Safety Review Report
Of On-Going ODA Loan Project
in India

February 2016

Japan International Cooperation Agency（JICA）

LANDTEC JAPAN INC.
Infrastructure Development Institute-JAPAN

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Chapter 1 Outline of Study

1.1 Background and Objective

(1) Background

This review was initiated based on the recommendation made by the committee deployed by Ministry of Foreign Affairs, Japan, in order to discuss the measures to prevent recurrence of the similar accident to that of Can Tho Bridge in Vietnam in September 2007. In July 2008, the committee recommended JICA to carry out an interim review of Special ODA Loan projects or Special Term for Economic Partnership (STEP) projects which include large scale and technically complex civil works. Eleven projects were reviewed up to 2014, which are located in Indonesia, Vietnam, Turkey, Uzbekistan, Philippine, Malaysia and Sri Lanka.

The review in 2015 is to be done for the two STEP projects under construction in India and Kenya. For those projects, accident (including near miss) analysis is to be done from various angles including not only engineering/technical aspects but also soft aspects such as safety control and occupational health. Furthermore, the effects of the accident preventive measures implemented on site will be verified, issues/concerns to be tackled to ensure prevention of future accidents will be confirmed, and finally, effective/efficient safety measures and/or improvements will be recommended. Those achievements will be fed back to the stakeholders to promote further efforts to prevent/mitigate occupational accidents and third party accidents to contribute to prevention of construction accident in Japanese ODA projects.

(2) Objective

The following tasks will be implemented to the on-going STEP project:

- To collect the latest information on the laws, standards, etc. of the recipient countries safety control in Yen-loan projects and occupational safety and health.
- To conduct accident analysis on the accidents occurred in the projects from various angles, and to confirm the status of implementation of safety control and compliance including verification of effects of accident preventive measures taken.
- To work out proposals for improvements, and to feed back the study results to the stakeholders to promote further efforts to prevent/mitigate occupational accidents and third party accidents to contribute to prevention of construction accident.
- To derive recommendations and lessons toward resolution of problems/issues which are common in other similar projects to contribute to prevention of construction accident in Japanese ODA projects.

Projects to be reviewed

- Dedicated Freight Corridor Project (Phase 1) (II) in India
- Mombasa Port Development Project in Kenya

1.2 Study Team

Team Leader / Safety Management1:	Toshio TAKEBAYASHI (Landtec Japan Inc.)
Safety Management 2:	Fujio ITO (Infrastructure Development Institute)
Accident Cause Analysis / Preventive Measures:	Toshiaki SHISHIDO (Landtec Japan Inc.)

