Basic Research on Preventive Countermeasures to Cope with Disasters on Roadside Slopes (QCBS)

HANDBOOK II:
CONSTRUCTION SUPERVISION AND QUALITY CONTROL IN ODA GRANTS FOR ROADS IN MOUNTAINOUS AREAS (ROCK FALL AND SLOPE FAILURE)

February 2023

Japan International Cooperation Agency (JICA)

Oriental Consultants Global Co., Ltd.
Japan Conservation Engineers Co., Ltd.
Eight-Japan Engineering Consultants Inc.

GL
JR
23-007

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List of Abbreviations and Acronyms

Abbreviation / Acronyms	Meaning
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ALOS	Advanced Land Observing Satellite
ASTM	American Society for Testing and Materials
AW3D	Advanced World 3D map
B/A	Bank arrangements
BOQ	Bill of Quantity
BOT	Build, Operate and Transfer
BS	British Standard
CBR	California Bearing Ratio
Ch.	Chainage
CHF	Swiss Franc
C/S	Construction Supervision
DB	Design Build
DCP	Dynamic Cone Penetration test
D/D	Detailed Design
DEM	Digital Elevation Model
DGPS	Differential GPS
DLP	Defect Liability Period
DNP	Defect Notification Period
DOD	Draft Outline Design
DoR	Department of Road
DPRM	Disaster Risk Reduction and Management
DSM	Digital Surface Model
E/N	Exchange of Note
EIA	Environmental Impact Assessment
EL	Elevation
EOT	Extension of Time
EPC	Engineering, Procurement and Construction
EPS	Expanded Poly-Styrene
FCB	Foamed Cement Banking
FIDIC	Fédération Internationale Des Ingénieurs-Conseils / International Federation of Consulting Engineers
F/S	Feasibility Study
Fs	Factor of Safety / Safety Factor
G/A	Grant Agreement
GCC	General Condition of Contract
GCP	Grand Control Point
GDP	Gross Domestic Product
GIS	Geographic Information System
GL	Ground Level
GNP	Gross National Product
GoJ	Government of Japan
GPS	Global Positioning System
GSI	Geological Strength Index
H.W.L.	High Water Level
ICB	International Competitive Bidding
IEE	Initial Environmental Examination
In-SAR	SAR Interferometry
JAXA	Japan Aerospace Exploration Agency

Abbreviation / Acronyms	Meaning
JGS	Japanese Geotechnical Society
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JPY	Japanese Yen
L/A	Loan Agreement
L/A	Land Acquisition
LCB	Local Competitive Bidding
L/D	Liquidated Damage
LiDAR	Light Detection And Ranging
M/D	Minute of Discussion
MDB	Multilateral Development Bank
MLIT	Ministry of Land Infrastructure, and Transport
MoRTH	Ministry of Road Transport, and Highway
MoFA	Ministry of Foreign Affairs
MVS	Multi-View Stereo
Mw	Momentum Magnitude
NEXCO	Nippon EXpressway COmpany Limited
NOC	No Objection Certificate
OD	Origin Destination
ODA	Official Development Assistance
O&M	Operation and Maintenance
PC	Pre-stressed Concrete
PFI	Private Finance Initiative
PMU	Project Management Unit
PPP	Public Private Partnership
PQ	Pre-Qualification
PRISM	Pico-satellite for Remote-sensing and Innovative Space Missions
P/S	Preparatory Survey
R/D	Record of Discussion
RFP	Request for Proposal
RMR	Rock Mass Rating
ROW	Right of Way
RQD	Rock Quality Designation
SAR	Synthetic Aperture Radar
SfM	Structure from Motion
SMR	Slope Mass Rating
SOW	Scope of Work
SPT	Standard Penetration Test
T/C	Technical Cooperation
TOR	Terms of Reference
TS	Technical Specification
TTB	Telegraphic Transfer Buying
TTS	Telegraphic Transfer Selling
UAV	Unmanned Aerial Vehicle
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	US Dollar
USGS	United States Geological Survey
VAT	Value Added Tax
V/O	Variation Order
WB	World Bank

CHAPTER 1 Content and Flow of Handbook

1.1 Slope Protection Works in Japanese ODA Grants

The high adaptability of Japanese slope countermeasure technology grows through unique experiences under various adverse conditions such as steep topography, complex geology, frequent heavy rains and earthquakes, and freezing in winter. On the other hand, in order to ensure the quality of slope countermeasures, it is necessary to implement construction procedures and plans that considers at least the following items.

- Procurement and maintenance of resources (personnel, materials and equipment, temporary works) for safe construction
- Safe schedule plans considering weather conditions such as rainy season and dry season
- Construction plans including weather observation, abnormal phenomenon monitoring, safety education and safety training
- Construction plans considering the prevention of harm and inconvenience to the life, body and property of a third party

This handbook is created as a guideline for the Consultant and the Contractor for ensuring the quality of slope countermeasures in ODA Grants, referring to past knowledge and countermeasure technologies from various countries. To know how to recognize the signs of collapse and to respond after a collapse are useful for preventing collapse and responding to minimize collapse, or for taking appropriate and prompt responses when encountering an unforeseen collapse.

The contents of this handbook are as follows. Chapters 2 and 3 are, respectively, for the roles Consultant and the Contractor in charge of construction supervision and management. These chapters include especially content of and effectiveness of supervision or construction plans and quality assurance methods during construction works. Chapter 4 describes precautions during construction based on past lessons. Chapter 5 deals with a method of predicting the danger of collapse, and Chapter 6 is about safe construction. Chapter 7 describes responses at or after slope failure, and Chapter 8 is about maintenance of slope countermeasures.

The terms “the Consultant”, “the Contractor” and “the Client” used in this handbook have the same meanings as those defined in the relevant project contract. The definitions conform to "Form of Consultant Agreement under JICA's Grants (JICA, 2016)" and are shown below.

- “the Consultant” has the meaning defined in the Recitals of the Consulting Service Agreement.
- “the Contractor” means the person or persons (physical persons), firm or company (juridical persons) who has (have) concluded the construction, procurement, service or any other contract for the Project with the Client and includes the Contractor’s successors and permitted assigns.
- “the Client” has the meaning defined in the Recitals of the Consulting Service Agreement. The Client shall include any person or persons authorized by the Client.

CHAPTER 2 Roles and Responsibilities of Consultant

2.1 Supervision by Consultant

The Consultant should familiarize themselves with and perform with contract documents, such as "General Conditions of Agreement for Consulting Service" and "Special Conditions of Agreement".

Japanese ODA Grants have strict condition on the amount and the construction period. Therefore, the Consultant needs to be aware of the total amounts of the grant relating to the project namely construction cost and consultant cost and others if any. Quality control and design change is also essential. The Consultant should oversee fulfillment of contracts and completion of payments of contract amounts of the works executed by the Contractor within the terms of validity of grants.

(JICA survey team, refer to JICA (2016.1), "Procurement Guidelines for the Japanese Grants")

(Description)

The Consultant's supervision activity at the construction stage is described in the General Conditions of Agreement for Consulting Services as follows.

(a) Organizing a supervisory team and elaborating the supervision plan for the Project,
(b) Carrying out inspections and testing of the works, materials and equipment on and off the site including verification of manufacturer's self-inspections,
(c) Reviewing and giving approval, consent or comment as appropriate to the following documents submitted by the Contractor;
  - construction schedule and revised construction schedule,
  - construction plan (method statement),
  - quality assurance and quality control documents,
  - health safety and environment management documents,
  - shop drawings, samples and catalogues,
  - other relevant documents,
(d) Issuing notices, certificates and instructions as appropriate,
(e) Carrying out research and investigations, if required, and issuing information and/or drawings, if necessary,
(f) Interpreting and explaining ambiguities and/or discrepancies in the documents which forms the Contract and issuing necessary clarifications or instructions,
(g) Supervising the Contractor to perform in efficient and appropriate manner,
(h) Supervising the Contractor to perform his work all the time in safety and hygiene conditions,
(i) Obtaining permissions, consent and/or approval from the Client, if required,
(j) In coordination with the Client, obtaining permissions, consent and/or approval from the relevant authorities,
(k) Reporting progress of the Project, As-built documents, and manuals as required in the contract to the Client and/or to JICA,
(l) Coordinating and organizing management meetings among the Client, the Contractor and other relevant third parties,
(m) Assisting the Client to modify or amend the Contract except for the Consultant Agreement,
(n) Assisting the Client to manage and settle difference or claims of the Contractor and
(o) Performing Test on Completion,

(p) Conducting search over the defects before the expiry of Defect Notification Period and
(q) Performing inspection and/or confirmation of remedial work done by the Contractor during the Defect Notification Period, and
(r) For the project which establishes the quality control meeting, providing technical and secretarial services for conducting the construction quality control meeting among the Client, the Contractor and the relevant organizations.

Reference: JICA (2016.1), Form of Consultant Agreement under JICA's Grants

2.1.1 Confirmation of Quality and Quantity/measurement of Works

The Consultant should supervise construction works according to construction supervision plans (preparation of the supervision plan is stipulated in the contract). The Consultant must share the contents of the construction supervision plans with the Client (implementing agency of the recipient country) and the Contractor. They should confirm that the quality and specifications of materials, the quality and finished form of construction works, etc., are in accordance with those stipulated in the contract.

The standard quality control items for major slope protection works are shown in Table 2-1. If they do not meet the contents stipulated in the contracts, the Consultant should judge whether it is technically allowable or not. After that, the Consultant should confirm approval of the Client. If design changes are required in the course of the construction work, the Consultant should carry out the necessary procedures.

In addition, it is also important for the Consultant to supervise the Contractor to ensure that construction records such as quality control data and photographs are properly organized and stored in order to fulfill accountability.

