Pressure Cement Autoclave	1	Quality Control
4-13	Automatic Digital mortar Mixer	1	Quality Control
4-14	Temperature and Humidity Controlled Cabinet	1	Quality Control
DOH (Concrete Testing (Lab-2))			
4-15	Pan-type Mixer with accessories	1	Quality Control

Item No.	Description	Quantity	Use
DOH (Soil Testing (Lab-3))			
4-16	Los-Angeles Abrasion Test	1	Quality Control
4-17	Triaxial Compression Test	1	Quality Control
DRRD (Soil Testing)			
5-1	CBR Apparatus	3	Quality Control
5-2	Direct Shear Test Equipment	1	Quality Control
5-3	Moisture Tester	2	Quality Control
5-4	Consolidation Test Equipment	1	Quality Control
5-5	Oven 100 Litters	1	Quality Control
DRRD (Aggregates Testing)			
5-6	Compressive Testing Machine	3	Quality Control
5-7	Los Angeles Abrasion testing machine	1	Quality Control
DRRD (Field Survey/Testing)			
5-8	Total Station	2	Survey/Testing
5-9	Level	1	Survey/Testing
5-10	SIT (Sonic Integrity Testing)	1	Survey/Testing
5-11	Theodolite	1	Survey/Testing
Furniture			
6-1	Experiment Table-1	27	Working and Testing
6-2	Experiment Table -2	19	Working and Testing
6-3	Experiment Table-3	38	Working and Testing
6-4	Experiment Table-4	32	Working and Testing
6-5	Experiment Table-5	21	Working and Testing
6-6	Lab Sink-1	42	Working and Testing
6-7	Lab Sink-2	21	Working and Testing

Source: JICA Study Team

3.2.7 Operation Plan

With the start of the preparation for the new facilities and equipment under the new Japanese Loan Project, Thuwunna RLTC will be requested to operate and maintain them properly. In addition, Thuwunna RLTC will also be expected to enhance its service quality and efficiency and to expand the business scale and contents. It is possible to secure new income sources which can be budgeted to cover for the shortage of operation funds and maintenance cost of new facilities and equipment, and to enhance and expand the business scale and contents through these events / circumstances.

The table below shows feasible business ideas based on good practices and actual situations in other ASEAN countries and the private sector in Myanmar. The estimated incomes are also shown below as potential utility values of new facilities and equipment. The incomes are estimated under the conditions that the operation and maintenance of the organization are established appropriately, that the necessary budget is allocated and efficiently utilized in consideration of the current management ability with no negative impacts on socio-economic environment, and that it is possible to secure a stable service demand.

Table 3-23 Feasible Business Ideas

	Business Idea	Revenue Description	Targets/ Payers expected	Feasible Start Time	Current Situation*
1	**Human Resources Development Services**				
1-1	Training (for current/ex MOC staff trainings, engineering)	training fee	MOC, Contractors	1. the current	A. ongoing for free
1-2	Training (for MOC staff trainings, administrations)	training fee	MOC	1. the current	A. ongoing for free
1-3	Training (for Skilled labor training)	training fee	Contractors	1. the current	A. ongoing for free*
1-4	Construction Workforce Registration System (for single skill)	application fee	Workers	1. the current	C. no service provided
1-5	Construction Workforce Registration System (for multi skills)	application fee	Workers	1. the current	C. no service provided
1-6	Personnel dispatching	introduction fee	Contractors	1. the current	C. no service provided
2	**Quality Authentication Services**				
2-1	Construction material testing	testing and certificating fees	Contractors	1. the current	A. ongoing for free*
2-2	Quality assurance testing	testing and certificating fees	Contractors	1. the current	A. ongoing for free*
2-3	Materials' quality certificating	certificating fee	Contractors	1. the current	C. no service provided*
3	**Contractors/Construction Works Management Services**				
3-1	Builders Licensing System (to carry out building works in the country)	licensing fee	Contractors	1. the current	C. no service provided
3-2	Contractors Registration System (to tender or carry out public sector construction and construction-related projects in the country)	licensing/registration fee	Contractors	1. the current	C. no service provided
4	**Information Description/Exhibition Services**				
4-1	Holding exhibitions	exhibition fee	Exhibitors	2. after the Project completion	C. no service provided
4-2	Information subscription (business expectations, tender price index, etc.)	subscription fee	Contractors	1. the current	C. no service provided
5	**Facilities Renting Services**				
5-1	Renting the Lecture rooms	rental fee	insider/outsider	2. after the Project completion	C. no service provided
5-2	Renting the Laboratories, Workshops, PC rooms	rental fee	insider/outsider	2. after the Project completion	C. no service provided
5-3	Renting the Hall	rental fee	insider/outsider	2. after the Project completion	C. no service provided
5-4	Renting the Dormitories	rental fee	insider/outsider	2. after the Project completion	C. no service provided
5-5	Renting the Equipment	rental fee	insider/outsider	2. after the Project completion	C. no service provided

Note*: The situations are as of March 2019. The ideas with * marks are especially necessary to confirm the status again.
Source: JICA Study Team

Table 3-24 Incomes Estimated from Feasible Business Ideas / Potential Utility Values

No.	Business Idea	Expected Incomes/year (the 1st year)
1	Human Resources Development Services	USD 1,657,937
2	Quality Authentication Services	USD 26,500
3	Contractors/Construction Works Management Services	USD 3,571
4	Information Description/Exhibition Services	USD 3,249
5	Facilities Renting Services	USD 284,986
	TOTAL	USD 1,976,243
	ROUND OFF	USD 1,976,000

Note: The estimated amount depends on operation conditions, outsider factors and so on.
Source: JICA Study Team

3.2.8 Construction Plan and Procurement Plan

(1) Survey on Construction Conditions

The construction sites for the MOC Training Center, the Vocational Training Center, and the Research Laboratory are located in Thuwunna, Yangon. Currently, high-rise buildings and large-scale shopping malls, etc., are under construction in Yangon. Some buildings, which are similar in terms of size and structure (RC structure) planned for this project, are under construction without causing problems to local contractors. Therefore, from the point of view of technical capabilities and safety management, it is deemed possible to carry out the construction works of the training center and research laboratory by local contractors.

Downtown of Yangon lined with many high-rise buildings

Facilities under construction in the Yangon. Tower cranes and other construction machines can be procured sufficiently.

Source: JICA Study Team

Figure 3-14 Construction Status in Yangon

In terms of financial capability of top local contractors, it has also been confirmed that they have abundant project experience with the same or larger contract amount in comparison with the assessment for the new training center. In addition, it has been confirmed that construction materials,

electrical and mechanical equipment, laborers, construction machinery, furniture, etc., can be procured in Yangon. In particular, cement and sand are prepared in Yangon, and several ready-mix concrete plants are located in Yangon. Therefore, there are adequate supplies required for this construction work.

Based on the ground survey results in the project site, soft ground is assumed for the site. There is a need to consider piling work and / or soil improvement work in the construction plan. There are several piling factories in Yangon that are producing PC piles, etc., and the factories have construction machines for piling work. Therefore, it was confirmed that piling work is possible in Yangon.

(2) Survey on Procurement Conditions

The functions of the target facility are the following: 1) performing a wide variety of vocational training and enforcing skills examination; and 2) quality control testing and research of new materials for construction and civil works. There exist some private testing facilities which examine materials such as rebar or the cement for use in civil works and building works, and conduct environmental examination including test of water quality in a facility similar to the target facility in Yangon City. However, its function and scale are limited, and no facility exists to substitute for the function of the target facility at the moment.

The equipment being used in the target facilities corresponding to the testing demand have been procured using the annual development budget of the government. However, precision and expensive equipment have been procured through the assistance of ADB and JICA technical cooperation project in recent several years.

The equipment procurement for the target facility has been implemented by local equipment agents and suppliers contracted by means of official bidding among registered companies. The suppliers are responsible for equipment procurement, installation, operation, training and maintenance services according to the supply contract. Local suppliers are quite limited to participate in the bidding on equipment procurement for this project, as their achievements and financial ability are not sufficient in comparison with the scale and procurement range of this procurement plan. Thus, it is assumed that procurement of the equipment for this particular project shall be determined by the International Competitive Bidding (ICB).

(3) Examination of Construction and Procurement Methods

1) Examination of Bidding Methods

The bidding methods of the project shall be based on standard bidding documents for the procurement of goods and works and standard request for proposals for the selection of consultants, as published by JICA

Table 3-25 JICA Guidelines on Bidding Methods of Yen Loan Projects

Item	Guidelines
Package 1: Procurement of Equipment	Standard bidding documents under Japanese ODA Loans Procurement of Goods, May 2013
Package 2: Construction of Training Center	Standard bidding documents under Japanese ODA Loans Procurement of Works, October 2012
Selection of Consultants	Standard request for proposals under Japanese ODA Loans Selection of Consultants, October 2012

Source: JICA Study Team

For the bidding methods, there are "Single-Stage One-Envelope" method, "Single-Stage Two-Envelope" method, "Two-Stage One-Envelope" method and "Two-Stage Two-Envelope" method.

Considering the scale of the project, "Single-Stage Two-Envelope" Method is recommended.

2) Bidding Package

The draft package plan is shown in Table 3-26 below:

Table 3-26 Draft Package Plan

Package	Summary
Package 1 (ICB: International Competitive Bidding)	Equipment Procurement（Total Station, Triaxial Testing Machine, Gyratory Compactor, Consolidation Testing Machine and so on）
Package 2 (LCB: Local Competitive Bidding)	Building Works for the MOC Training Center, Vocational Training Center, Research Laboratory, Hostels, adjustment pond, on-site roads, entrance gates

Source: JICA Study Team

- Package 1 Procurement of Equipment

  Procurement of vocational training equipment and testing equipment is planned in one package.

- Package 2 Building works

  Construction of Training Center and Research Laboratory is planned in one package.

3) Facilities

The result of the survey of local construction status and procurement methods and the material plan for the training centers and research laboratory shall be formulated based on climatic conditions, location of the site, local construction situation, construction period, construction cost, and maintenance and operation costs. The following shall be considered as basic policies:

- Local procurement of construction materials shall be considered to reduce construction costs and construction period.
- The maintenance and operational costs shall be reduced by considering adapting to local climate conditions, resistance against climate impact and selection of materials that are easy to maintain and locally obtainable.

In general, the facilities for the training center and research laboratory are planned to use local construction materials that can be procured in Myanmar. Also, it is assumed that local contractors will undertake construction of these facilities.