1.3 Study Schedule

Table1.3.1 Field Study Schedule

M	D		Schedule	Accomodation	Country
10	3	Sat	◇Depart from Narita at 22:00	night flight	
	4	Sun	◇Arrive at Dubai at 04:15 ◇Depart from Dubai at 06:00 ◇Arrive at Nairobi at 10:15	Nairobi	
	5	Mon	■JICA Kenya Office (10:15) ■Ministry of Labour (Division of Occupational Health & Safety) (14:40)	Nairobi	
	6	Tue	■National Construction Authority (11:40)	Nairobi	
	7	Wed	◇Depart from Nairobi at 13:05 ⇒ Arrive at Mombasa at 14:05	Mombasa	
	8	Thu	■Kenya Port Authority (10:35) ■JPC (14:00)	Mombasa	
	9	Fri	■Toyo (9:15) ★Site Office, Site Visit	Mombasa	**Kenya**
	10	Sat	Sort out information, Prepare seminar materials	Mombasa	
	11	Sun	Sort out information, Prepare seminar materials	Mombasa	
	12	Mon	★Site Office, Site Visit	Mombasa	
	13	Tue	■Prepare for seminar	Mombasa	
	14	Wed	■Seminar at Mombasa Venue: KPA 10:00	Mombasa	
	15	Thu	◇Depart from Mombasa at 10:10 ⇒ Arrive at Nairobi at 11:10 ■JICA Kenya Office 14:30 ◇Depart from Nairobi 19:15	night flight	
	16	Fri	◇ Arrive at Dubai at 01:20 ◇Depart from Dubai at 04:35 ◇Arrive at Delhi at 09:25 ■JICA India Office 13:30 ■DMRC 15:00	Delhi	
	17	Sat	■Delhi Metro Site Office 9:30 ■L&T meeting at 14:25 ■Sojitz meeting at 15:20	Delhi	
	18	Sun	Sort out information, Prepare for interviews	Delhi	
	19	Mon	■Consultant Delhi Office 10:00 ■Dedicated Freight Corridor Corporation India Ltd. (DFCC) 13:00 ■Ministry of Railways 16:30	Delhi	
	20	Tue	■Ministry of Labour and Employment DGFASLI 10:20 ◇From Delhi 19:55 ⇒ To Jaipur (by flight) 20:50	Jaipur	
	21	Wed	■Jaipur Office (DFCC) 10:05 ■Jaipur Offices (Consultant) 12:10 ■Jaipur Offices (Contractor) 15:10	Jaipur	
	22	Thu	Sort out information, Prepare seminar materials	Jaipur	**India**
	23	Fri	★Site Visit Package A, Bhagega Site	Jaipur	
	24	Sat	Sort out information, Prepare seminar materials	Jaipur	
	25	Sun	Sort out information, Prepare seminar materials ★Site Visit Package C	Jaipur	
	26	Mon	◇From Jaipur ⇒ To Ajumer (by car)	Ajmer	
	27	Tue	■Ajmer Offices (DFCC) 10:50 ◇ From Ajmer ⇒ To Jaipur (by car)	Jaipur	
	28	Wed	■Prepare for seminar	Jaipur	
	29	Thu	■Seminar (at Jaipur) 14:00 Venue: Radisson Blu Jaipur	Jaipur	
	30	Fri	◇From Jaipur at 7:50 ⇒ Arrive at Delhi at 8:50 (by air) ■Seminar (at Delhi) 12:00 ■JICA India Office 15:30 ◇Depart from Delhi at 20:20	night flight	
	31	Sat	◇Arrive at Narita at 07:10	–	

1.4 Interviewees (India only)

Table1.4.1 List of Interviewees

Organization	Name	Position
During preparation in Japan		
<Project-related>		
Sojitz Corporation	Mr. Masaki Yamaguchi	Assistant General Manager, Environmental Infrastructure Dept. Infrastructure & Environment Business Division
	Mr. Naoki Kazama	Assistant Manager, Transportation Project Sec., Environmental Infrastructure Dept. Infrastructure & Environment Business Division
	Ms. Risa Koi	Project Coordinator, Transportation Project Sec., Environmental Infrastructure Dept. Infrastructure & Environment Business Division
Nippon Koei Co., Ltd.	Mr. Shisei Sakoda	Safety Officer, Overseas Consulting Administration
	Mr. Toru Nakagawa	Senior General Manager of Railway Division, International Consulting Operations
<General>		
Oriental Consultants Global	Ms. Reiko Abe	President, Oriental Consultants India Pvt. Ltd.
	Mr. Yoshio Kobayashi	Quality Management Section
JFE Engineering Corporation	Mr. Takashi Aihara	General Manager, Engineering Dept., Overseas Business Division, Steel Structure Engineering Sector
During Field Survey		
<Project-related>		
DFCCIL	Mr. Ashutosh Rankawat	Executive Director, WDFC
	Mr. D.S. Rana	Director(Infrastructure)
	Mr. Narinder Kumar Singla	GGM
	Mr. Sunil Kumar Singh	Joint General Manager
	Mr. R.C. Khatn	Joint General Manager
DFCCIL (JAIPUR)	Mr. C.L. Meena	Chief Project Manager
	Mr. Punit Agrawal	Deputy Chief Project Manager
	Mr. N.S. Yadav	Assistant Project Manager (Traffic)
DFCCIL (AJMER)	Mr. U.V. Singh	Chief Project Manager
Sojitz	Mr. Osayasu Sano	General Manager,
	Mr. Toshiharu Yagi	Deputy General Manager
	Mr. Naoki Yoshino	General Manager, Engineering
L&T (Haryana Office)	Mr. S.C. Gupta	Head–DFC Business
	Mr. S.B. Sarawat	Project Manager
	Mr. Pascal Joseph	Chief Track Engineer, Technical Expert