Table 2-1 Standard Quality Control Items in Slope Protection Works

(JICA Survey Team)

Type of Works	Standard test	Test for daily management	Quantity/measurement management	Remarks
Shotcrete/ Mortar spraying	Meter (aggregate and water), Quality of materials (cement, water, fine aggregate, coarse aggregate, etc.), Quality of mortar spraying/ shotcrete (compressive strength, chloride content), Quality	Check materials, mix and compressive strength within the standard values	Check the spray thickness at regular intervals	Cleaning slope surfaces before spray works, drainage treatment of spring water, adjusting the wire mesh to conform to unevenness, maintain perpendicular spraying angle to slope surfaces, installing the drainage holes on slope surfaces etc.
Spray crib works	In addition to the above, check standard certifications for rebar	In addition to the above, check of processing and assembly of rebar	Check the length and cross section of crib	In addition to the above and note for the crib works (no joints at the intersections of the frames, fill the space under rebar, finishing the cross section of crib uniformly)

Type of Works	Standard test	Test for daily management	Quantity/measurement management	Remarks
Cast-in-place concrete crib works	General construction management of concrete			Cleaning slope surfaces, drainage treatment of spring water, adhesion of the formwork to slopes, prevention of formwork deformation etc.
Rock bolt/ soil nailing	Qualities of materials and mix of grout	Quality of grout, pull-out test and loading test	Accuracy of drilling, processing of reinforcing material, and grout injection	Selection of drilling method and machine according to ground conditions, self-supporting height of slope, accuracy of angle and length of rebar, removal of slime in drilled hole, filling the back of the reinforcing material head, prohibiting construction at 5°C or less in principle, etc.
Ground anchor	Qualities of materials, mix of grout, and products of anchor	Quality of grout, pull-out test, and loading test (multi and single cycles)	Accuracy of drilling, assembling and processing of tendon, and grout injection	Handle with care for tendon, hole wall retention during drilling, slime removal after drilling, keep clearance between tendon and casings, accurate placement of tendon, check of fluidity and specific gravity of mortar during inserting of tendon, curing, prevention of grout loss, treatment of head after loading, frequency and quantity of tension control, selection of load cell, etc.
Horizontal drainage boring	Material and quality of screen pipes	Drilling and assembly and processing of screen pipes		Joint connection during casing installation and blockage of underground pipe end
Lightweight embankment with air mixed cement	Meter (cement, water and soil material), Quality of materials (cement, water, soil material, foaming agent etc.), and test of mix proportion in laboratory	Soil material (moisture content, fine particle fraction) and lightweight embankment (Density, air ratio, flow value, compressive strength, chloride content, etc.)	Quantity/measurement standards	Management of casting thickness, weather conditions during construction, temperature rise after construction, drainage and water stoppage treatment, waterproofing

2.1.2 Ensuring Construction Safety

When constructing facilities in ODA Grants, local subcontractors involved in the construction may be unfamiliar with such large-scale construction as ODA grants project or may behave unsafely due to lack of safety considerations during construction work. In order to prevent accidents during construction, it is necessary to consider differences between social customs and site conditions of the partner country and those of Japan.

2.1.3 Final Inspection for Acceptance

Upon completion of facility construction and/or installation of equipment, the Consultant should conduct the final inspection in the presence of the Client (implementing agency of the recipient country). In addition, it is necessary to obtain the approval of the Client regarding the contents of the final inspection report. During the final inspection, the Consultant should inspect by measuring the form completed and its size and confirm that the series of completion documents (As-built drawings, construction photos, quality control reports, maintenance documents, etc.) is submitted to the Client with appropriate and sufficient content. It is important for road administrators to ensure that the contents of the as-built documents, including as-built drawings, are consistent with the site. The Consultant should pay attention not only to the principal slope protection structures of the construction, but also to the ancillary facilities that are adjusted and determined at the site and/or properties occupied by third party such as electricity, water, sewage etc. (both above and underground of the road).

2.2 Preparation for Accidental Slope Instability

The Consultant should share information with the Contractor regarding anticipated slope destabilization. They should check the site together and reach a common understanding. They should discuss risk projections at regular meetings, such as weekly and monthly meetings. Above proper preparations are essential to reduce risk of accidents in construction works.

(JICA Survey Team)

(Description)

After site clearance and removal of topsoil before construction, factors that destabilize the slope (e.g., weathering, faults, dip slopes, boulders, springs, etc.) that were not found out at the survey stage may appear. Based on a risk assessment by a detailed on-site survey during preparatory and/or detail design stage (see chapter 5.1), the Consultant should provide advice so that the Contractor can build a disaster prevention system by predicting the impact on construction work, including third parties, such as traffic and worker safety in the event of a collapse.

Since slope failures are often caused by rainfall in Japan, traffic is regulated by setting threshold values of hourly rainfall and/or cumulative rainfall. In the target countries of the project as well, establishing warning standards in advance based on weather conditions and similar disaster cases can be useful in preventing accidents and securing the initial response to emergencies.

The Consultant and the Contractor should discuss the initial response system taking into account the above-mentioned local events and natural conditions at regular meetings (weekly and monthly). It activates risk communication in advance, resulting in risk reduction (occurrence of collapse event and suppression of expansion).

In this regard, response measures for slope failures during construction are described in Section 7.1. When an abnormal phenomenon is detected and if an emergency activity and/or a revised planning become necessary. Section 7.1. and 7.2. should be refereed.

CHAPTER 3 Roles of Contractor

3.1 Roles of Contractor

After contract agreement with the Client, the Contractor should be responsible to conduct construction work of designated facilities described in contract documents. The Contractor should be requested to perform quality control activities for securing requested functions of target facilities under an appropriate construction control. The Contractor should select appropriate procedure of construction work, such as personnel, material, methodology, machine and funds, and make/execute a construction plan containing appropriate quality control activities, schedule and cost management to achieve the purpose. The Contractor should describe the methodology for the quality, schedule, and security control in the construction plan.

(Description)

In the ODA Grants, the bidding is conducted in line with “Procurement Guidelines for Japanese Grants 2016”, and the Contractor is selected. The Contractor exchanges a contract with the recipient country. The Contractor is requested to execute the scope of work stated in the bidding documents and is responsible for the quality control.

The checking methods, standards, and specifications in order to judge their consistencies with the construction work are clearly stated in the contract documents. The Contractor should describe them clearly in the Construction Plan. In the Construction Plan, organization chart, work procedure including temporary works, quality control with checking and testing method, scheduling, security control or other necessary items should be stated. For the checking and testing method, the adopted standards should be used in principle. The Construction Plan will be made thorough discussion with the Consultant. And it will be submitted to the Client after obtaining approval and agreement by the Consultant (Form of Consultant Agreement under JICA’s Grants, JICA, January 2016).

Civil works originally contains many unknown factors. Particularly in the slope protection works, risk of slope instability is likely to become obvious during construction. Therefore, considering the natural and social condition, such as material and labor procurement of the partner country/region is important when preparing the Construction Plan.

For the quality control, the Contractor should follow the standards and the checking criteria of the recipient country or criteria shown in the construction specifications. However, the Contractor can establish reasonable methodology with its responsibility under the agreement with the supervision consultant based on the work scale, execution capacity or internal standard of the Contractor. There may be a case to propose reasonable slope gradient and slope protection considering the past example of the neighboring section or surrounding area.

Safety countermeasures based on “The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects, JICA, September 2014” should be taken for the safety control. Consideration of the natural and social condition of the partner country and its region is important. As for natural condition, rainfall pattern widely varies in the country or region, and there is country-specific meteorological condition such as monsoon, rainy/dry season alteration. From the viewpoint of safe construction, it is wise to avoid rainy season for the earthwork because of the risk of slope failure. The role of the Contractor to cope with unforeseeable slope failure is to have a smooth cooperation with the Consultant to identify the cause and to determine the countermeasure.

3.2 Construction Control by Contractor

Economical and reasonable quality control should be conducted in line with the contract documents. And the Contractor should certainly execute the work based on standards and guidelines stated in the contract documents. The Construction Control Plan should define control methods for quality, shape, safety and schedule at every process, and the plan should be submitted to the Client through the Consultant.

(Description)

The modification work in civil works at the final phase is impossible or cost/time consuming. Appropriate quality control at every step of the construction process is important to avoid the reworking. Therefore, the construction control testing is regarded as an essential step. The Contractor should execute quality control to meet standards over all work process from products and material delivery, machinery to execution method all the time from the beginning until the completion. The Contractor can propose reasonable alternative methods to the Consultant whenever he thinks it necessary. The Contractor should state items, frequency, and standards in the construction plan. The Contractor must summarize the result immediately and feedback it to the quality control activities in the work. In the past project, there was a case in which temporary work plan was insufficiently stated. Therefore, the Contractor needs to review the work plan from the constructor's viewpoint and propose necessary update of the work plan.

The Construction Control Plan must be made in consideration of the following points.

- Perform quality control for every type of work with reference to standards and guidelines.
- Clarify technical grounds of the items, frequency and standards of construction control.
- Materials /work methods and schedule plan should be included in the construction plan. Field machinery/facility and temporary structure should also be added to the plan. Following items should be also noted in the plan.
  - (a) Work Procedure
  - (b) Order and timing for check/testing
  - (c) Additional documents for work method and machinery
- The Contractor should plan on the quality control, which shows that the condition and requirement of the contract documents is satisfied.

3.3 Preparedness toward Unstable Slope

The Contractor should carry out preliminary survey before commencement of the main construction work. In this survey, the Contractor should gather information on past slope failure incidents in the vicinity of the target area as much as possible. And preventive countermeasure should be examined and proposed to the Client through the Consultant as far as possible. The Contractor should always keep observation of the slope status, i.e., antecedent phenomena of slope failure, in order to secure the safety during the construction work. The Contractor should inform to the Consultant once unexpected hazardous factors are discovered. And the Contractor and the Consultant should consider the countermeasure together.

(Description)

Thorough identification of all potential disastrous risks from the geological risk's viewpoint is unrealistic. Therefore, to detect the signs of the slope failure and to act promptly for effective countermeasure as well as to notice to the Consultant is essential during the construction work. In the past project, there was a case in which cracks, spring and boulder were discovered in the vicinity of the slope in the preliminary survey or plant/tree clearance work before commencing the main work. The risk of the slope failure and damage of road became obvious in the case.