4) Equipment Procurement

As the result of equipment procurement survey, the following are proposed as basic policies for the equipment procurement and / or installation method giving consideration of the conditions of infrastructure in Myanmar, procurement situation, procurement and installation period, installation fee and maintenance costs:

- To ensure that the selected equipment correspond to the technical level of officers of the target facility;
- To prioritize items that comply with ASTM due to recent transition from BS to ASTM;
- To consider the durability of equipment and other specifications to satisfy local infrastructure conditions such as power supply and water quality;
- To take into consideration the safety and hygiene of officers during equipment planning, as testing samples include toxic substances;
- To prioritize items in which local agents are established and to secure after-sales services, as this equipment procurement plan includes many precision equipment items which require periodic calibration and procurement of spare parts;

It is assumed that a supplier would be an international contractor for this equipment procurement, taking into consideration the possibility of procuring equipment in this country, the scale of the project, procurement of varied equipment, and the difficulty of installation works, etc.

4. Project Implementation, Operation and Maintenance Structure

4.1 Project Implementation Structure

(1) Project Implementing Agency

The executing agency of the yen loan project is MOC. CTC was established in 1966 under MOC in order to provide training for MOC staff as its main function. Currently, reorganization of MOC is in progress, and the position of CTC in the ministry is under review at this point. MOC will be in charge with supervisory function.

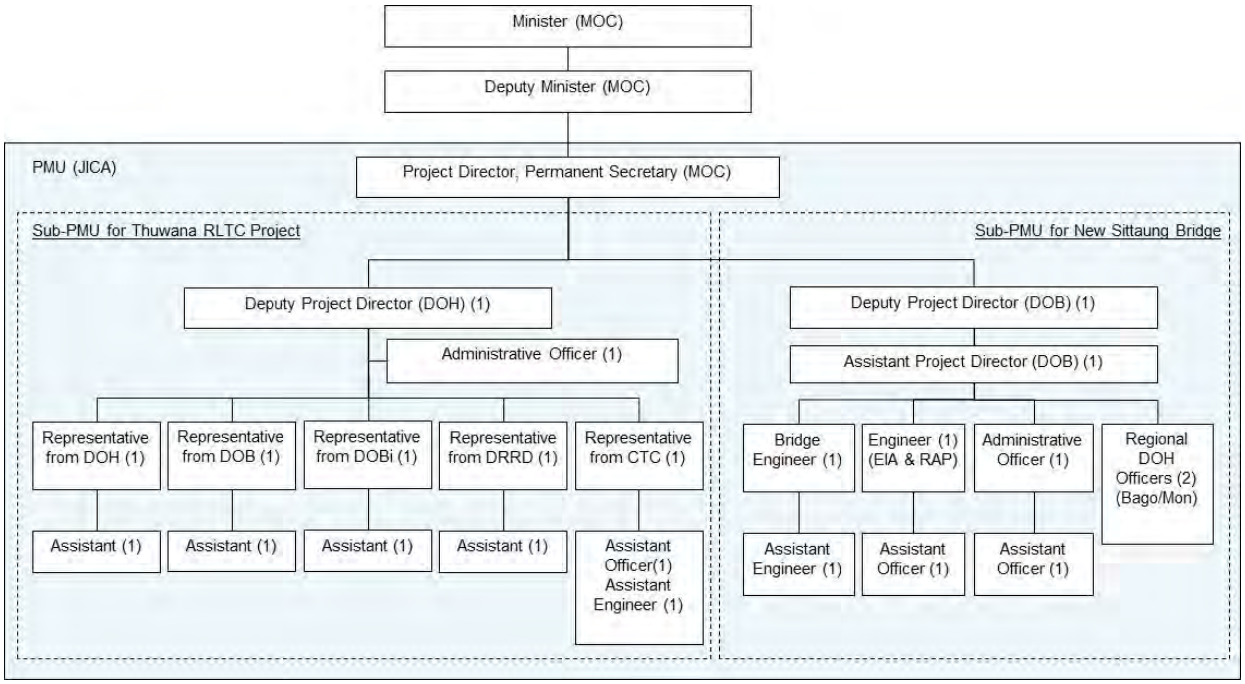
(2) Project Management Unit (PMU)

For smooth implementation of this project, a Project Management Unit (PMU) will be established jointly with the Construction of New Sittaung Bridge Project. The PMU will be composed of relevant organizations related to the implementation of this project. In addition to having a project implementation function, PMU will be responsible for facilitating coordination among relevant organizations. As a cross-organizational unit, it is expected to be established directly under MOC Permanent Secretary in order to minimize the impact of various political, economic and social transformations in the counterpart country on the implementation of this project. The outline of PMU is shown in Table 4-1 and the Organization of PMU is shown in Figure 4-1 below:

Table 4-1 Outline of PMU

Purpose	For smooth implementation of the yen loan project, PMU will be established directly under the MOC Deputy Minister as a cross-sectional unit of relevant organizations on the Myanmar side. One PMU will be established jointly by the Construction of New Sittaung Bridge Project and the Upgrading of Thuwunna RLTC Project.
Main Functions / Activities	1. Implementation and adjustment of necessary procedures on the Myanmar side pertaining to the implementation of the project. 2. Progress confirmation, information sharing / storage and coordination among relevant organizations including those from the Japanese side. 3. Procurement and supervision of consultants. 4. Approval of tender documents, tender implementation, contract with the construction / procurement supplier and construction / equipment installation supervision. 5. Approval of payment to the consultant / vendor. 6. Report to JICA.
Organization	MOC, DOH, DOB, DOBi, DRRD, CTC

Source: JICA Study Team



Source: JICA Study Team

Figure 4-1 Organization of PMU

(3) Related Organizations

The organizations related to the implementation of this ODA loan project are as shown in Table 4-2 below:

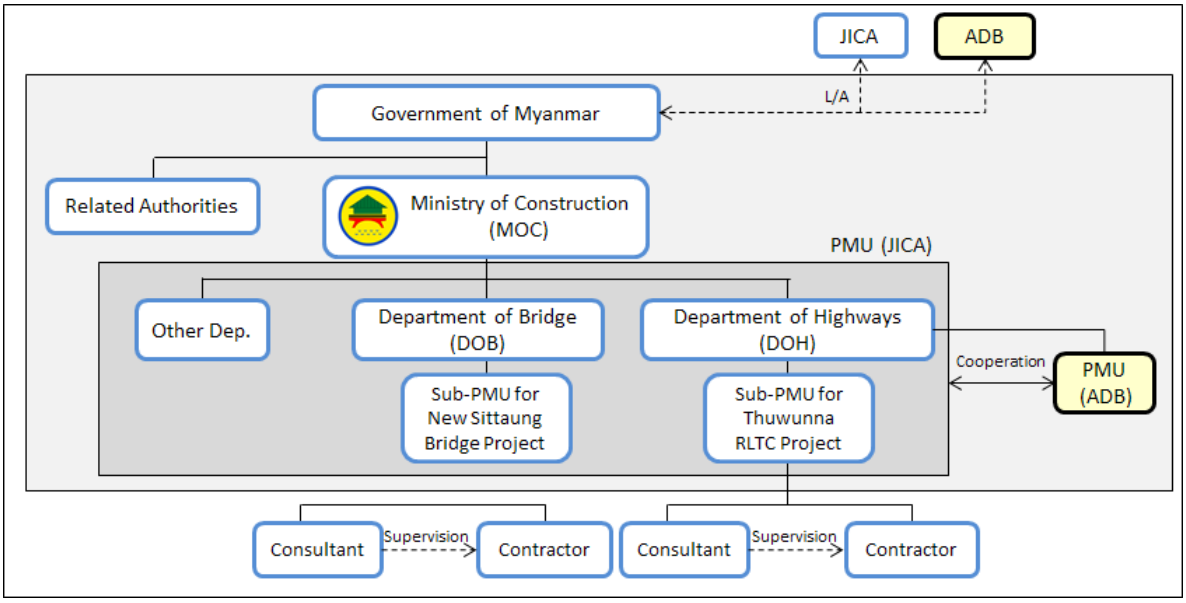
Table 4-2 Mission of Each Related Organization

Mission	Organizations in Charge
Project implementation procedure, etc.	Treasury Department, Budget Department, Ministry of Planning and Finance (MOPF) Foreign Economic Relations Department, Ministry of Planning and Finance (MOPF)
Loaned country payment bank	Myanmar Economic Bank, Ministry of Finance
Judicial audit	Attorney General Office
Accounting audit	Auditor General Office
Business supervisor	MOC: Ministry of Construction
Project implementation	PMU
Technical cooperation	Research cooperating organizations such as higher education institutions etc.

Source: JICA Study Team

(4) Project Implementation Organization

In addition to Myanmar's related organizations as mentioned above, it is planned that a detailed design and construction/procurement supervision consultant will be hired during the implementation of this yen loan project. This consultant will be responsible for the preparation of tender documents, implementation of tender(s), contract management, etc., and the PMU will also manage, confirm and approve each operation. The diagram shown in Figure 4-2 illustrates the relationship between the Myanmar side and the Japan side.



Source: JICA Study Team

Figure 4-2 Project Implementation Organization

4.2 Operation and Maintenance Structure

4.2.1 Securing the Budget Necessary for Operation and Maintenance

The budget for operation and maintenance of CTC and each department's research laboratory – which will be the implementing agency of the Project – are requested from each organization by MOC and will be secured within the MOC budget. The actual budget transition for CTC and each department's research laboratory in 2016-2018 are shown below. Based on previous records, the amount of budget in most organizations has been increasing year by year.