L&T (Jaipur Office)	Mr. V N Gokhale	Project Director
	Mr. Nigel Wirtz	Head of Environment, Health & Safety
	Mr. S. K. Saxena	Project Manager, CTP-2, Package C
	Mr. S. Deenadayalau	Senior Engineer, EHS
	Mr. Sabhash Rawat	ARE, Labour
	Mr. Ashish Jaitty	DGM (Civil)
	Mr. Mugukoham	DGM
	Mr. Karuna Gopal	Chief Accident Prevention Officer
PMC	Mr. Ryota Fujiwara	Project Director
	Mr. Minoru Yoshida	Project Manager
	Mr. Mitsushi Matsuyama	Technical Advisor
	Mr. Savin Bhatia	Deputy Project Director
	Mr. Ajay Gupta	Environmental Expert
	Mr. Subhash Rawat	ARE, Labour Protection
	Mr. Manoj Kumar	Resident Engineer
	Mr. G.N. Sharma	IRTS (Rtd.), ARE/Safety
	Mr. H.S. Prajapati	ARE/Labour Issue
	Mr. D. Parashar	Engineer/Safety
	Mr. Ranul Jain	Electrical Safety Engineer
	Mr. Nimish Mathur	Environmental Engineer
<General>		
JICA India Office	Mr. Takema Sakamoto	Chief Representative
	Mr. Akira Sato	Representative
	Mr. Hiroshi Yoshida	Representative
	Mr. Sanjeev Moholkar	Principal Development Specialist
JICA South Area Division 1, South Asia Dept.	Mr. Yoshikazu Taniguchi	Assistant Director
Ministry of Railway	Mr. Manoj Kumar Srivastava	Executive Director Perspective Planning
	Mr. Sandeef Srivastava	Director Planning (Special)
Ministry of Labour & Employment	Mr. M.R. Rajput	Director In-charge
	Mr. D.K. Saxena	Assistant Director (Safety)
	Dr. Brij Mohan	Dy Director, Regional Labour & Institute
	Dr. S. Saini	Dy Director (Medical), Regional Labour & Institute
Delhi Metro Rail Corporation LTD.	Mr. Devendra Gill	Additional General Manager/Safety
	Mr. S.C. Gupta	Dy. Chief Engineer/Planning
J. KUMAR (Contractor)	Mr. Pawan Kumar Bishnsi	Chief SHE Manager (CC-24 Portion)
Consultant (DMRC Project)	Mr. Masanori Tsurumaru	Senior Project Manager
	Mr. Martyn Gomersall	Chief Safety Expert

Chapter 2 Current Situation of Construction Safety in India

2.1 India Construction Industry - Outline

(1) The new government since 2014 and its economic policy

As a result of the election in May 2014 of the members of the lower house, a government led by the Indian People's Party (BJP) came into power and Mr. Narendra Modi took office as the 15th prime minister of India. At the summit meeting held during his visit to Japan at the end of August the same year, the two governments agreed to target a total of 3.5 trillion yen loans from Japan to India and double direct investments and business expansion by Japanese companies into the country. While diplomatic movements with major countries such as Japan, China, and U.S. have been intensified, the influence of the regime change on the country's economy has not been significant, the rate of economic growth hovering around 6%.