The Contractor is requested to place monitoring devices proactively for the identification of the risk factors and establish practical organization for daily monitoring. If unforeseeable failure is encountered, the Contractor should take emergency action to secure the safety of labors, passing vehicles and surrounding residents as the first priority, and propose an investigation to identify the cause of the failure and necessary design change with the Consultant together.

CHAPTER 4 Points to Note in Countermeasure Works

4.1 Construction Methods in ODA Grants

Common points of note in ODA grant construction works are stated in this section. Points of note for each construction method is described in section 4.2 and beyond.

(a) Pre-construction Survey

The Contractor should promptly conduct a pre-construction survey soon after signing the contract. The purpose of the survey is to understand the slope conditions as much as possible. Since the perfect survey of the entire slope area is difficult to conduct at the design stage, the risks of slope failure can be overlooked and remain in the construction phase.

(b) Work Organization, Personnel Training

Regarding the Contractor's work organization, the Contractor should re-verify whether sufficient technical personnel are allocated which coincides with the scale and content of the slope countermeasures based on the results of the preliminary survey. And the Contractor needs to consider, if necessary, the increase of engineers/labors involved in slope countermeasures if necessary. In addition, the Contractor's responsibility is to clarify the applied technical standards within the construction plan, to describe the quantity/measurement and quality control/assurance methods in accordance with the standards, and to ensure that construction management is performed appropriately. However, in case an unpopular construction method is used in the partner countries, it is important to provide pre-training to local engineers/labors on construction methods and management methods to satisfy the required quality.

(c) Actions during Construction

The Consultant should check the contents of the construction plan prepared by the Contractor. Besides providing necessary advice in case deficiencies are found, the Consultant should supervise whether the construction work is executed appropriately according to the construction plan while ensuring the prescribed quality in accordance with the specifications, design documents, etc. stipulated in the contract.

Contractor has the responsibility to ensure that first, the appropriate management methods (shape and quality) are implemented according to construction method, and second, the confirmation tests are conducted in accordance with technical standards (whether compliant with the standards or not is one of the crucial factors to deal with the Contractor's responsibility for the defect). In this regard, it is strictly avoided that the Contractor adopt arbitrarily simplified management/inspection method for the convenience of the Contractor. Moreover, during slope countermeasures construction, stakeholders should address the problem carefully in case that slope conditions are different from design.

If a slope failure occurs during construction, the Contractor should provide the highest priority on human life safety and ensure the safety of workers, vehicles, and surrounding residents.

In addition, temporary work, temporary roads, traffic di-version, safety management costs, etc., must be included in the countermeasures planning.

In the past, there was a case that the predictability of slope failures has become one of the important points of discussion. Contractor should summarize the construction progress and slope observation status before and after the failure, and also share the information among the stakeholders.

4.2 Cutting Works

For cutting works, the Contractor should carefully observe changes in the geology and groundwater that appear on the slope, and report to the Consultant and stakeholders in considering countermeasures if the geological conditions differ from design.

(Description)

Natural ground is heterogeneous and not all can be elucidated by limited investigations. The Consultant must describe the matters to be noted during the survey and design in the preparatory survey report and project monitoring report.

To predict slope failures perfectly is difficult in fact. However, some of slope failures can be prevented if signs of failure are detected in advance. Examples of geological conditions that Contractor should pay attention to during cutting slope include the following:

(1) Type of soil/bedrock
(2) Status of soil/bedrock (hardness/softness, weathering/alteration, moisture content, etc.)
(3) Status of discontinuity (joint, bedding, schistosity, fault plane, etc.)
(4) Presence of unstable stones, boulders, and spring water
(5) Presence of cracks and trace of past failure on the ground surface
(6) Freeze-thawing status

For the schedule of the work, the rainy season should be avoided as much as possible for the timing of the slope cutting. If rain falls during the construction work, taking measures to prevent rainwater penetration, such as covering the cut part with a sheet, is desirable to reduce the risk of slope failure.

Handling of boulders that appear on the slope (If the shape of the slope is greatly damaged, remove boulders by statically breaking into small pieces since otherwise, there is a risk of damaging the stability of the slope)

If an unexpected spring water is encountered, take measures such as guiding the spring water with pipes and gutters to prevent it from penetrating the slope, and installing a temporary drainage ditch leading the water to river. After cutting slope, quickly build water collection and distribution channels and protect slopes, also limit rainwater infiltration to the slope as much as possible.

Cut the slope from top to bottom of the slope. Do not excavate the lower part of the slope so that the upper part overhangs. It should strictly be avoided the simultaneous working on places of different height on the same slope.

The Contractor is desirable to survey the slopes after rainfall to check for new stream or spring water, and to check if there are any changes in the slope surface such as cracks.

4.3 Concrete Crib Works

The concrete crib works are divided into two types, cast-in-place concrete crib works suitable for construction at low height and on flat slopes, and spray crib works that can be applied on uneven slopes. In the crib works, quality should be ensured by examining performance of spraying machine used for construction and skill of nozzle man (in the case of spray crib works).

(Description)

Expected functions are almost the same for both cast-in-place concrete crib works and shotcrete concrete crib works, but due to differences in construction methods, the constraints on application are different.

Even though cast-in-place concrete crib works does not require special skills because concrete is poured after setting up a formwork. However, the concrete crib works is not suitable for small cross-sections, uneven slopes, and work at high places. In particular, if the geological conditions are different than expected during construction such that a flat slope cannot be secured, or if the slope becomes uneven due to the removal of large boulders, the application of cast-in-place concrete crib works is not effective. In such cases, the Contractor is expected to consult with the Consultant promptly, and to cooperate in considering appropriate countermeasures such as changing to shotcrete concrete crib works depending on situation.

Avoiding spray work in hot or cold weather (higher than 30ºC or lower than 4ºC) is desirable, but for overseas, construction under the above conditions is unavoidable in some cases. Sufficient water sprinkling and covering the concrete crib with a sheet are required to keep the temperature and moisture of concrete in desirable condition.

4.4 Ground Anchor Works

Ground anchor works mainly consists of underground structures, and since examination cannot be conducted directly for the quality of the main structure after construction. From this, to comply with the construction procedures, the construction management methods and the management standards described in the construction plan is important to keep quality of works. If different geological and groundwater conditions are encountered during drilling for the anchoring, the Contractor should promptly report to the Consultant to have discussions.

(Description)

One of the characteristics of ground anchor works is that the main mechanical structure is built underground, and the quality control during construction and the measurement of the finished shape can only be done indirectly. Therefore, the most essential point for the works is to follow the construction procedures stipulated in the construction plan and to implement construction management methods and management standards in a reliable manner.

Problems during construction that cannot be anticipated at the time of planning are geological conditions, groundwater, and underground obstacles. As for geological conditions, changes in geological composition of strata unevenness or faults, differences in geological types and conditions are the examples. As for water, encounters with confined water, changes in the amount of spring water, loss of drilling water and grout, etc. are examples. In urban areas, hidden structures built in the past might remain and might be desirable to construct anchor bodies in some cases. Since either of these problems may lead to produce a defective anchor body that does not exhibit the desired function, the Contractor should immediately report to the Consultant and have discussion for countermeasures when one of above unexpected conditions is encountered.

4.5 Rock Bolt / Soil Nailing

Workers and construction managers should carefully observe the condition of the slope and in order to minimize the undesirable loosening of the ground during construction of this work.

(Description)

Rock bolt/soil nailing is a method that aims to stabilize the ground by reinforcing to prevent the loosening due to deformation of the ground. Therefore, the Contractor needs to share, among the engineers and the workers, the importance of suppressing the loosening at the beginning of excavation. The construction works should be done step by step, and workability should not be prioritized, such as leaving bored hole for a long time after drilling until inserting the reinforcing material. If even a slight unexpected change is encountered on the slope condition, such as when there is even a slight deformation on the slope or cement milk and other injection materials are lost and are not returned, the workers should report to the construction manager of the Contractor. And training of the workers is desirable to carry out construction carefully and not to overlook the slight change.

A predetermined drilling diameter for rock bolt/ soil nailing can be secured if an appropriate drilling machine is used. However, paying careful attention on the possible collapse of hole and on the change of drilling sludge is essential to secure the quality, because the condition inside the hole cannot be visually checked. This point is especially important for foreign workers who are unfamiliar with this type of construction. The construction works should be carried out under the supervision of an expert engineer who has specialized knowledge, such as judging the occurrence of bored hole collapse and determining the geology based on the removed sludge.

4.6 Mortar Spraying Works

As mortar spraying works is often carried out at high places, commencement of the work only after ensuring safety is essential for securing the safety of work. To ensure the safety work, it is necessary to train and to educate the workers so that they understand the safe method of equipment maintenance and the safe construction procedures. By doing so and by assigning skilled workers, the quality of construction could be secured.

(Description)

In overseas construction, where safety awareness is usually lower than in Japan, to formulate a construction plan that can fully ensure safety in terms of equipment and facilities, construction procedures, and enhance workers' behavior and awareness is important for securing the safety of work.

Regarding quality assurance, as same in Japan, cleaning the surface of target slope, checking the condition of the spraying equipment, ensuring the thickness through test spraying, and the worker's skill are essential for the work. Especially in this type of work, to confirm that the worker has skills such as stable pumping, avoiding voids behind the reinforcing bars, and avoiding contamination with rebounding materials is desirable prior to the work since the quality depends on the close cooperation between the nozzle man and the gun man.

If construction is to be performed in a climate different from Japan (high temperature, low temperature, dryness, humidity, etc.), the Contractor should consider appropriate curing methods (wet compress, water sprinkling, coating, etc.).

4.7 Rock Fall Barrier

Rock fall barrier is roughly divided into conventional type and high energy absorption type, and there are multiple products for each type. The construction method must comply with the construction manual for each product.