Table 4-3 Budget for Thuwunna CTC and Relevant Agencies (2015-2018)

Currency: Million Kyats

Period	CTC		DOH(RDS)		DOB		DOBi	
	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual
2015-2016	271.780	271.780	167.233	166.573	154.156	154.156	703.887	504.561
2016-2017	331.361	331.361	634.116	634.116	264.917	264.917	1,072.479	881.003
2017-2018	518.666	518.666	681.031	681.031	462.666	462.666	1,022.900	848.168

Notes: There was no answer from DRRD regarding the budget.
Source: JICA Study Team

4.2.2 Project Operation Plan

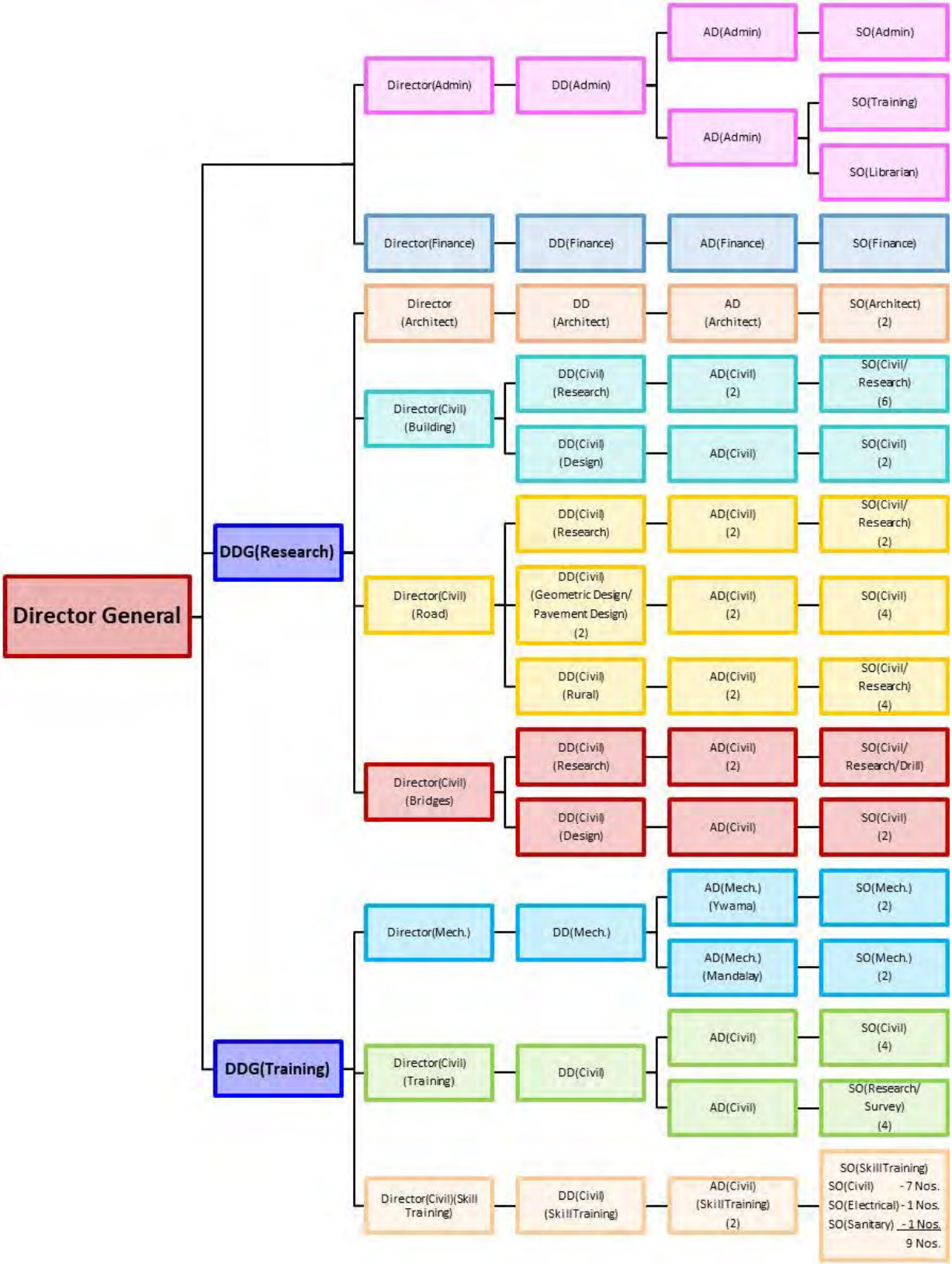
(1) Operation and Maintenance Plan for Facilities

For Thuwunna CTC, facility management and maintenance is currently performed by electricians (3 people), technicians for water supply (5 people) and gardeners (7 people). For other department labs, the work is conducted mainly by junior engineers in each department. However, since the

existing buildings have severely deteriorated and / or have become hazardous, there are some buildings that are no longer being used, and some have been repurposed as storage areas for equipment items and others.

Following the reorganization in the future, it has been decided that four research laboratories belonging to different departments of MOC and CTC under DOH will be integrated into the newly established as "Research Laboratory and Training Department". Therefore, for RLTC, it is proposed to allocate a dedicated maintenance manager to maintain the entire facility. In addition, it is proposed that the maintenance manager of the new facilities shall retain the as-built drawings of the existing facilities, regularly carry out daily inspections and keep records. Furthermore, it will be necessary to establish maintenance procedures premised on preventive maintenance and documentation of records (computerization, etc.), and it will also be necessary to educate and train the workers in charge of maintenance and inspection works.

Although the organizational structure of the newly established "Research Laboratory and Training Department" is currently being discussed within the MOC and the contents have not been finalized, the current organizational chart (draft) is shown in the figure below. The total number of staff is expected to be 100-120 people.



Note: - It also includes the organization of Mechanical Training Center (MTC) in Mandalay and Ywama of Yangon.
- Organizational Chart is currently under consideration in the MOC.

Source: JICA Study Team

Figure 4-3 Research Laboratory and Training Department Organizational Chart (Draft)

(2) Operation and Maintenance Plan for Equipment

There is no specific section which takes charge of equipment maintenance, and thus each department chief takes responsibility for maintenance works. The maintenance works consists of breakdown maintenance and implementation of periodical checks, including calibration to keep the accuracy of measuring equipment. It requires the training of users regarding the operation method and daily maintenance to ensure that the equipment will run efficiently and properly. A registered equipment supplier or a local agent provides such training as specified in the supply contract. A registered supplier also takes full responsibility for breakdown maintenance, supply of spare parts and consumables, and calibration of equipment. Though each department has kept no recording of maintenance history by item, it has kept recording of periodical checks including calibration. According to interviews with each department chief, maintenance budget is not allocated. Thus, each department applies to the higher authority of the ministry for the provision of such necessary budget for repair and calibration services, with price quotations obtained from local agents. The same kind of procedures is also undertaken for the procurement of new equipment, and the ministry has budget allocation for equipment procurement.

For the establishment of the maintenance system for this Project – considering the above-mentioned situation – equipment types that has an local agents on site should be prioritized when procuring new equipment, and this condition should be reflected in the bidding documents. Each department chief is in charge of the maintenance of the equipment and will take responsibility throughout the duration of the project. It has been said during an interview that improper operation and/or non-availability of necessary spare parts and consumables would most likely cause failure and equipment troubles. Hence, plans for this Project include training of users on operation, frontline maintenance to prevent malfunctioning and securing maintenance services by local agents.

4.2.3 Operation and Maintenance Cost

(1) Expenses Required for the Facilities

The total running cost (i.e. expenses for water, power and fuel) for the RLTC is calculated as follows:

Table 4-4 Annual Running Cost for RLTC

Unit: MMK

No.	Items	Annual cost	VAT (Tax 5%)	Total Amount	Remarks
1	Electric Cost	600,525,360	30,026,268	630,551,628	
2	Water Supply Cost	99,000	4,950	103,950	YCDC city water: fixed rate
3	Fuel Cost for Standby Generator	57,000,000	2,850,000	59,850,000	
4	LPG Cost	16,464,000	823,200	17,287,200	
5	Telephone Cost	2,160	108	2,268	
6	Internet Access Cost	25,380,000	1,269,000	26,649,000	
	Total	699,470,520	34,973,526	734,444,046	

Source: JICA Study Team

The detailed running costs for each item are calculated as follows:

1) Electricity Cost

a) Tariff of Electricity

Fixed Charge: 1,624,320 MMK/month

Unit Charge: 180 MMK/kWh at normal hours

b) Annual Cost

Annual Cost is calculated as follows:

Table 4-5 Annual Electricity Cost

	Load Category	Electrical Characteristic	Floor Area	Load Density	Load	Demand Factor	Demand	Load Factor	Power Consumption	Monthly Cost			Annual Cost
										Fixed Charge	Unit Charge	Total	
			m^2	VA/m^2	kVA	%	kW	%	kWH/month	MMK／month	MMK／KWH	MMK／month	MMK／month
Research Laboratory													
1	Lighting	1φ2W	7,620	15	114	50.00	57.0	15.00	6,156				
2	Small appliances	1φ2W	7,620	10	76	50.00	38.0	15.00	4,104				
3	Air conditioning	1φ2W	7,620	60	457	80.00	365.6	30.00	78,970				
4	Laboratory Equipment	3φ3W	7,620	30	229	50.00	114.5	15.00	12,366				
5	Pumps, WWTP etc.	3φ3W	7,620		40	100.00	40.0	50.00	14,400				
	Sub total				916		615		115,996	1,624,320	20,879,280	22,503,600	270,043,200
MOC Training Center, Vocational Training Center													
1	Lighting	1φ2W	12,280	15	184	50.00	92.0	15.00	9,936				
2	Small appliances	1φ2W	12,280	10	123	50.00	61.5	15.00	6,642				
3	Air conditioning	1φ2W	12,280	30	368	80.00	294.4	30.00	63,590				
4	Training Euipment	3φ3W	12,280	15	184	50.00	92.0	15.00	9,936				
5	Pumps, WWTP etc.	3φ3W	12,280		40	100.00	40.0	50.00	14,400				
	Sub total				899		580		104,504	1,624,320	18,810,720	20,435,040	245,220,480
Hostels 3 buildings													
1	Lighting	1φ2W	7,280	15	109	50.00	54.5	15.00	5,886				
2	Small appliances	1φ2W	7,280	10	73	50.00	36.5	15.00	3,942				
3	Air conditioning	1φ2W	7,280	5	36	80.00	28.8	30.00	6,221				
4	Pumps, WWTP etc.	3φ3W	7,280		40	100.00	40.0	50.00	14,400				
	Sub total				258		160		30,449	1,624,320	5,480,820	7,105,140	85,261,680
	Total												**600,525,360**

Source: JICA Study Team

2) Water Supply Cost (Water Sewage Cost is not applicable)

Annual Cost is calculated as follows:

Table 4-6 Annual Water Supply Cost

	Buildinbg Name	Number of Trainer, Trainees	Water Consumption			Monthly Cost	Annual Cost
		Day	Liter/day･Person	Liter/day	m3/month	MMK/Month	MMK/Year
		(a)	(b)	(c)=(a)*(b)	(d)=(c)*30*0.001	(e): YCDC City water fixed rate	(f)=(e)*12
1	Research Laboratory	220	100	22,000	660	2,750	33,000
2	MOC TC, Vocational TC	804	100	80,400	2,412	2,750	33,000
3	Hostels 3 buildings	300	200	60,000	1,800	2,750	33,000
	Total	1,324			4,872	8,250	**99,000**

Source: JICA Study Team

3) Fuel Cost for Standby Generator

a) Specification of Generator

250KVA, 3φ4W, 380/220V50Hz

Fuel: Heavy Oil

b) Annual Cost

Annual Cost is calculated as follows:

Table 4-7 Annual Fuel Cost for Standby Generator

	Generator	Quantity	Runnning Time	Monthly Running Time	Unit Fuel Consumption	Monthly Consumption	Unit Rate of Fuel	Monthly cost	Annual Cost
			Hours/week	Hours	L/hour	L/month	MMK/L	MMK／month	MMK/year
1	Research Laboratory Capacity 250KVA	1	5	20	95.0	1,900	1,000	1,900,000	22,800,000
2	MOC TC, Vocational TC Capacity 250KVA	1	5	20	95.0	1,900	1,000	1,900,000	22,800,000
3	Hostels 3 buildings 125KVA	1	5	20	47.5	950	1,000	950,000	11,400,000
	Total					4,750		4,750,000	**57,000,000**

Source: JICA Study Team

4) LPG Cost

Annual Cost is calculated as follows:

Table 4-8 Annual LPG Cost

Unit rate of LPG 1,250 MMK/kg

	Laboratory	Quantity	Runnning Time*	Runnning Time*	Monthly running time	Load factor	Unit LPG Consumption	Monthly Consumption	Unit rate of LPG	Monthly cost	Annual Fuel Cost
		lot	Hours/day	Hours/week	Hours/month		kg/hour	kg/month	MMK/L	MMK／month	MMK/year
1	Research Laboratory	1	6.0	42	168	0.3	4.0	202	1,250	252,000	3,024,000
2	Hostel	1	8.0	56	224	0.5	8.0	896	1,250	1,120,000	13,440,000
	Total							1,098		1,372,000	16,464,000

Source: JICA Study Team

5) Telephone Cost

Annual Cost is calculated as follows:

Table 4-9 Annual Telephone Cost

	Fixed Telephone	Quantity	Monthly Cost per Line	Monthly cost	Annual Cost
		Line	MMK/line	MMK／month	MMK/year
1	Research Laboratory Fixed telephone line	8	10	80	960
2	MOC TC, Vocational TC Fixed telephone line	8	10	80	960
3	Hostels 3 buildings Fixed telephone line	2	10	20	240
	Total		30	180	**2,160**

Source: JICA Study Team

6) Internet Access Cost

Annual Cost is calculated as follows:

Table 4-10 Annual Internet Access Cost

Internet Access Cost	Quantity	Monthly Cost per Line	Monthly Cost	Annual Cost
	Line	MMK/line	MMK／month	MMK/year
1 Research Laboratory One contract	1	705,000	705,000	8,460,000
2 Vocational TC, MOC TC One contract	1	705,000	705,000	8,460,000
3 Hostels 3 buildings One contract	1	705,000	705,000	8,460,000
Total		2,115,000	2,115,000	**25,380,000**

Source: JICA Study Team

(2) Operation, Maintenance and Management of Equipment

As mentioned above, this project plans to provide maintenance management services (including supply of spare parts, consumables, and chemicals) by the equipment agency. As the annual maintenance cost is assumed to be around 5% of equipment cost, it is proposed that this amount should be secured by MOC as part of the annual budget. According to the trial-calculation, around JPY 20 million is required to secure the annual maintenance budget, assuming that total equipment procurement cost is approx. JPY 400 million.

4.3 Evaluation of the Project

JICA evaluates ODA loan projects to (i) improve its assistance; (ii) monitor and provide feedback for effective resource allocation; and (iii) assure accountability. As part of its results-based management system, JICA is trying to establish a coherent evaluation system throughout the project cycle and enhance joint evaluations for capacity development.

4.3.1 Operation and Monitoring Indicators for Post-Implementation Stage Evaluation

Operation and effect indicators are intended to quantitatively measure the Project's operational performance and effects in light of its objectives. These indicators include target figures for intermediate supervision during implementation, post-completion monitoring and ex-post evaluation.

(1) Validity of the project implementation

The project aims to strengthen the function of RLTC through the reconstruction of Research Laboratory and Training Facilities and procurement of necessary training equipment for these facilities. The objectives of this project are to strengthen the government's administration of the construction sector in line with recent changes in the construction sector in Myanmar, and the

organizational reform of the Ministry of Construction by upgrading the training facility for MOC staff.

In addition, this project will improve the skill level of construction workers by upgrading vocational training facilities, and strengthen quality control of construction works by upgrading research laboratory facilities.

Furthermore, this improvement of vocational training will contribute to the market needs in the construction sector and is expected to lead to the improvement of employment rate as well as poverty reduction.

The expected achievement of the project objectives also contributes to the priority areas in the basic policies of Japan's assistance to Myanmar, which are the following: 1) development of infrastructure and related systems necessary for sustainable economic development; and 2) capacity building and development of systems to sustain the economy and society according to Japan's "Government Development Assistance (ODA) Country Data Book 2017".

(2) Indicators for Evaluation

This Project includes two components with different goal values. Hence, it is necessary to set optimal indicators for each goal.

The 1st component – or the redevelopment of training facilities for MOC staff and skilled labor– is expected to contribute towards improving skills and knowledge of various types of human resources in the construction sector in Myanmar. Provision of training will upgrade the skills of MOC staff, including both administrative officers and engineers responsible for construction administration. Vocational training will be provided to skilled workers in a variety of construction fields to meet the required skill level among ASEAN countries.

The 2nd component – or the redevelopment of the Research Laboratories – is expected to upgrade the quality control function of MOC to meet ASEAN standards.

Table 4-11 Operation and Effect Indicators (Draft)

Operation and Effect Indicators (Draft)	Baseline Value (2019)*1	Target Value(2029)	Available means of data and Monitoring methodology
1. Quantitative Indicators			
1-1. Prospective number of MOC staff trained at the Training Center per year	1,061 pers.(2017/18)	2,000 pers.	Collect data from the Center
1-2. Prospective Number of MOC Staff Training Courses	21 courses	30 courses	Ditto
1-3. Prospective number of workers trained at the Training Center per year	Training : 150pers Assessment Course : 160pers	Training : 1,440 pers (30 pers x 16 courses x 3 times) Assessment Course :960 pers (20 pers x 16 courses x 3times)	Ditto
1-4. Prospective number of Vocational Training Courses	Training : 5types Assessment Course : 8 types	Training : 16 types (level I) Assessment Course :16 types	Ditto
1-5. Laboratory test	Laboratories provide BS base test.	All laboratories provide test responding to ASEAN standards.	Ditto
1-6. Quality assurance of Laboratory	Only one laboratory has been applied to ISO.	All laboratories becomes ISO certified laboratories	Ditto
2. Qualitative Indicators			
2-1. Type of training provided in the RLTC	More administration courses are provided, rather than planning and technical courses.	More courses will be provided for planning, project management, and quality assurances.	Collect data from the Center
2-2. Satisfaction degree with training contents by MOC staff	Generally, trainees are satisfied with training contents.	Trainees are satisfied with the training contents, facility and equipment.	Collect data through Q&A to participants
2-3. Evaluation by construction companies		Construction companies are satisfied with level of skilled workers who own the certificate issued by the RLTC	Collect data through Q&A at the target construction companies
2-4. Quality of constructions in the country		Contractors are satisfied with the quality of test provided at RLTC	Collect data through Q&A at the target construction companies

Note*1: Baseline value and target value to be arranged through the discussion with the authority of Myanmar side.
Source: JICA Study Team

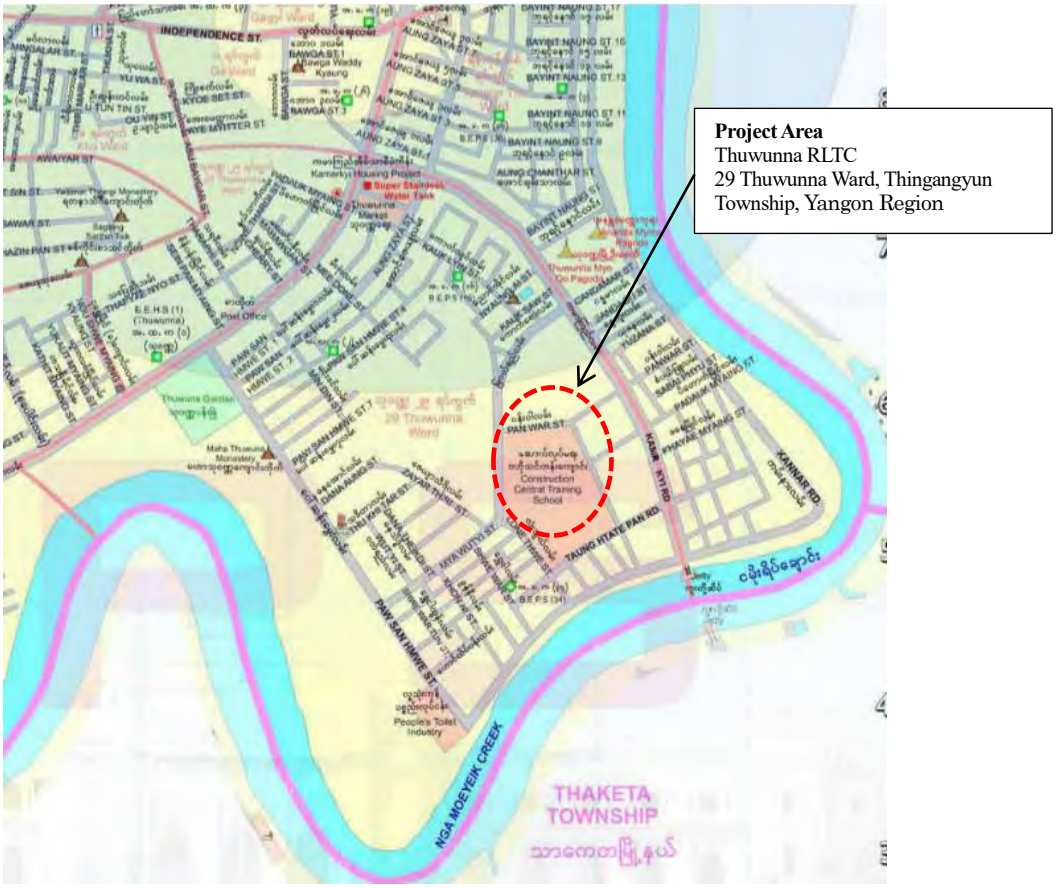
5. Environmental and Social Considerations

5.1 Project Location

The project area is located in 29 Thuwunna Ward, Thingangyun Township, Yangon Region as shown in Figure 5-1 and Figure 5-2 below.