(Description)

The installation procedure of rock fall barrier should be complied with the construction manual for each product. The structure of the protective fence is divided into the pillars that support the protective fence, the foundation that supports the pillars, and the blocking surface that catches falling rocks. Ensuring thorough quality control in overseas needs a careful attention to the proper installment of foundations and the connection between foundation and pillars that cannot be visually confirmed after construction because connection part will be hidden in the foundation concrete.

4.8 Rock Fall Protection Net

There are two types of rock fall protection nets, pocket type and covered type. Each type has multiple products. The construction method must comply with the construction manual for each product.

(Description)

The work method of rock fall protection net should be complied with the construction manual for each product.

For pocket type, the pillars and suspension ropes that support the protective fence should be firmly fixed in the ground. In case of the cover type, the suspension ropes should be firmly fixed to the ground. In overseas, ensuring thorough quality control needs a careful attention to fixation of the product to ground.

For a long-term use, it is the layout that should be thoroughly considered so that not to be damaged by rock fall. If a rock fall danger spot that was not discovered at the survey and thus not assumed at design stage is identified during construction at the time of plants/trees clearance for preparation of the works, etc., it is desirable to have discussions with stakeholders about changing network arrangement of supports and suspension ropes or changing countermeasures taking into account of the scale of the rock fall.

In addition, there are cases in which overseas transport trucks have a higher loading height due to overloading compared to Japan. So long as the pocket type, depending on the slope, can be protruded over the road, there may be cases where it overhangs and disturbs the traffic. Careful attention should be paid for the configuration of the pocket-type, therefore.

4.9 Rope Covering Works

Rope covering method is used to fix large rocks or boulders on the slope. It is a construction method in which grid-shaped wire ropes are fixed by anchors fixed in the ground. The work should be conducted by using appropriate material and anchor fixing type.

(Description)

The work method should be complied with the construction manual for each product.

Fixing anchor firmly to sound ground is important to maximize the effect of the works. As shape and dimensions of anchor must be selected appropriately based on the size and the shape of the rocks/boulders and geological conditions, to select the position of the anchoring part and to confirm the error-free anchoring is desirable under the guidance of an experienced engineer. The secure anchor fixing should be confirmed by conducting a pull-out test.

4.10 Horizontal Drainage Borings

The direction and angle of boring drilling are important control items in order to demonstrate the expected drainage function.

(Description)

For the management of the boring direction, the Contractor needs to set reference lines before and after the drilling point, and to devise ways to manage the drilling direction according to the construction plan. The Contractor should record volume of sludge discharged from the hole mouth during drilling and should observe and check the ground condition under the guidance of experienced engineers.

Hard polyvinyl chloride (PVC) pipes processed with a strainer are often used for outer casing pipes inserted after drilling. In Japan, PVC with internal screw joint processing is available while in overseas the same processing is not easily available but external socket connection in. In case of external socket connection, the drilling diameter will be large, so be careful when selecting the drilling diameter.

4.11 Concrete Casting

Quality control at the time of concrete casting must be performed according to the test and quality control standards specified in the design documents and construction plans. However, the quality of concrete is susceptible to change due to temperature and weather, hence the Contractor should not only check the actual work situation. They should have necessary communication with local workers to quickly find any abnormalities and should have solutions to keep the quality of concrete within the specified range.

(Description)

Quality of concrete is often thought that it can be mechanically controlled based on control criteria such as test results and pouring time. However, automatic judgement is difficult for those such as the condition of fresh concrete at the time of its acceptance from the manufacturer or at on-site plant, the workability, the vibrator insertion position and the compaction time, etc. Furthermore, even with concrete with the same slump value, the workability varies depending on the construction conditions and materials used, so in some cases, it is quired to take the comprehensive improvement measures such as changes of the materials and their proportion, and to confirm the quality and the characteristics by preliminary construction tests. This kind of response requires specialized knowledge and organizational communication skills, so in order to maintain high construction quality in overseas, allocation of skillful construction management personnel and craftsmen who can instruct local workers is necessary.

Table 4-1 Example of Concrete Quality Control Flow

(Kuroiwa・Iijima, Concrete Engineering, Vol. 52, No.9, pp780-783, 2014)

Type of work	Management item	Inspection method	Management standards	Inspection time	Inspection frequency
Construction plan	Mix proportion plan, material's quality	Check with compounding table and material test report	Consistent with design documents and construction plans. Workability is considering construction conditions	Before casting day	Per compounding
	Casting range, casting step, and casting quantity	Check with construction plan	Workers acknowledge casting location, pumping route, casting quantity and pitch	Before casting day	Per casting
	Others	Check with construction plan	Worker's knowledge on retaining frames, joint processing, equipment inserts, etc.	Before casting day	Per casting
Casting preparation	Casting preparation	Check with construction plan	Cleaning before casting, personnel, vibrator and mortar receiver, concrete top, adjust bar, inserted bar	Before casting day	Per casting
Inspection before casting	Formwork, reinforcing bar	Check with construction drawing	Cover, spacer	Before casting day	Per casting
Joint part checking	processing, cleaning	Visual check	Water stoppage treatment, laitance, cleaning dust, etc.	Before casting	Per casting
Checking before casting	Checking before casting	Check with construction plan	Pump placement, nozzle position, traffic line of Fresh concrete vehicle, shipping instructions, equipment deployment, slit position transmission, watering	Before casting	Per casting
Acceptance inspection	Fresh concrete condition	Visual check	No errors	When unloading	All casting
	Slump	JIS A1101	5cm ≤ slump < 8cm: tolerance ±1.5cm; 8cm ≤ slump < 18cm: tolerance ±2.5cm		1 time/day or when 1 time/20-150m^3 and quality change is required
	Air content	JIS A1128	±1.5% (Tolerance)		
	Chloride content	JASS 5 T-502	Less than 0.30kg/m^3 (Average value of 3 times of measurements)		
	Compression strength	JISA 1108	The average value of the three specimens exceeds the design strength at 28th day	After 28 days	
Transportation Casting Compaction	Workability	Visual check	No errors in pumping and casting	While casting	Per casting
	Pumping, casting speed	Time management			
	Compacting, filling	Visual check	Appropriate tapping and vibrating		
	Reinforcing, inserted bar	Visual check	No disturbance		
	Frame	Visual check	No loosening or falling		
	Interval of intermittent casting	Time management	Within the allowed time		

Type of work	Management item	Inspection method	Management standards	Inspection time	Inspection frequency
Curing	Weather	Visual check, thermometer	Avoid rapid drying, high temperature, and low temperature	Initial curing	Once per day
	Loading weight, vibration, shocking	Visual check	Prohibit of Loading heavy objects	The day after casting	Per casting
Treatment after frame removal	honeycombs, cold joint	Visual check	No significant defects	After demolding	Per driving
	Cracks	Visual check, crack scale	No harmful cracks	Before finishing	Each part

4.12 Counterweight Fill and Soil Removal Works

Foot part counterweight filling works and the head part soil removal are both conducted in the vicinity of possible slope failure areas. During the construction, careful observation should be performed for the slope and the surrounding area.

(Description)

The same points as the cutting works shown in section 5.2 should be noted for the head part soil removal. The foot part counter fill weight is applied in toe of the possible slope failure area, but base ground of the counter fill might be disturbed by the past slope movement or by other reasons. Therefore, the deformation, such as vertical/horizontal movement and/or open crack~~,~~ on the slope in construction including the surrounding areas should be carefully observed during the construction.

CHAPTER 5 Risk Prediction

5.1 Before Main Construction Work

First step of risk prediction on the construction work is to check the design conditions with actual field status and to inform the gap to the Consultant. Risk factors, such as cliff, cracks, spring, etc. can be discovered during the plant/tree clearance. New risk factors may become obvious in case that rainy season is between the design work and the construction work. Thus, the careful preliminary survey before the construction is necessary to gather the latest information in the field.

(Description)

Unknown geological factors can remain for the target slope even after the Consultant performed detailed investigation prior to the construction. In other words, the Contractor needs to execute the construction work with a certain amount of slope failure risk.

The Contractor must check the contract documents carefully after receiving them at the order of the work and must review the document contents with the field condition before commencing the work. New risk factors may become obvious in case that rainy season intervenes between design and the construction. The careful preliminary survey to update the data is necessary for gathering information in the target section or the neighboring section through field observation. There might be cliff, rock falling, spring, distorted tree growth, change of vegetation, deformation of the structures in the vicinity constructed in the past, etc. And there might be different condition on weathered condition, cracks and fractures of the rock comparing to design. The Contractor needs to envisage those factors for the risk prediction. It is recommended to interview to nearby residents on historical incidents, such as slope failure, rock fall, surface water flow during rainfall in order to gather useful information. The Contractor must check difficulty of slope excavation at the sight. When they find the gap between the document and the filed status, they should inform it to the Consultant and should have a meeting on future action with the Consultant and the Client.

Accident and trouble usually occur due to mis- and/or insufficient information or misunderstanding on the risk among the stakeholders. Therefore, to share both the confirmed and unconfirmed information, which can affect the project, is important to build strong cooperation among the stakeholders. Conditions/limitations of the information are called “the information for the information” and become the basis of the determination. Confirmed results or conclusions are usually shared without fail, but uncertainty also should be visualized and shared among the stakeholders as “the information for the information”.

5.2 Check during Cutting and Filling

Slope failures might be predicted when cutting and filling performed in the construction of slope protection if a geological change or spring are carefully observed. The Contractor should stop the work in case encountering un-expected geological condition during the work and should inform the difference from an original information used for the design to the Consultant. The Consultant should consider a design change if necessary.

(Description)

As geological and stratigraphical conditions in a natural ground are quite complicated and different by its place, checking rock and soil condition, presence of spring is important to find hidden risk at the time for preparation such as cutting for temporary road etc. The Contractor needs to always pay attention to the cut slope condition and surrounding natural slope during the construction. In case that unexpected conditions, such as the position of soil-rock boundary is different from expected, presence of crack, boulder, spring and swelling, are observed, the Contractor must inform the situation to the Consultant immediately.

According to a design workflow for long cut slopes established by Kochi prefecture, one of the mountainous local governments of Japan, geologist/geotechnical engineers need to examine the slope through walkover survey and visual assessment, and additional investigation or design change is proposed if necessary.