Source: JICA Study Team based on Google earth map

Figure 5-1 Project Location Map (Thuwunna RLTC)



Source: https://www.ycdc.gov.mm/content.php?yangon=Townships

Figure 5-2 Detailed Project Location Map (Thuwunna RLTC)

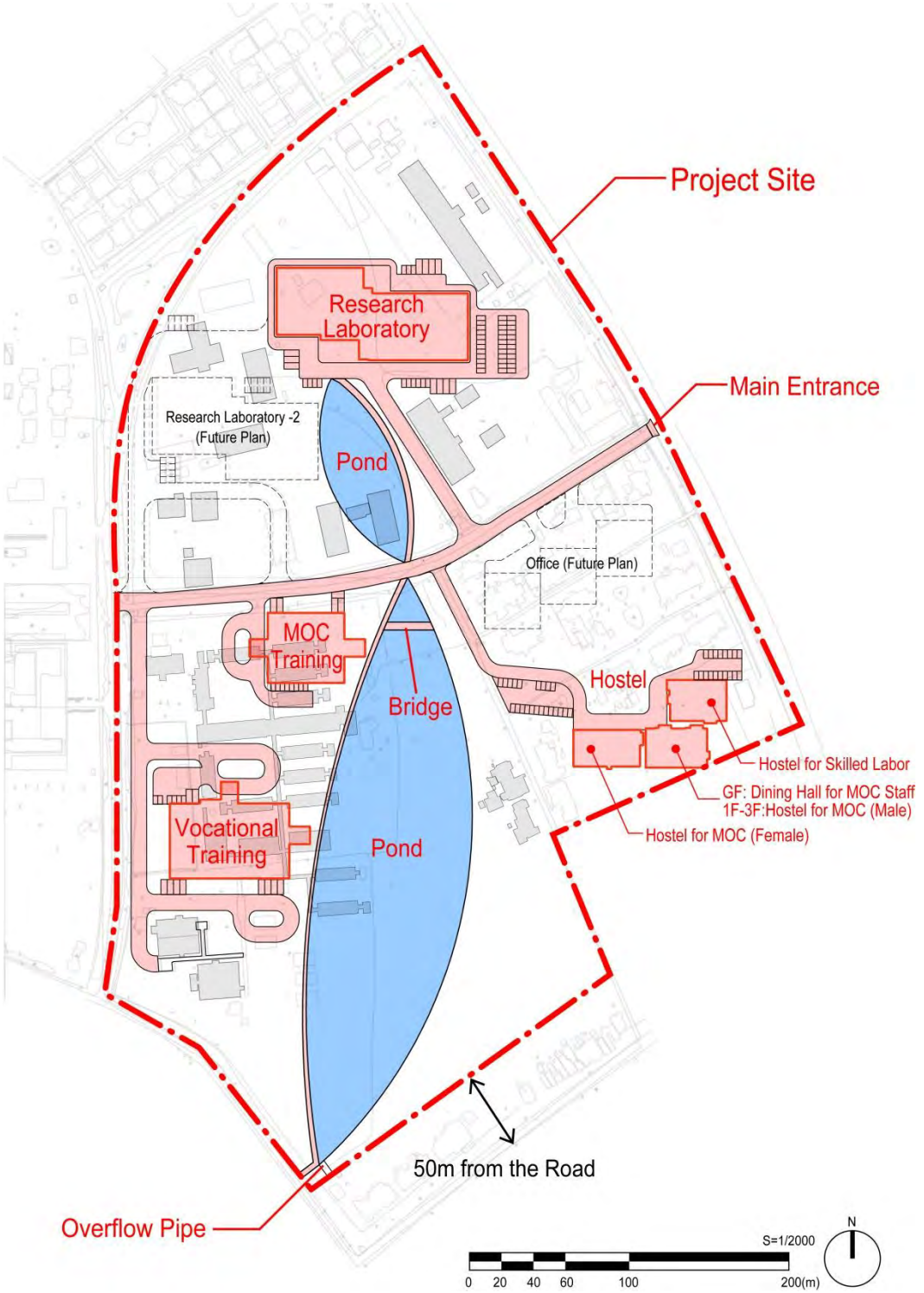
5.2 Project Outline

The main project activities are the reconstruction of Research Laboratory, MOC Training Center, Vocational Training Center, Hostels and related facilities such as access road and reservoir pond as shown in Table 5-1, Figure 5-3 and Figure 5-4 below.

Table 5-1 Construction Facilities in Thuwunna RLTC

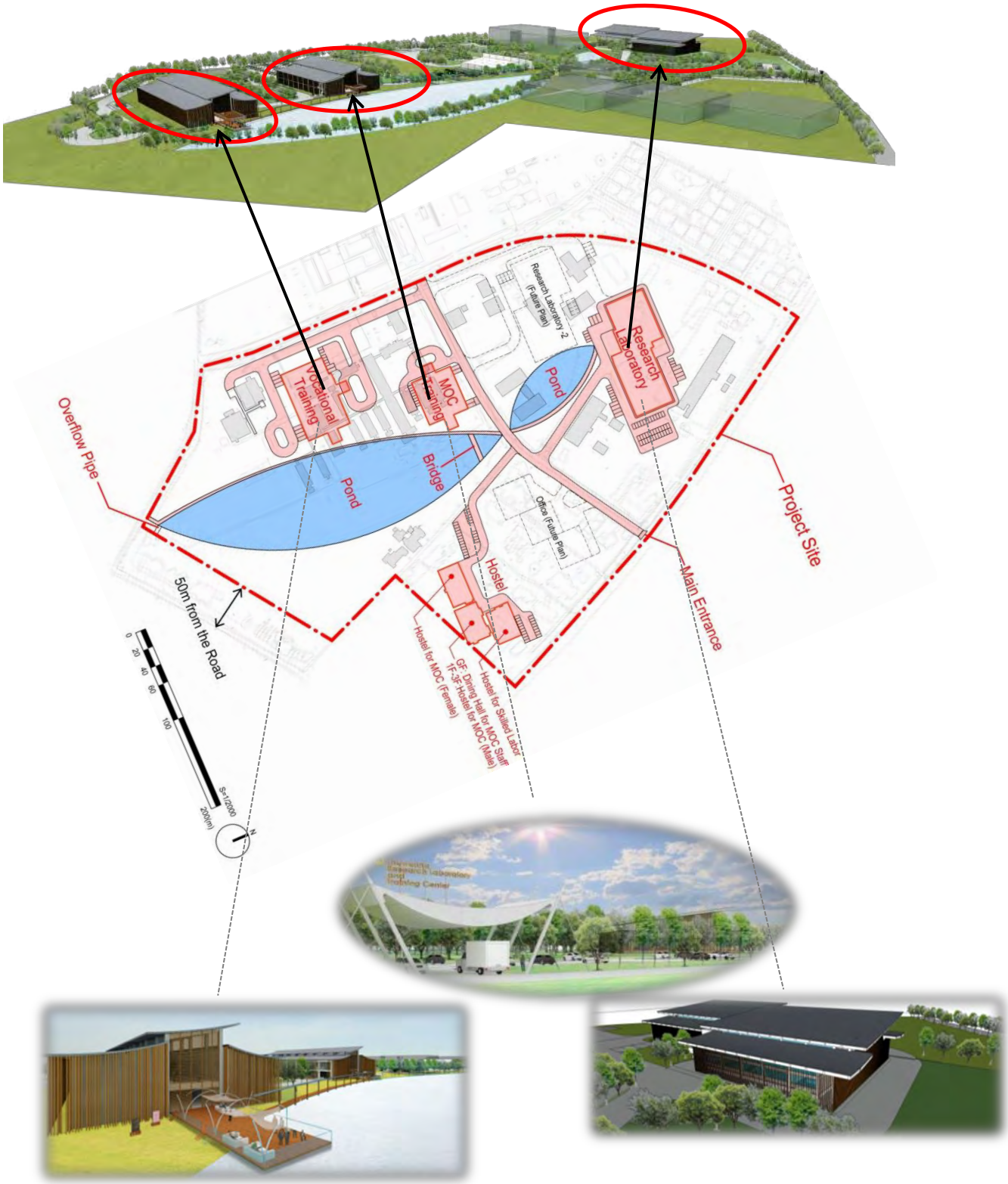
Name of Facility	Specification		
	Function	**Building Construction Area**	**Story and Floor Area**
1. Research Laboratory	Conducting of material tests	5,190 m^2	2 stories, 7,620 m^2
2. MOC Training Center	Training of policy, planning, administration, Theory & Practical Training	2,380m^2	3 stories, 6,100 m^2
3. Vocational Training Center	Lectures and Practices for 19 fields. Assessment and Certification for labors and trainees.	3,850m^2	2 stories, 6,180 m^2
4. Hostels	3 Hostels and 1 Dining Hall for trainees and lecturers. Those facilities are expected to be a) Hostel for Skilled Labor; b) Hostel for MOC Female; c) Hostel for MOC Male and Dining Hall for MOC.	Building Construction area for each facilities are followings; a) 880m^2; b) 910m^2; c) 1010m^2. Total : 2800 m^2	Story and Floor area for each facilities are followings; a) 3 stories, 2060m^2; b) 3 stories, 2,550m^2 (excluding balcony); c) 3 stories, 2670m^2 (excluding balcony); Total Floor area : 7,280 m^2
5. Redundancy Pond	Redundancy pond for rainfall control in the compound	28,250 m^2	-
6. Access Road	Improvement of current access road in the compound (pavement)	20,400 m^2	-
Total Project Area	-	1) Building Construction Area: 14,220 m^2 2) Pond: 28,250 m^2 3) Access Road : 20,400m^2	27,180m^2

Source: JICA Study Team



Remarks) This figure shows the layout of the facilities. The colored area in pink and blue are the area to be developed
Source: JICA Study Team

Figure 5-3 Facilities Layout and Project Affected Area



Source: JICA Study Team

Figure 5-4 Image of Facilities

5.3 Environmental Feature in the Project Area

The project area, including the MOC compound, is located in a developed area shown in Figure 5-5 below. The current status of the project area is an open grass land with some single story and/or 2 stories buildings, and its surrounding areas are mainly residential area, open land and industrial area.

Source: JICA Study Team

Figure 5-5 Land Use in the Project Area and Surrounding Area

The project area is located in a developed urban area of Yangon City. Thus natural and native vegetation does not exist in the project area, thus only some horticultural species are observed. Hence, it is expected that various types of important natural ecosystem, including considerable fauna-flora species, do not exist in the project area.

With regard to the social feature of the project area, residence for the Ministry of Construction (MOC) was observed during the environmental reconnaissance on May 7th, 2019. However, the residence is planned to be relocated to the outside of the project area by the other MOC project. Therefore any adverse impacts on land acquisition and resettlement are not expected to be caused.

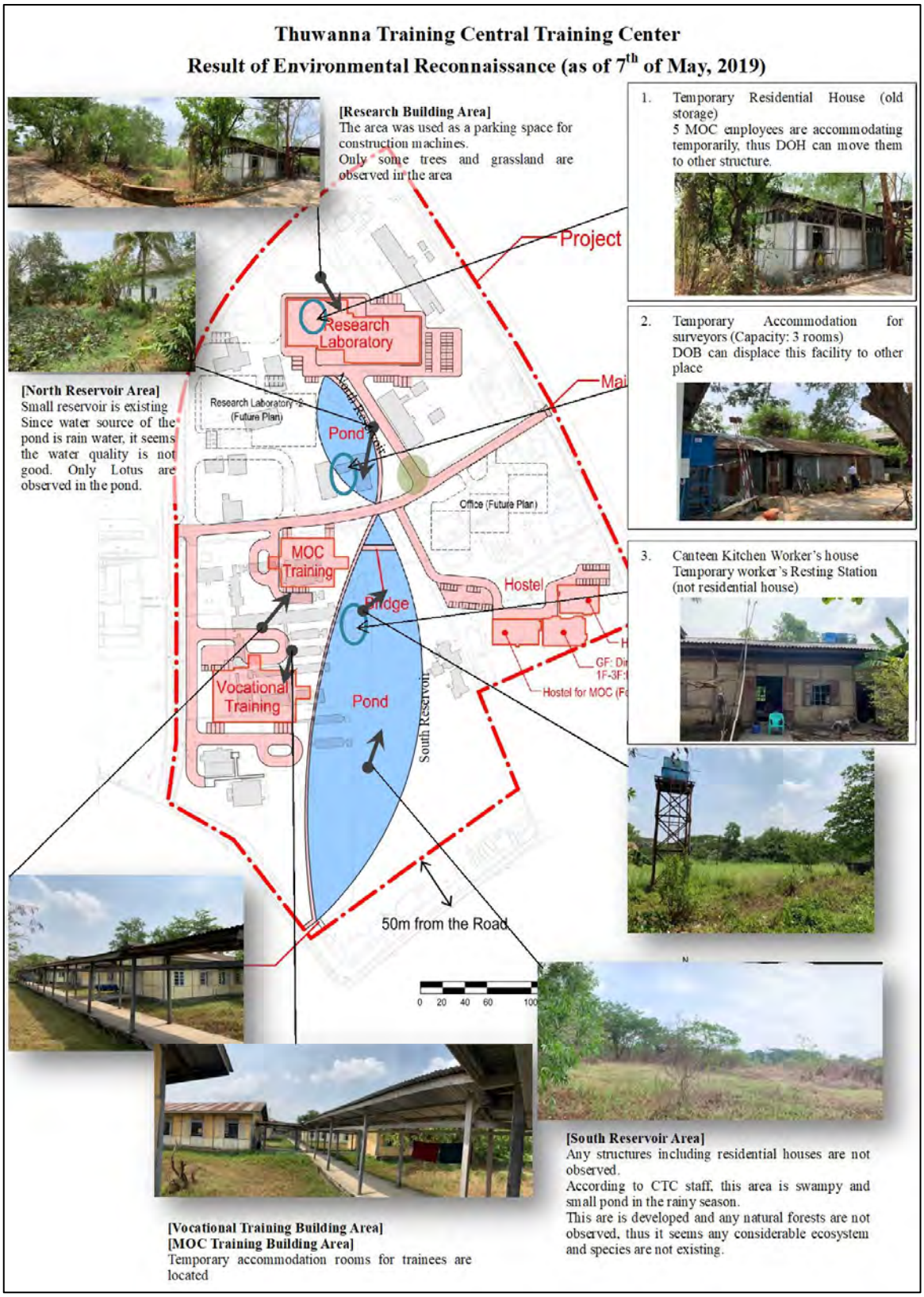
The population of Yangon Region, Thingangyun Township is shown in Table 5-2 below. However, there are no inhabitants living in the project area.

Table 5-2 Population in the Project Area

Area	Population (persons)	Population Density (p./km2)
Yangon Region	7,360,703 (2014)	716.3
Thingangyun Township	209,486 (2014)	18,382

Source: JICA Study Team

Photos of natural and social environments are shown below:



Source: JICA Study Team

Figure 5-6 Natural and Social Environmental Features in the Project Area

5.4 Degree of Project Impacts

The degree of impact on each item based on the environmental reconnaissance is shown in Table 5-3 below:

Table 5-3 Expected Degree of Impact Degree on Each Item

	No	Affected Activities / Impact Items (JICA)	Pre/ During Construction Phase										Operation Phase			
			Rating during Pre/During Const.	Land acquisition and loss of properties	Change of land use plan, control of various activities by regulations for the construction	Reclamation of wetland, etc.	Deforestation	Alteration of the ground by cut land, filling, drilling, tunnel, etc.	Operation of construction equipment and vehicles	Construction of roads, building, parking areas, and other related facilities	Traffic restriction in construction area	Influx of construction workers, construction of base camp	**Rating after Construction**	Increase of Traffic Number and Activities	Appearance/Occupancy of building and other structure	Discharge of Waste Water and Wastes
Pollution	1	Air pollution	**B-**	D	D	D	D	D	B-	D	D	D	D	D	D	D
	2	Water pollution	**B-**	D	D	D	D	B-	D	D	D	B-	**B-**	D	D	B-
	3	Waste	**B-**	B-	D	D	D	D	D	D	D	B-	**B-**	D	D	B-
	4	Soil contamination	**C**	D	D	D	D	C	D	D	D	D	D	D	D	D
	5	Noise and vibration	**B-**	D	D	D	D	D	B-	D	D	D	D	D	D	D
	6	Ground subsidence	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	7	Odor	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	8	Sediment quality	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Natural Environment	9	Protected area	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	10	Ecosystem	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	11	Hydrology	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	12	Topography and geology	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Social Environment	13	Involuntary resettlement	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	14	The poor	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	15	Indigenous and ethnic people	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	16	Local economy such as employment and livelihood	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	17	Land use and utilization of local resources	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	18	Water Usage	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	19	Existing social infrastructures and services	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	20	Social institutions such as local decision making institutions	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	21	Misdistribution of benefits and damage	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	22	Local conflict of interests	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	23	Cultural Heritage	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	24	Landscape	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	25	Gender	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	26	Right of Children	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	27	Infectious diseases such as HIV/AIDS	**B-**	D	D	D	D	B-	D	D	D	D	D	D	D	D

	No	Affected Activities / Impact Items (JICA)	Pre/ During Construction Phase										Operation Phase			
			Rating during Pre/During Const.	Land acquisition and loss of properties	Change of land use plan, control of various activities by regulations for the construction	Reclamation of wetland, etc.	Deforestation	Alteration of the ground by cut land, filling, drilling, tunnel, etc.	Operation of construction equipment and vehicles	Construction of roads, building, parking areas, and other related facilities	Traffic restriction in construction area	Influx of construction workers, construction of base camp	**Rating after Construction**	Increase of Traffic Number and Activities	Appearance/Occupancy of building and other structure	Discharge of Waste Water and Wastes
	28	Labor environment (including work safety)	**B-**	D	D	D	D	D	D	D	D	B-	D	D	D	D
Others	29	Accidents	**B-**	D	D	D	D	D	B-	D	D	D	**B-**	B-	D	D
	30	Cross Boundary impacts and climate change	D	D	D	D	D	D	D	D	D	D	D	D	D	D

Note) Rating:
A: Serious adverse impacts are expected. B: Some adverse impacts are expected. C: Extent of impact(s) is unknown (serious impact is not expected, but survey and analysis shall be done) No mark: Light or few adverse impacts are expected. Detailed quantitative survey is not necessary.
Source: JICA Study Team

The reasons for improvement during evaluation are shown in Table 5-4 below:

Table 5-4 Reasons for Improvement During Evaluation of Thuwunna RLTC

Area	No	Impacted Item on JICA Guidelines	Rating		Reasons of the Rating
			Pre/ During Construction	Operation Phase	
Pollution	1	Air pollution	B-	D	**Construction phase:** Temporary negative impacts are expected on dust due to operation of construction machines and equipment. However this impact is controlled by mitigation measures. **Operation phase:** Serious negative impacts are not expected because road surface is paved and traffic number in the training center is limited.
	2	Water pollution	B-	B-	**Construction phase:** Turbid water may be generated by earth works especially during rainy season. Additionally organic polluted water may be discharged from the base camp and offices during construction. **Operation phase:** General domestic effluent from hostels, office and laboratory is discharged from hostels, offices and testing laboratory. However quality of effluent does not exceed standard value for waste discharge because mainly soil and concrete material test is conducted.
	3	Waste	B-	B-	**Construction phase:** Construction waste such as demolished building and waste soil are expected. Additionally domestic waste and night soil may be generated from the construction base camp and/or offices. **Operation phase:** General domestic waste and night soil is generated from relevant offices such as hostels.
	4	Soil contamination	C	D	**Construction phase:** Excavated soil in the compound may be polluted. **Operation phase:** Activities in the training center does not give any impacts on soil contamination
	5	Noise and vibration	B-	D	**Construction phase:** Noise generation is expected due to works of construction machines and equipment. **Operation phase:** Noise generation is not expected because of no activities which generates noise in the training center.
	6	Ground subsidence	D	D	**Construction and operation phase:** No impacts are expected since activities which cause ground subsidence not expected.
	7	Odor	D	D	**Construction and operation phase:** No impacts are expected since activities which cause odor are not expected.
	8	Sediment quality	D	D	Refer to No.4 Soil Contamination
Natural environment	9	Protected area	D	D	**Construction and Operation phase:** The project area is not located in any natural and cultural protected areas. The nearest natural protected areas is Hlawga National Park, 4km away from Thuwunna RLTC.
	10	Ecosystem	D	D	**Construction and Operation phase:** The project area is located in developed urban area, and any forest and natural pond is not existing. Thus any rich ecosystem is not observed in the area.
	11	Hydrology	D	D	**Construction and Operation phase:** There are not any activities which gives adverse impacts to rivers and streams nearby.
	12	Topography and geology	D	D	**Construction and operation phase:** Considerable topography and geological sites are not located in the Project Area, thus no impact is expected.
Social environment	13	Involuntary resettlement	D	D	**Pre-Construction and Operation phase:** All project land belongs to Myanmar Government, and no inhabitants are expected in the project affected area. Thus neither resettlement nor land acquisition is necessary.
	14	The poor	D	D	**Pre-Construction and Operation phase:** Any adverse impacts are not expected due to no resettlement in this project
	15	Indigenous and	D	D	**Pre-Construction and Operation phase:** Any adverse impacts are not expected