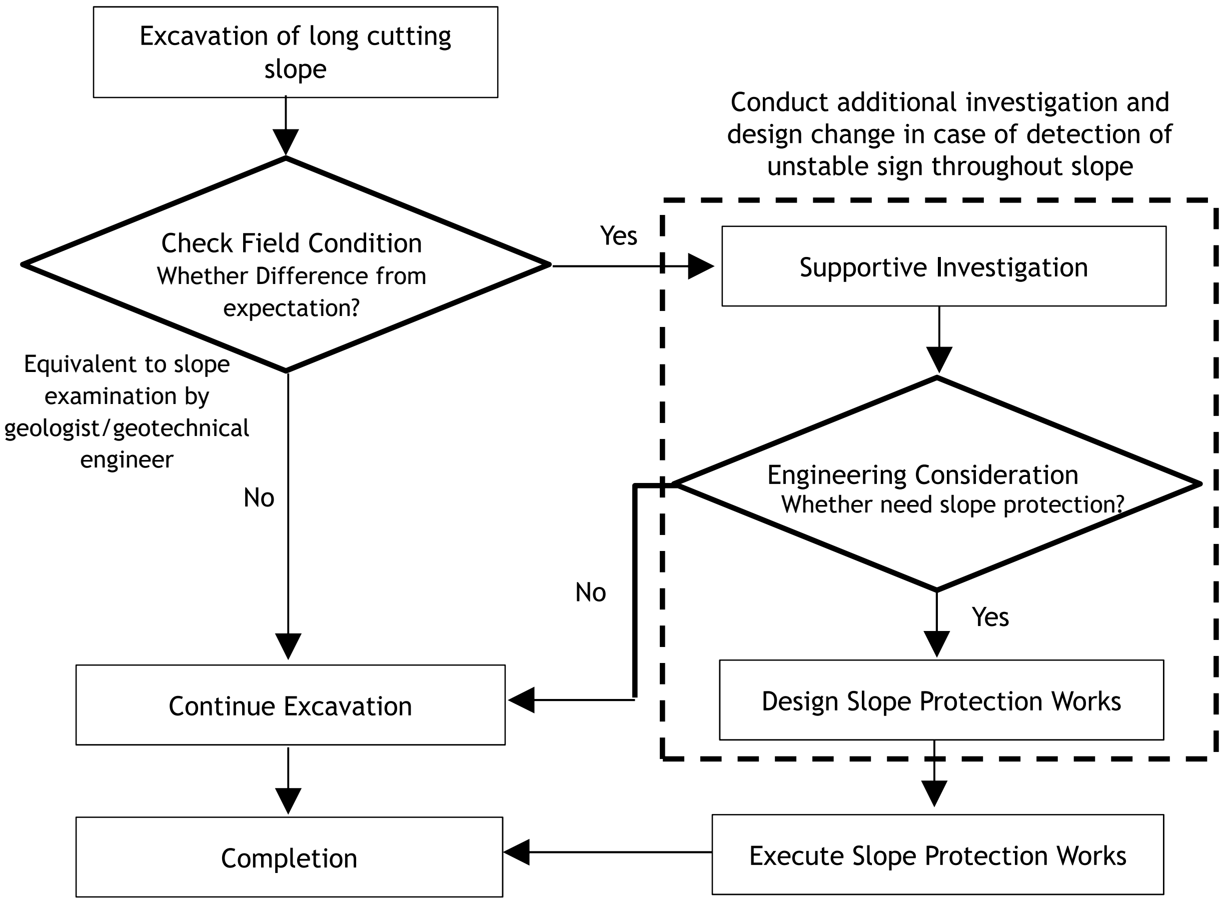


Figure 5-1　Workflow for Long Cut Slope

(Edited "Manual of Investigation, Design and Supervision for Long Cutting Slope, p17, Kochi, Japan", 2018)

General check points for phenomena of slope failure are as follows.
(1) Field reconnaissance in target area
(2) Presence of cracks in the upper area above cutting slope shoulder
(3) Condition of geological boundary between layers on cut slope
(4) Presence of unstable boulders
(5) Presence of spring and seepage, volume change of spring water
(6) Presence of freezing and thawing
(7) Comparison with failure incident for natural slope and cut slope in the neighboring area

In the check report shared among the stakeholders, area, depth, and scale should be clarified with diagrams and photos for smooth delivery of the information. In case of presence of spring, temporary drainage ditch is helpful to reduce the slope failure risk and the cost for this temporary works should be usually discussed with the Consultant and determined how to deal. In addition, geological condition revealed during the construction should be summarized for future reference.

For embankment on the slope, failure accompanying deep slip caused by poor drainage is worried about, especially for half-cut half-embankment section. Even without rainfall, water seepage from upper natural slope can raise groundwater table in the embankment resulting in unstable slope condition. The Contractor needs to pay careful attention to groundwater condition in mountain side, situation of catchment area during rain and snowmelt, status of spring during the cutting and permeability of embankment material used. And the Contractor needs to inform the situation to the Consultant if different condition is encountered from the design. If the original plan or design is needed to change due to newly discovered reasons during construction or material/equipment procurement phase, the Consultant should take necessary process immediately for the design change according to G/A, JICA's purchase guideline, and contract with the Client, and should obtain consent/no objection from JICA in advance.

5.3 Risk Prediction by Slope Surface Survey at Fixed Reference Point and Monitoring Instruments

> Movement monitoring is necessary to ensure safe construction for the Contractor as slope can become unstable due to slope cutting. Reasonable methods should be selected by considering cut slope size, topography, geological condition, rainfall and past failure etc.

(Description)

In case of possible slope failure or emergency action after slope failure, monitoring instruments are placed to observe slope movement. The instruments need to be available in the developing countries and to be easy to handle. Placing wooden plates and stakes on the slope are the simplest method with no special devices and no electricity required. For emergency action after the occurrence of the failure, basic action is to cover the slope with plastic sheet, to dig a drainage ditch around the slope for prevention of water infiltration in the area. Continuous observation is also necessary in the working area where the slope is likely to be unstable. Observation plan for slope movement should include the following ten (10) items.

(1) Purpose of observation of slope movement
(2) Target area of observation
(3) Selection of items and instruments for observation
(4) Configuration of instruments
(5) Determination of period and frequency of observation
(6) Control criterion
(7) Organization chart for daily and emergency observation
(8) Process method of observational data
(9) Maintenance of instrument
(10) Actions-To-Be-Taken list in emergency

Device with ingenuity such as lock or guard fence etc. is necessary to protect the instrument from outsider who might break or steal them.

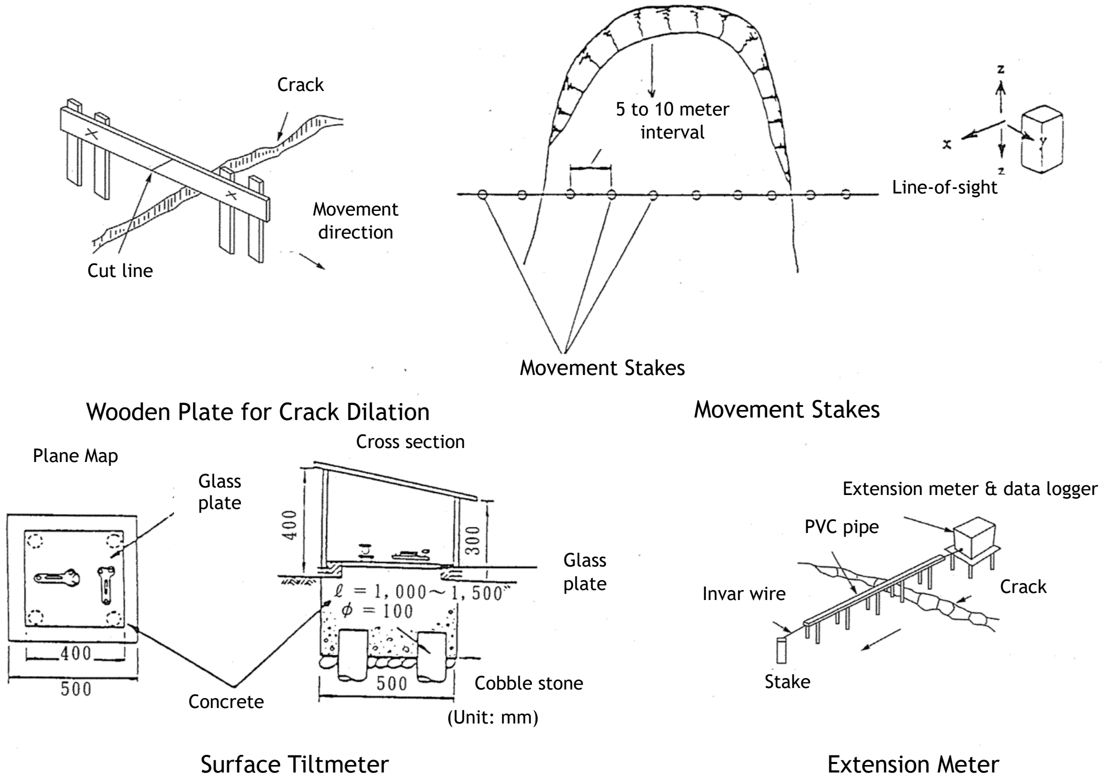


Figure 5-2 Example of Surface Movement Monitoring

(Investigation Guideline, NEXCO, p Ref 2-1, 2020)

5.4 Application of Observational Execution Method

Observational execution is effective to conduct safe and reasonable countermeasure works because uncertainty of geological / geotechnical condition always accompanies the slope protection works. Risk information should be revised with new data gained by field measurement, investigation and analysis. And the updated information should be shared among the stakeholders.

(Description)

The Contractor is recommended to measure surface movement by electro-optical distance measuring instrument and to check presences of abnormality of slope surface condition during cutting. In the case of long cutting slope, monitoring with instrument is necessary to observe subsurface condition, such as subsurface geology and groundwater, as deep slip failure is possible to occur. Consensus building through sharing method of measurement, data management and its utilization among the stakeholders, such as the Contractor, the Consultant, the Client, is important for reasonable decision making.