Area	No	Impacted Item on JICA Guidelines	Rating		Reasons of the Rating
			Pre/ During Construction	Operation Phase	
		ethnic people			due to no resettlement in this project.
	16	Local economy such as employment and livelihood	D	D	**Pre-construction and Operation phase:** Project activities does not give any adverse impacts on local economy and livelihood because of no land acquisition nor resettlement
	17	Land use and utilization of local resources	D	D	**Pre-construction and Operation phase:** All land belongs to Myanmar Government, and current land use does not change.
	18	Water usage	D	D	**Construction phase:** Current water source is water supply system and underground water. Any large scale cutting land and excavation which may give adverse impacts to underground is not planned on this project. **Operation phase:** Underground water is one of water source after operation of the facilities. However the project does not change volume of pumping water from underground
	19	Existing social infrastructures and services	D	D	**Construction and Operation phase:** There are not any social infrastructures such as hospitals, schools and meeting places in the project area. Additionally any access routes are not existing in the project affected area for nearest social infrastructures.
	20	Social institutions such as local decision making institutions	D	D	**Construction and operation phase:** In the project affected area, any inhabitants and communities are not observed. Thus project does not give any adverse impacts on this item.
	21	Misdistribution of benefit and damage	D	D	**Construction and operation phase:** Misdistribution of benefit and damage caused by the project is not expected.
	22	Local conflict of interests	D	D	**Construction and Operation phase:** All project affected area is located in the government area and isolated from private land. Thus local conflicts are not expected.
	23	Cultural heritage	D	D	**Construction and Operation Phase:** Any cultural heritages and religious facilities such as Pagodas and monasteries are not observed in the project affected area, thus the project does not give any impacts on this item
	24	Landscape	D	D	**Construction and Operation phase:** There are no law-based designated landscape areas around the Project Area.
	25	Gender	D	D	**Construction and operation phase:** Negative impacts specified for women are not expected.
	26	Right of children	D	D	**Construction and operation phase:** Negative impacts specified for children are not expected.
	27	Infectious diseases such as HIV/AIDS	B-	D	**Construction phase:** Since only construction labors can enter the construction area without accommodating, it is expected infectious diseases such as STDs are not spread. However alteration to ground by cut land and filling may provoke to provide habitats for mosquitoes that possibly transmit dengue fever. **Operation phase:** Since mainly employees of MOC enter the site, it is not likely to spread infection diseases.
	28	Labor environment	B-	D	**Construction phase:** Construction work environment needs to be considered in accordance with relevant laws and regulations. **Operation phase:** No impact is expected.
Others	29	Accidents	B-	B-	**Construction phase:** Construction vehicles may use existing local roads near residential areas, thus the number of traffic accident may increase. **Operation phase:** Increase of the variety of training activities and number of training course may cause the accidents in the implementation of training.

Area	No	Impacted Item on JICA Guidelines	Rating		Reasons of the Rating
			Pre/ During Construction	Operation Phase	
	30	Cross boundary impacts and climate change	D	D	**Construction phase:** Operation of construction machines and construction of structures generates GHGs, however total volume is negligible level. **Operation phase:** Operation of the training center may generate GHGs, however expected volume is limited and negligible level.

Note) Rating:
A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (serious impact is not expected, but survey and analysis shall be done) No mark: Light impact expected. Detailed quantitative survey is not necessary.
Source: JICA Study Team

5.5 Related Laws Regarding EIA and Screening Process

The EIA Procedure 2015 in Myanmar prescripts that any projects need to submit a project proposal to the Environmental Conservation Department (ECD) under Ministry of Natural Resources and Environmental Conservation (MONREC). ECD classifies the project category as i) EIA; ii) IEE; iii) EMP; and / or iv) No need for approval.

MOC has submitted a project proposal for screening in May 2019, and ECD has concluded the project category as "iv) No need approval" in July 2019.

5.6 Implementation of Public Consultation

The results of public consultation are shown below:

MOC in cooperation with JICA Study Team has explained the outline of project, degree of impacts, contents of EMP and tentative schedule in the meeting.

Some comments and questions were given from attendee of the meeting. However, all participants agreed to proceed with the project and have formulated consensus of the project.

Table 5-5 Overview of Public Consultation

Objectives of Meeting (date and venue)	Agenda	Major Attendee	Methodology
Public Consultation for explanation of project and EMP (18th July 2019, 13:00~14:00 , Thuwunna CTC meeting room)	1. Project Outline 2. Expected positive and negative impacts 3. Environmental Management Plan (mitigation measures and monitoring plan) 4. Tentative schedule of the project 5. Exchange opinions	Total: 55 (Male: 31, Female: 24) Government: 30, Parliament: 2, Local People: 23, JICA Study Team: 4, E Guard Environmental Services: 7	1) Information Disclosure 2 newspaper disclosure 2) Language English and Burmese

Source: JICA Study Team

The opinions, questions and answers during discussion session are shown below:

Table 5-6 Opinions During Public Consultation (18th July, 2019)

No	Major opinion and Answer				
	Question/Comment		Answer		Reaction of questioner
	Name/Position	Question/Comment	Name/Position	Answer	
1	Parliament Member in Thingangyun Township (Male)	After the presentation, he knows this Project is conducted by the MOC and the technical support by JICA (Feasibility Study). He comments on behalf of villagers, they welcome this project. He considers that construction vehicles may damage the road and drainage system around the Thuwunna CTC during construction phase. For maintain the public road and drainage system, the budget for the project located ward, the 29th Ward, should be secured. (Comment)	MOC (The Principal of Thuwunna CTC)	Comments are confirmed. We would consider and secure the budget for maintenance cost of public road and drainage system.	-

Source: JICA Study Team

5.7 Preparation of Environmental Management Plan (EMP)

In general, EMP consists of i) mitigation measures and ii) monitoring plan. Tentative EMP is described hereinafter:

5.7.1 Mitigation Measures

Tentative mitigation measures on feasibility study stage are as shown in Table 5-7 below. These mitigation measures shall be updated based on final design and construction plan during detailed design stage.

In general, all relevant costs for general mitigation measures during construction shall be included as construction cost.

Table 5-7 Environmental and Social Mitigation Measures

Area	No.	Item	Draft Mitigation Measures		Responsibility	
			During Construction	After Construction	Implementation Agency	Responsible Agency
Pollution	1	Air Pollution	☐ Water sprinkling shall be carried out on construction area and connected road, if required. ☐ Periodical cleaning shall be done for connected public road	Not required	[During Const.] Contractor	[During Const.] MOC/T-CTC
	2	Water pollution	☐ Turbid water from unpaved construction area shall be treated in sedimentation pond and discharged to the river, if required ☐ Waste oil of construction machines shall be stored and disposed to designated site ☐ Construction machines shall be maintained not to leak oil in the base-camp site. ☐ Provision of sanitation facilities, if required ☐ Domestic waste water and night soil from construction area shall be treated and discharged to designated site and facilities.	☐ Waste water and night soil shall be treated and discharged below the standard value.	[During Const.] Contractor	[During Const.] MOC/T-CTC
	3	Waste	[Construction waste (Waste soil, cutting trees and waste oil, hazardous material)] ☐ Waste soil from construction area shall be reused or disposed to designated land fill site in Yangon ☐ Cutting trees are sold to surrounding inhabitants or licensed collector ☐ Waste oil of the construction machines is collected and disposed at licensed agent. ☐ Waste chemical and hazardous material are stored at contractor's office and disposed by licensed agent [Domestic waste and Night soil from contractor offices] ☐ Domestic solid wastes shall be collected and disposed by YCDC. ☐ Domestic waste water and night soil shall be treated and/or collected by licensed agent.	☐ Waste generated from hostels, office and laboratory shall be disposed at designated site. ☐ Waste water and night soil shall be treated and discharged below the standard value.	[During Const.] Contractor	[During Const.] MOC/T-CTC
	4	Soil Contamination and Sediment	☐ Excavated soil shall be analyzed and confirm the quality is under standard values. Polluted soil shall be treated and used as construction material if excavated soil is polluted. ☐ Construction machines shall be	Not required	[During Const.] Contractor	[During Const.] MOC/T-CTC

Area	No.	Item	Draft Mitigation Measures		Responsibility	
			During Construction	After Construction	Implementation Agency	Responsible Agency
			maintained not to leak oil in the construction site. ☐ Waste oil of the construction machines is collected and disposed at licensed agent ☐ Waste chemical and hazardous material are stored at contractor's site and disposed at licensed agent			
	5	Noise and Vibration	[Construction noise and Vibration] ☐ Construction activities and operation of construction machines shall be limited in the daytime and weekday ☐ Construction machines shall be well maintained and checked everyday ☐ Information disclosure such as construction schedule and activities in advance to surrounding community.	Not required	[During Const.] Contractor	[During Const.] MOC/T-CTC
Social Environment	6	Gender	☐ Provision of job opportunities and fair salary for any gender. ☐ At least 10% of Female workers should be hired as simple workers	Not required	[During Const.] Contractor	[During Const.] MOC/T-CTC
	7	Right of Children	☐ No employment under the age of 18 (Article 6.21 " Child Labor" of Conditions Of Contract For Construction For Building And Engineering Works Designed by the Employer Multilateral Development Bank Harmonized Edition (June 2010) General Conditions/ International Federation Of Consulting Engineers (FIDIC) shall be followed	Not required	[During Const.] Contractor	[During Const.] MOC/T-CTC
	8	Infectious diseases such as HIV/AIDS	☐ Installation of sufficient drainage facilities not to provide habitat for vector mosquito ☐ Provision of adequate temporary sanitation facilities ☐ Enforcement of medical screening and periodical medical check-up for workers ☐ In order to prevent spread of infectious diseases such as HIV/AIDS, awareness of the labors is promoted during construction ☐ Article 6.7 " Health and Safety" of Conditions Of Contract For	Not required	[During Const.] Contractor	[During Const.] MOC/T-CTC

Area	No.	Item	Draft Mitigation Measures		Responsibility	
			During Construction	After Construction	Implementation Agency	Responsible Agency
			Construction For Building And Engineering Works Designed by the Employer Multilateral Development Bank Harmonized Edition (June 2010) General Conditions/ International Federation Of Consulting Engineers (FIDIC) shall be followed			
	9	Labor Environment and Safety	☐ Relevant laws in Myanmar such as "the Workmen's Compensation Act", "the Factories Act", "the Leave and Holidays Act", "the Law relating to Overseas Employment", "the Labor Organization Law", "the Settlement of Labor Dispute Law", "the Social Security Law" and "the Minimum Wages Law" shall be followed ☐ Additionally article 23 Occupational Health and Safety, Labor and Working Conditions in IFC Performance Standard 2 shall be applied. ☐ Chapter 6 Staff and Labor including 6.6 "Facilities for Staff" of Conditions Of Contract For Construction For Building And Engineering Works Designed by the Employer Multilateral Development Bank Harmonized Edition (June 2010) General Conditions/ International Federation Of Consulting Engineers (FIDIC) shall be followed	Not required	[During Const.] Contractor	[During Const.] MOC/T-CTC
Others	10	Accident	☐ Deploying flagman at the gate of construction area and intersections for traffic management ☐ Installation of safety sign board such as speed limit and residential area in the project area ☐ Installing fence around the construction site to keep out local people such as children ☐ Installation of lightning facility in the night time in the construction area ☐ Restricting mobilization speed less than 20km/h in the construction	☐ Notification and implementation of safety instruction for the trainers	[During Const.] Contractor	[During Const.] MOC/T-CTC

Area	No.	Item	Draft Mitigation Measures		Responsibility	
			During Construction	After Construction	Implementation Agency	Responsible Agency
			site ☐ Implementation of safety training for the workers			

Source: JICA Study Team

5.7.2 Environmental Monitoring Plan

Tentative monitoring plan on pre- and during construction stage are shown in Table 5-8 below. These monitoring plan shall be updated based on final design and construction plan during detailed design stage.