CHAPTER 6 Safety Work on Slopes

6.1 JICA's Approach to Work Safety Measures

JICA established a basic policy on safety measures for construction. JICA conducts construction safety measures based on the policy.

The basic policy for safety management is as follows.

- Elimination of causes
- Thorough precautions
- Thorough compliance with relevant laws and regulations
- Thorough prevention of public accidents
- Thorough implementation of PDCA cycle for safety management
- Thorough sharing of information
- Thorough participation of all Project Stakeholders

To realize safe construction, JICA presented "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects". JICA strives to implement safety measures in compliance with the Guidance in projects involving facility construction. In addition, JICA experts, JICA survey teams, and JICA officials carried out site visits to ensure thorough implementation of safety measures.

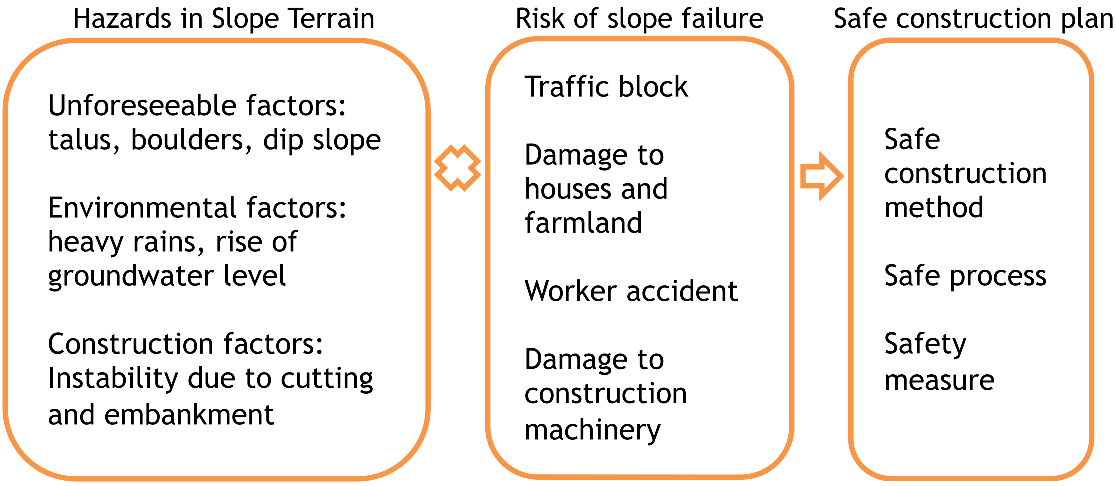
6.2 Risk Assessment for Safe Construction

Slope hazards do not contain only the instability of topography and geology, but also the destabilization of the slope due to climate condition such as differences in rainy and dry seasons, extreme weather conditions such as heavy rain, and due to landform alteration during construction. In order to carry out safe construction on the slopes, it is necessary to evaluate the risk of these hazards against people involved in construction works and against third parties at the site. The Contractor should prepare construction plans that considers countermeasures to minimize the risks in advance.

(JICA Survey Team)

(Description)

Since slopes, which are the target of slope countermeasure projects for road disaster prevention, have unforeseeable hazards that threaten safe construction. The Contractor should prepare construction plans that incorporate best possible countermeasures against risks of slope instabilities. In this context, it is desirable for the Contractor to refer the contents of the “Industrial Safety and Health Act” as well as the affiliated ordinance of Japan. The English version can be found in the following address (https://www.jisha.or.jp/international/act/index.html).



(JICA Survey Team)

Figure 6-1 Approach to Risk Assessment for Safe Construction

The procedure for the concept of risk reduction measures for safe construction planning is based on the following priorities (JICA Standard Safety Specification (JSSS)[1] for project implementation under Japanese ODA, 2020.9);

(1) Removal of hazards such as eliminating dangerous methods of construction.
(2) Changing to a safer construction method and alternating to low-risk processes, operations, materials or equipment.
(3) Engineering measures.
(4) Management measures including improving skills with additional training.
(5) Use of Personal Protective Equipment (PPE).

Regarding the elimination of the hazard itself under (1), there exist cases where it may be physically difficult to satisfy (1) for the projects in the mountainous area, depending on the slope situation, within economically rational construction cost and period. In that case, it is necessary to handle it at investigation or design stage so that the Contractor can bid with the rational and responsive price and construction duration.

(2) is an area where the Contractor's ingenuity can be utilized. The Contractor is expected to derive, with the maximum use of his/her experience and ingenuity, the optimal solution that can be obtained under the constraints of site conditions, weather conditions, procurement conditions, construction cost and construction period, and reflect it in the safety construction plan and in the procedure manuals.

Regarding (3), the Contractor should consider not only ensuring the safety of construction at the site, such as installing temporary protective fences and signboards, but also the impact on third parties and the prevention of traffic obstruction.

Regarding (4), since workers are often employed locally, the Contractor should understand the safety awareness of the target country, should plan and conduct training for new workers, should conduct safety patrols and appropriate training assuming the occurrence of site-specific disaster etc.

Regarding (5), the Contractor should provide workers with the necessary safety equipment such as helmets, safety belts, and safety shoes/gloves, and ensure that they wear them.

[1] JSSS is officially bound to the Yen Loan projects, but its contents are useful in the grant aid projects.

6.3 Safe Construction Plan

In accordance with the "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects" (JICA, September 2014, here in after "the Guidance"), the Contractor should prepare "Safety Plans" as basic plans for safety management in the pre-construction stage and "Method Statements on Safety" as detailed implementation plans applied for safety management in the construction stage. The Contractor should submit both plans to the Client and the Consultant who supervises the construction.

The Consultant and the Client should review both submitted plans from the perspective of ensuring safety, and if there are any questionable issues in ensuring safety, they should make questions and give instructions and guidance, if any, to the Contractor for their improvements. The Contractor should improve and correct deficiencies and reflect indications regarding safety assurance.

The Contractor should proceed with the work according to the prepared plans, and if the plans need to be revised due to site conditions, etc., they should be updated promptly and be reviewed by the Client and the Consultant. The Consultant and the Client should confirm whether the construction is being carried out according to the plans properly, and if necessary, give instructions for improvement to the Contractor.

(Reference of "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects" JICA, September 2014)

(Description)

"Ensuring Human Safety" and "Respect for Basic Human Rights" have the top priority in ODA construction. The stakeholders are therefore obliged to comply with the relevant laws and regulations of the recipient country in order to establish a safe and health-conscious working environment. They also need to establish a so-called "Culture of Safety", whereby all organizations and individuals involved in the construction prioritize safety on top of everything, establish a mechanism that automatically promotes active implementation of occupational safety measures in the relevant organizations, and enhances people's awareness of safety.

It is necessary for all project stakeholders to be aware that (1) appropriate safety management will produce specific benefits such as increase of efficiency, productivity, and sufficient quality assurance, and (2) that appropriate cost sharing is necessary to manage safety in an appropriate manner. In particular, in order to raise the safety level and safety awareness of local companies and third country companies, it is necessary to (1) ensure that the partner government has the fundamental responsibility for the workplace safety of the local companies, and (2) that the Client has ~~a~~ high level of safety awareness. The Consultant should enhance the safety awareness of the Client to encourage compliance with safety-related matters specified in the contracts and intergovernmental documents such as E/Ns, more specifically the Guidelines.

A typical Safety Plan, which is submitted as one of the bidding documents, should comprise of the following:

(1) Basic Policies for Safety Management
(2) Internal Organization Structure for Safety Management
(3) Promotion of the PDCA Cycle
(4) Monitoring
(5) Safety Education and Training
(6) Voluntary Safety Management Activities
(7) Information Sharing
(8) Response to Emergencies and to Unforeseeable Circumstances

Since these items apply generally to all ODA Projects, The Contractor should incorporate all those items into their Safety Plan.

The Contractor should formulate a Method Statements on Safety for each type of the works based on the design or documents implementing the design. This document should be prepared, submitted and obtained the approval of the Consultant after the conclusion of the Contracts before the commencement of the related work items. The Contractor should incorporate safety measures of each of the following items in any Method Statements on Safety, as a matter of course including temporary works:

(1) Construction plant and machinery
The Contractor should include the specifications and quantity of any construction plant and machinery to be used for the works.

(2) Equipment and tools
The Contractor should include any equipment and tools to be used for the works.

(3) Materials
The Contractor should include the specifications and quantities of any major materials to be used for the works.

(4) Necessary qualifications and licenses
The Contractor should include the required qualifications and licenses required for each type of the works.

(5) The order of command for the works
The Contractor should include the order of command for the construction specifying the relevant supervisors for each type of procedures. At times, the process for monitoring the implementation may be unclear, especially in cases involving subcontractors. As such, in order to avoid any confusion, the Method Statements on Safety should specify the relevant supervisors for each type of procedures (including those by subcontractors).

(6) Work items
The Contractor should categorize each item of construction works and set them out according to the work schedule.

(7) Procedure for the execution
The Contractor should specify the procedure for the execution of major work operations for each type of procedure.

(8) Foreseeable risks
The Contractor should include all foreseeable risks for each work item.

(9) Precautionary measures
The Contractor should review and include precautionary measures to prevent occurrence of foreseeable risks, including information on the type of protective gear required for the construction.

6.4 Safe Construction Technology

The Guidance provides the minimum safety standards for the management of work and of accidents that are commonly applied in ODA Projects, according to the type of work in question. The Guidance as a whole is applied when the Contractor plans and executes the safety management principles and when the Consultant tests and confirms the same. It is recommended that, prior to determining an agreed plan and procedure for the execution (method statement), safe work methods, and procedures/strategies for safety should be fully reviewed in light of foreseeable risks of accident (if any). In addition, it should be reviewed with reference to the Guidance. It is recommended that the results of these reviews should be compiled in writing in a Method Statements on Safety in order to eliminate or reduce the risk of accidents occurring.

Such recommended application of the Guidance, however, does not preclude any party from adopting in their construction contract any other standards which are more comprehensive and stringent than those stipulated in the Guidance. This is particularly important for the case with respect to individual contracts which require special attention to safety measures of which safety measures/considerations is not or hardly stipulated in the Guidance.

(Description)

The Guidance contains "Technical Guidance for Safe Execution (by the Type of Work)" and "Technical Guidance for Safe Execution (by the Type of Accident)". The items stipulated in the guidance are as shown in the table below. When reflecting them in the "Safety Plan", it is necessary to note that the relevant laws and regulations applicable to construction work in the project country are satisfied, But in case the safety levels required by those laws is thought to be quite low compared with international standard or Japanese experience, it is also necessary to try to satisfy as much as possible the relevant international standards and/or Japanese laws and regulations (ordinance) including its latest revisions. Although the Contractor is free to choose safety measures under his/her responsibility, it is reminded that JICA examines the appropriateness of the construction cost and duration estimated by the Consultant assuming that the safety-related cost is estimated based on these regulations.

Based on the above, it is necessary to formulate criteria for the purpose of tentative suspension of the works and/or restriction of public traffic that reflect the topography and geology of the site and the risk of slope instability during the rainy season, utilizing the cases and experiences of JICA HQ, JICA local office, the Consultant and the Contractor. As a result, the Contractor can formulate a safe construction plan according to individual site conditions and construction methods, including regional natural and social characteristics.

Table 6-1 Contents of Technical Guidance for Safe Execution

(JICA Survey Team based on "Technical Guidance", JICA, September 2014)

Technical Guidance for Safe Execution (by the Type of Work)	Technical Guidance for Safe Execution (by the Type of Accident)
1. Excavation Work 2. Pile Foundation Work 3. Formwork and Form Shoring System Work 4. Reinforcing Bar Work 5. Concrete Work 6. Work over water 7. Demolition Work 8. Work where there is danger of oxygen deficiency 9. Slinging Work	1. Measures for Prevention of Fall Accidents 2. Measures for Prevention of Accidents Involving Flying or Falling Objects 3. Measures for Prevention of Accidents Involving Collapse of Structures 4. Measures for Prevention of Accidents Involving Construction Machinery 5. Measures for Prevention of Explosion Accidents 6. Measures for Fire Prevention 7. Measures for Prevention of Public Accidents 8. Measures for Prevention of Traffic Accidents 9. Protective Gear

6.5 Accident Prevention during Construction

Even if the Contractor takes sufficient safety measures as much as possible in advance and executes construction works according to a safe construction plan, there may be the case that unexpected geological features such as heavy rains once in several decades and earthquakes cause slope instabilities and slope failures during the construction. Therefore, the Contractor is required to prepare a disaster prevention management system that can respond to unforeseeable slope disasters prior to commencing construction of slope protection works. In addition, from the viewpoint of preventing the further spread of damage after a disaster occurs, it is also recommended to include to prepare and keep emergency items in the disaster prevention system such as plastic sheets and extensometers on-site.

(Description)

At the time of bidding, the Contractor is required to submit the "Safety Plan" described in Chapter 6.3, comply with safety regulations, and ensure the safety of all parties involved at the construction site (Forms of Bidding Documents under JICA's Grants, JICA, March 2016). As a rule of sum of the construction contract, the primary responsibility for safety management at the construction site rests with the Contractor.

(Article 29, Forms of Bidding Documents under JICA's Grants)

29. Safety Procedure
The bidder shall:
(1) comply with all applicable safety regulations;
(2) take care for the safety of all persons entitled to be on the Site;
(3) use reasonable efforts to keep the Site and the Work clear of unnecessary obstruction so as to avoid the danger to these persons.

In preparation for unforeseeable landslide disasters, (1) establishment of a disaster prevention system including personnel, equipment, and training, (2) implementation of construction methods and construction periods considering disaster prevention, and (3) give priority to safety in the event of a disaster based on the above (1) and (2) are important.

(Civil Engineering Common Specifications (in Japanese), NEXCO EAST, July 2022)

1-25-6 Prevention of disasters
(1) The Contractor shall always prepare equipment, to minimize damage from heavy rain, heavy snow, floods, strong winds, earthquakes, lightning strikes, etc. during construction, and shall establish a disaster prevention system.
(2) When drafting a construction plan, the Contractor shall determine the construction method and construction period, taking into consideration the existing weather and flood records and local conditions such as topography.
(3) In the event of a disaster, the Contractor shall give priority to ensuring the safety of third parties and employees.

6.6 Role of Consultant during Construction

As part of the supervision entrusted by the Client, the Consultant should confirm that safety management is being implemented according to the "safety plan" and "method statements of safety" submitted by the Contractor. In addition, the Consultant should confirm on-site whether the Contractor's safety management is appropriate for the site. When unsafe behavior or unsafe facilities are pointed out, the Consultant should estimate and confirm their safety level and give necessary instructions and guidance for improvement (including temporary suspension of construction, etc.) to the Contractor.

In addition, the Client has an obligation not to hinder the safety activities of the Consultant and the Contractor. The Consultant, as a representative of the Client, has also the same obligation towards the Contractor. The Consultant should work with the Client to supervise the safe construction.

(Description)

As mentioned in “2.1 Supervision by the Consultant”, among the Consultant's supervision duties, safety-related matters are document control and construction supervision.

- Document Control: Reviewing and giving approval, consent or comment as appropriate to the following documents;
  - Construction schedule and revised construction schedule,
  - Construction plan (method statement),
  - Quality assurance and quality control documents,
  - Health safety and environment management documents,
  - As-built drawings, samples, and catalogues,
  - Other relevant documents submitted by the Contractor,
- Construction Supervision: Supervision of the Contractor to ensure that construction is always carried out in accordance with safety and public health of the workers and third party.

The Consultant is authorized by the Client to give necessary improvement instructions and guidance to ensure safety.

The Consultant should confirm on-site that construction is in progress according to the "safety plan" and "method statements of safety" submitted by the Contractor, and at the same time determine whether the above two documents meet the actual site conditions. The Consultant should exercise the authority to give instructions for improvement to the Contractor as necessary.

CHAPTER 7 Responses after Slope Failure

7.1 Contractor's Responses after Slope Failure

In the event where a slope failure occurs during construction, the Contractor should give top priority to human life and ensures the safety of third parties and workers, and promptly notifies the Consultant.

The Contractor should examine, investigate appropriate, reasonable emergency measures to prevent further collapse and to secure traffic, and should implement them after consulting with the Consultant.

The Contractor should actively cooperate with the Consultant for fixed-point observation, deformation monitoring using observation equipment, and surveys aimed at permanent countermeasures.

In response to the Consultant's request, the Contractor should make proposals that include not only the plan of countermeasures with its effectiveness, but also the procurement feasibility and its constructability.

(Description)

The first priority must be put on the protection of human life. The Contractor should respond quickly, for example, calling for evacuation of workers and traffic vehicles of third party as well as nearby residents who may be affected.

Collapses may occur several times consecutively or with some interval, so it is desirable for the Contractor to take appropriate emergency measures such as indicating no-entry areas with ropes or barricades and setting up lookouts to prevent people from approaching the collapsed slope carelessly. In addition, the Contractor must promptly take emergency measures such as covering the slope with plastic sheets in order to prevent further collapse with care for the workers not to get involved in the possible secondary failure. The Contractor should pay attention to prevent secondary disasters so that safety equipment is not neglected even in an emergency. Generally speaking, it is also important not to force the work in stormy weather, which is regulated also in Japan.

As an emergency measure, the Contractor should work with the Consultant to devise an appropriate countermeasure by combining, if any, construction methods that can be easily and quickly procured locally, such as installation of gabions and movable fences.

Field surveys are necessary in order to envisage permanent measures facing the occurrence of the unpredictable collapse. When site reconnaissance, sounding, boring surveys, etc. by geological experts are executed, the Contractor should actively cooperate in the site preparation, in the procurement of items and in the implementation of these surveys. In addition, the Contractor also cooperates in the installation of fixed-point observation and monitoring equipment. Planning of permanent measures will be led by the Consultant, but it is better for the Contractor to provide the Consultant with opinions based on local procurement and constructability upon request.

Manufacturers with overseas bases and/or export/import records may have by themselves or have availability to prepare construction methods that is easy for smooth transportation and customs clearance. The Contractor should also prepare a realistic temporary structure plan.

It is necessary to determine the road section to be restricted in consideration of the safety of vehicles passing through the site.

7.2 Consultant's Responses after Slope Failure

If a slope failure occurs during construction, after ensuring the safety of third parties and workers with the highest priority on human life, the Consultant should promptly notify the Client (recipient country) and JICA and should envisage further measures including the planning of new permanent countermeasures.

Although the responsibility for construction safety management rests with the Contractor, the Consultant should give appropriate advice and should cooperate with the Contractor in an effort to bring the situation under control as soon as possible.

In addition, the Consultant should monitor the deformation movement and plan further emergency measures if the collapse is likely to expand.

The Consultant should summarize the collapse event from a scientific point of view, should investigates, designs and estimates countermeasures to stabilize the collapsed area, and should consider feasible and effective countermeasures. Based on above, the Consultant should promptly discuss with the Client (partner country) and JICA and decide on countermeasures. When selecting permanent measures, it is necessary to consider rationality, availability, cost, duration, and process. Depending on the situation, the Consultant should ask the Contractor for its intention to execute the countermeasure works that have been decided. The Consultant instructs the Contractor to execute the works if they agreed. To procures other contractors to carry out the works is another option.

(Description)
If a slope failure occurs during construction, the Consultant should give top priority to consulting with the Contractor on emergency measures to save human life and to give instructions.