Table 5-8 Environmental Monitoring Plan, Pre- and During Construction Phase (2 years)

Area	No.	Item	Parameter	Method	Location	Frequency a year	Direct Cost (Thousands USD)	Conservation Target[*3]
Natural Environment	1	Air pollution	NO_2, $PM_{2.5}$,PM_{10}, SO_2, CO and Ozone	Base on the National Environmental Quality (Emission) Guidelines And/or same methodology of baseline surveys	**1 Location** Where baseline monitoring was carried out.	**1 time / year x 2 years** (Dry season)	**1.0** (1 time /year x 500 USD / point x 1 point x 2years)	**National Environmental Quality (Emission) Guidelines [Air Emissions] Maximum limit values of ambient air quality parameters** 1. Nitrogen Dioxide (NO^2) · 1 year: 40 $\mu g/m^3$ · 1 hour: 200 $\mu g/m^3$ 2. Ozone · 8-hour daily max.: 100 $\mu g/m^3$ 3. PM_{10} (Ø< 10µm) · 1 year: 20 $\mu g/m^3$ · 24 hours: 50 $\mu g/m^3$ 4. $PM_{2.5}$ (Ø< 2.5µm) · 1 year: 10 $\mu g/m^3$ · 24 hours: 25 $\mu g/m^3$ 5. Sulphur Dioxide (SO_2) · 24 hours: 20 $\mu g/m^3$ · 10-minutes: 500 $\mu g/m^3$ **Japanese Standard** 6. Carbon monoxide (CO) · 24 hours: 10 ppm · 8 hours: 20ppm
	2	Water Quality	BOD, COD, Oil & Grease, pH, Total Coliform, T-N, T-P and TSS	Base on the National Environmental Quality (Emission) Guidelines And/or same methodology of baseline surveys	**2 Locations** Upstream of construction area and downstream of construction area	**2 times / year x 2 years** (1 time / Dry and Rainy season)	**1.6** (2 times /year x 200 USD / point x 2 points x 2 years)	**National Environmental Quality (Emission) Guidelines [Site Runoff and Wastewater Discharges (construction phase)]** 1. BOD : 30 mg/l 2. COD : 125 mg/l 3. Oil and Grease : 10 mg/l 4. pH : 6-9 5. Total Coliform bacteria[4]: 400 count/100ml 6. T-N : 10 mg/l 7. T-P : 2 mg/l 8. TSS : 50 mg/l
	3	Waste	Volume of waste soil, cutting tree and domestic garbage	Record volume of generated waste in the project area	**Waste Storage and collection points**	**4 times / year x 2 years**	**1.6** (4 times /year x 200 USD/time x 2 years)	Waste Management Law (No.1996-766 of October 1996) Generated construction waste and domestic shall be reused or disposed at designated site.
	4	Soil Contamination and Sedimentation Quality	As, Cd, Cr6, Se Cu, Pb, Benzene, Carbon Tetrachloride, 1,2-Dichloroethane, 1,1-Dichloroethylene, Cis-1,2-	same methodology of baseline surveys	**3 Locations** Station-1 and 2: Excavated point at piers on the land Bago Region and Mon State Station-3: Excavated	**1 time (before excavation)**	**3.0** (1 time x 1,000 USD / point x 3 points)	There are not law-based criteria nor international guidelines to be followed, thus following is established as conservation target 1. Thailand Standard Soil Quality Standards for Habitat and Agriculture, Notification of the National Environmental Board, Thailand (No. 25, B.E. 2547/ 2004) 2: Japanese Standard:

Area	No.	Item	Parameter	Method	Location	Frequency a year	Direct Cost (Thousands USD)	Conservation Target*3
			Dichloroethylene, Dichloroethylene, Tetrachloroethylene, Trichloroethylene 1,1,1-Trichloroethane 1,1,2-Trichloroethane		point in the river			Environmental Quality Standards for Soil Pollution, Ministry of Environment/ 1991)
	5	Noise and Vibration	Construction noise (dB(A)L_{Aeq})	Noise: 24hrs continuous measurement (at least 10min in a hour x 24hours)	**2 Locations** (Boundary of Thuwunna RLTC adjacent to residential area)	**4 times / year x 2 years** (2 times / Rainy and Dry Season)	**16.0** (Noise and Vibration 2 items (noise/vibration) x 500 USD /point x 2 locations x 4 times / year x 2 year)	There are not law-based criteria nor international guidelines to be followed, thus following is established as conservation target Japanese Standard during Construction [Noise] dB(A) Reference standard in Japan 07:00-19:00: 85 dB(A)
			Construction Vibration (mm/sec) *Unit shall be converted from mm/s to dB	Vibration 24hrs continuous measurement (at least 10min in a hour x 24hours)	↑ ditto	**4 times / year x 2 years** (2 times / Rainy and Dry Season)		[Vibration] dB Reference standard in Japan 07:00-19:00 : 75 dB
Social Environment	6	Gender	Construction workers (gender)	Confirmation of workers list from contractor	Project area	**4 times / year x 2 years** (2 times / Rainy and Dry Season)	**2.4** (4 times /year x 300 USD/time x 2 years)	There are not law-based criteria nor international guidelines to be followed, thus following is established as conservation target Employment opportunity shall be provided fairly from the view of gender
	7	Right of Children	Construction workers	Confirmation of workers list from contractor	Project area			There are not law-based criteria nor international guidelines to be followed, thus following is established as conservation target FIDIC 2010 (General Condition) No employment under the age of 18
	8	Infectious diseases such as HIV/AIDS	Number of infected patient	Confirmation of health check list from contractor	Project area (base-camp site)	**4 times / year x 2 years** (2 times / Rainy and Dry Season)	**1.6** (4 times /year x 200 USD/time x 2 years)	There are not law-based criteria nor international guidelines to be followed, thus following is established as conservation target Infection diseases are not caused by the project
	9	Labor Environment	Construction worker's condition	Confirmation of safety devices and conditions via	Project area (base-camp site)	**4 times / year x 2 years** (2 times / Rainy and Dry Season)	**1.6** (4 times /year x 200 USD / time x 2	Following laws and guidelines shall be followed 1. The Factories Act 1951 2. IFC Performance Standard 2 Labor and Working Conditions

Area	No.	Item	Parameter	Method	Location	Frequency a year	Direct Cost (Thousands USD)	Conservation Target*3
				interviews			years)	3.FIDIC 2010
Other	10	Accident	Number of accidents	Confirmation of accidents list from local government/ police department	Project area	**4 times / year x 4 years** (2 times / Rainy and Dry Season)	**1.6** (4 times /year x 200 USD / time x 2 years)	There are not law-based criteria nor international guidelines to be followed, thus following is established as conservation target Any accidents are not caused by construction activities
Total Cost during Construction : *30,200 (USD)* for 2 years (during construction)								

Remarks
*1: Frequency and timing of monitoring shall be modify at detailed design stage
*2: The cost indicates direct cost, not including consultant fee, overhead and personal expense
*3: Conservation Target: If quantitative values are existing, such values prioritized as target based on Myanmar Laws, International Guidelines and other references. If quantitative values are not existing, qualitative target is established as project base.

Source: JICA Study Team

The environmental monitoring survey plan during operation phase is proposed as shown in Table 5-9 below. The proposed monitoring period is at least two (2) years.

Table 5-9 Environmental Monitoring Plan After Construction Phase (2 Years)

Area	No.	Item	Parameter	Method	Location	Frequency a year	Direct Cost (Thousands USD)	Conservation Target*3
Natural Environment	1	Water Quality	BOD, COD, Oil & Grease, pH, Total Coliform, T-N, T-P and TSS	Base on the National Environmental Quality (Emission) Guidelines And/or same methodology of baseline surveys	**2 Locations** Upstream of construction area and downstream of construction area	**1 time / year x 2 years** (1 time / Dry season)	**0.8** (1 time /year x 200 USD / point x 2 points x 2 years)	**National Environmental Quality (Emission) Guidelines [Site Runoff and Wastewater Discharges (construction phase)]** 1. BOD : 30 mg/l 2. COD : 125 mg/l 3. Oil and Grease : 10 mg/l 4. pH : 6-9 5. Total Coliform bacteria[4]: 400 count/100ml 6. T-N : 10 mg/l 7. T-P : 2 mg/l 8. TSS : 50 mg/l
	2	Waste	Volume of domestic waste / night soil from offices	Record volume of generated waste from offices	**Waste Storage and collection points**	**1 time / year x 2 years**	**0.4** (1 time /year x 200 USD/time x 2 years)	Waste Management Law (No.1996-766 of October 1996) Generated construction waste and domestic shall be reused or disposed at designated site.
Other	29	Accidents	Number of accidents	Confirmation of accidents list from Thuwunna RLTC	**Project area**	**1 time / year x 2 years**	**0.4** (1 time /year x 200 USD/time x 2 years)	There are not law-based criteria nor international guidelines to be followed, thus following is established as conservation target Any accidents are not caused in Thuwunna RLTC
Total Cost during Construction : *1,600 (USD)* for 2 years (after construction)								

Remarks
*1: Frequency and timing of monitoring shall be modify at detailed design stage
*2: The cost indicates direct cost, not including consultant fee, overhead and personal expense
*3: Conservation Target: If quantitative values are existing, such values prioritized as target based on Myanmar Laws, International Guidelines and other references. If quantitative values are not existing, qualitative target is established as project base.

Source: JICA Study Team

5.8 Conclusion on Environmental and Social Considerations

Giving consideration to the project location and scale as well as activities during and after construction, the project will not give serious impacts on natural and social environment in the project area and its surrounding area. Thus, ECD has concluded the category as “no need for ECC project”. On the other hand, this project gives minimal or few adverse impacts on natural and social environments. However, this project is one of the components under the project for the construction of new Sittaung Bridge. Thus, the preparation of EMP and public consultation were conducted during the feasibility study.