On the other hand, depending on the scale and characteristics of the collapse, there may be cases where it is impossible to continue the construction works with its original plan. The Consultant should follow the same process as that taken for the original plan, namely, conducting an appropriate survey, identifying the cause of a slope failure, and designing an appropriate countermeasure under the leadership of the Consultant. It often takes a certain period of time to re-design and to complete the construction of revised permanent measures. As it is not recommended to leave the collapsed slope as it is for long time, it is necessary for the Consultant to respond flexibly to consider, design, and procure permanent measures.

When adopting Japanese slope countermeasure works for the revised plan, especially in the case that the scale of the revised plan become larger and more complex than original one, it is assumed that the partner country does not have applicable management standards (quantity/measurement and quality). In order to prevent collapses caused by inappropriate construction by local contractors due to the lack of management standards in the partner country, the Consultant should describe all management standards in the technical specification for the revised countermeasures.

Since the unstable condition of the slope tends to continue during construction of the countermeasure works, the Consultant should appropriately plan the installation of fixed-point observation and monitoring equipment to ensure the safety of workers and passing vehicles.

The contents of this chapter will also be applied to the situation when some risk of slope failure is detected before the real occurrence during the construction work.

CHAPTER 8 Maintenance of Slopes

The maintenance and management areas dealt with in this chapter are for roadside earthwork structures installed within the scope of the slope countermeasure projects. As for natural slopes, they are limited to areas that directly affect the collapse of cut slopes (Fig. 8-1).

After handover, the partner country and its road administrator take responsibility of the maintenance work of the slope. Therefore, the Consultant and the Contractor need to hold a meeting for the risk communication with the stakeholders of the partner country on the slope failure occurred during the construction and remained slope failure risk after the handover. And those risks should be documented as a record in a report. The above contents are also applied to the partial handover of the works contained in the whole project. In this case, another coordination is necessary because there is a concern that the construction work of the Contractor and the maintenance work of the road administrator may be complicated and disturbed each other for example the inspection route for the maintenance work is closed by the construction work. On the other hand, it is noted that without partial handover the responsibility of the maintenance and management of the completed part of the works still rests with the Contractor.

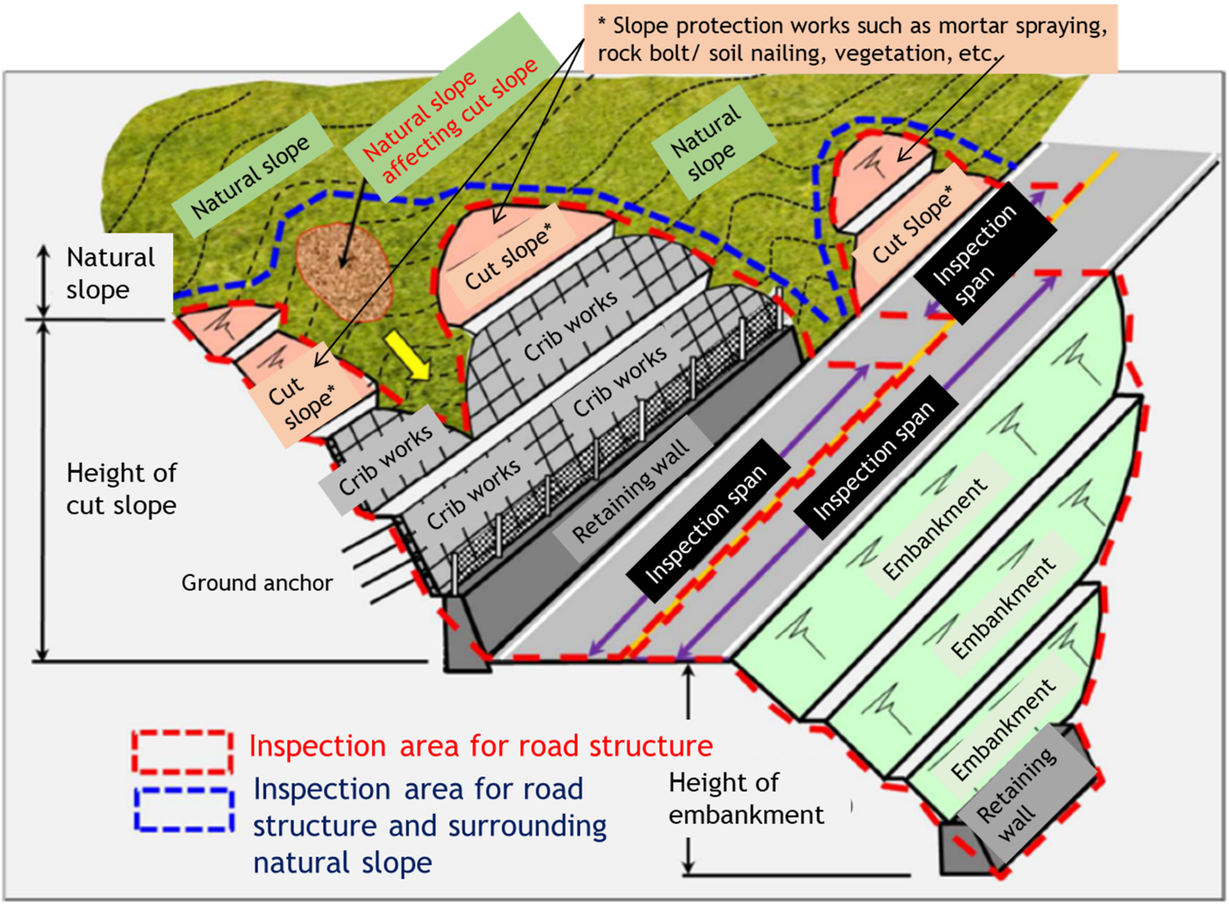


Figure 8-1 Maintenance and Management Area Set in Slope Countermeasure Project

"Inspection Guidelines for Highway Earthwork Structures (in Japanese)"
(Road Bureau, Ministry of Land, Infrastructure, Transport and Tourism, 2017.8)

8.1 Preparation of Delivery Note

The road administrator of the partner country will be responsible for the maintenance and management of the slope protection works after handover. When conducting inspection, it is essential to have a "Close-up Visual Inspection" rather than a distant view from the road in order to accurately assess the soundness of the facility and take necessary measures. Taking into account of the fragility of the road maintenance system in developing countries, it is desirable to include the contents necessary for maintenance into the handover document prepared by the Contractor.

The method of maintenance should be within the ability and availability of the road administrator of the partner country. Depending on the contractive scope of the work of the Consultant, the Consultant should consider technical transfer through soft components. From the perspective of maintenance, it is necessary to consider the weather condition and the subsoil condition such as presence of spring water, surface water and small gully at the slope countermeasures, the scale of countermeasures, and the type of the works. Examples are shown below.

1. Inspection Frequency (The standard is once every five years in Japan. If there is no existing inspection system, as the interval of 5 years may be relatively long. It may happen that the knowledge of the inspection method will be disappeared, or the inspection results will not be systematically saved. In that case, set an appropriate interval for the periodical inspection according to the situation of the partner country, for example 1- or 2-year intervals.)
2. Seasonal inspection before and after rainy season, and ad-hoc inspection after heavy rainfall or earthquake
3. Season of Inspection (Set the appropriate time when vegetation is as little as possible to make easier the observation according to the local situation on vegetation and climate.)
4. Inspection Route (Select a safe route that can fulfil the purpose of inspection and has little danger of slipping during inspection. It is desirable that the easiness and the certainty of the maintenance is considered in the design stage.)
5. Inspection Targets and Inspection Points taking into account of the possibility from the Inspection Route
6. Equipment Required for Inspection (camera, ranging rod, tape measure, etc.)

8.2 Delivery of Maintenance Equipment and Spare Parts

If any deformation is found in the slope countermeasure works during the inspection, road administrators must take appropriate measures to prevent destabilization of slopes due to the expansion of deformation and to eliminate dangers to traffic.

Examples of equipment that may be necessary for this purpose are shown below. The maintenance equipment and spare parts exemplified here are based on the ordinary method (routine works) taken by the road administrator. Equipment such as heavy machines used for construction by specialized contractors is not included in the list below.

Table 8-1 Examples of Maintenance Equipment and Spare Parts Required for Maintenance

(JICA Survey Team)

Type of Works	Deformation	Response	Equipment
Cut Slope	Cracks, Steps, Swellings	Regular measurement, Prevention of surface water inflow	Construction lumber, Nails, Extensometers, Plastic sheets, Mortar
	Erosion, Spring Water, Small Failure	Debris removal, Water plumbing	Shovels, Sandbags, Plastic sheets, etc.
	Cracks on the road	Repair of Road Surface	Asphalt Repair Material
Shotcrete, Spray crib works	Cracks	Repair	Mortar
	Peel-off	Removal (Fall prevention)	Hammers
Ground Anchor	Breakage of loading plates	Hammering test	Hammers
	Breakage of covers	Replacement of covers	Covers for replacement
	Overgrowth of weeds	Removal of weeds	Mowing sickles
Retaining Wall	Blockage of drainage pipe	Cleaning of drainage pipe	Drainage pipe cleaner
	Cracks on the road	Repair of road surface	Asphalt Repair Material
Drainage Works	Blockage of drainage ditch, Sediment in drainage ditch	Sediment removal	Shovels
	Open cracks, Open joints	Repair	Mortar
	Erosion along drainage ditch	Backfill	Sandbags
Rock Fall Barrier	Collapsed sediment (Large fallen rocks not included)	Sediment removal (Empty the pocket)	Shovels
	Broken net	Repair	Nets for Repair
Rock Fall Protection Net	Broken net	Repair	Nets for Repair

8.3 Preparation of Maintenance Manual and Delivery of Special Maintenance Equipment

For the types of works listed below, the Contractor should prepare, on a voluntary basis and/or under the contract, a maintenance manual and deliver the maintenance equipment necessary to keep functioning of the facilities constructed/installed in ODA grant project.

- Ground Anchors (equipment and manuals necessary to maintain tension, corrosion prevention manuals, and necessary consumables and parts)
- Horizontal Drainage Borings (cleaning manual and necessary equipment to maintain drainage capacity)
- Drainage Well Construction (cleaning manual and necessary equipment for maintaining drainage capacity)