The economic measures and policies announced by the Modi administration include the following:

- ●Infrastructure
  Improvement of freight railways and expressways; promotion of inter-big-city industrial arteries development projects; and development of energy-related infrastructures (Wind and nuclear);
- ●Inward direct investment
  Active reception of inward direct investment that would help create employments and improve technical levels;
- ●Improvement of administrative efficiency
  Improvement of efficiency in administrative systems with IT technologies; simplification of tax systems (e.g. possible introduction of GST);

(2) Infrastructure improvement five-year plan

The total budget of the 12th Infrastructure Development Five-Year Plan (2012-2016) promoted by the Indian government amounts to more than 80 trillion yen. Allocating a budget of 13 to 18 trillion yen every year, the plan accounts for almost 10% of the country's annual GDP (180 to 260 trillion yen) during the same period. Table 2.1.1 shows the annual budgets for the infrastructure projects of the five-year plan published by the Central Public Works Department. The total budget of the 12th Five-Year Plan is about 80 trillion yen, but how to find money for about 30%, or 24 trillion yen, of this budget has not been determined yet, the general speculation being that they will be financed by loans from Japan and other countries and funds from international institutions.

The budget for the infrastructure projects may be broken down as follows:

(i) Power generation projects: About 24 trillion yen;
(ii) Road and bridge projects: About 10 trillion yen;
(iii) Irrigation-related projects: About 9 trillion yen;

(iv) Railway projects (including subways): About 7.5 trillion yen;

(v) Water resource development projects: About 4 trillion yen;

(vi) Airport and port projects: About 2.8 trillion yen;

These many large-scale infrastructure projects are or expected to be carried out in design-and-build (D/B), public-private partnership (PPP), or build-operation-transfer (BOT) schemes.

Table 2.1.1 12th Infrastructure Development Five-Year Plan (Source: CIDC Report 2014)

Projected Investment in Infrastructure during the Twelfth Five Year Plan

Year	Base Year FY12	FY13	FY14	FY15	FY16	FY17	Total 12th Plan
GDP at FY07 Prices (Rs. Crs.)	6,314,265	6,882,549	7,501,978	8,177,156	8,913,100	9,715,280	41,190,063
Infrastructure Investment as % of GDP	8.37%	9.00%	9.50%	9.90%	10.30%	10.70%	9.95%
Infrastructure Investment (Rs. Crs. in FY07 prices)	528,316	619,429	712,688	809,538	918,049	1,039,535	4,099,239
Infrastructure Investment (Rs. Crs. in current prices)	721,781	888,572	1,073,470	1,280,315	1,524,526	1,812,581	6,579,463

Source: Mid-Term Appraisal Eleventh Five Year Plan, Planning Commission, GOI; WPI inflation used to convert to current prices; FY12 inflation based on PMEAC projection

Further, Table 2.1.2 shows the evolution of amounts invested in the infrastructure projects, classified by sector, between the 10th (2002-2006), 11th (2007-2011), and this 12th Five-Year Plans. Since the 10th Five-Year Plan, the sector that has received the largest amount of investment in the field of infrastructure has been *power generation*, followed by *roads and bridges*, *irrigation-related*, and *railways*. Although the *power generation* sector received the largest investment, the percentage of investment in construction works (new plants) is only 40%, indicating that a large part of the budget is allocated to the maintenance, repair, management, etc. of existing facilities.

Meanwhile, the *railways* (including MRT projects), *irrigation*, *ports*, *roads and bridges* sectors each show a large percentage of investment in the construction of new facilities. We assume that, in these sectors, there will be active demand for infrastructure construction works for the time being.

Table 2.1.2 Amount of investment in the infrastructure projects between the 10th and 12th Five-Year Plans (India)

unit : 10,000,000Rs

Sector	Investment			Share			Constructio n Intensity	Construction Opportunity		
	10th Plan	11th Plan	12th Plan	10th Plan	11th Plan	12th Plan		10th Plan	11th Plan	12th Plan
Electricity	340,237	658,630	1,314,320	38%	32%	32%	40%	136,095	263,452	525,728
Roads & Bridges	127,107	278,658	556,072	14%	14%	14%	65%	82,620	181,128	361,447
Railways (incl. MRTS)	102,091	200,802	400,708	11%	10%	10%	75%	76,568	150,602	300,531
Irrigation	106,743	246,234	491,369	12%	12%	12%	75%	80,057	184,676	368,527
Water Supply	60,108	111,689	222,879	7%	5%	5%	60%	36,065	67,013	133,727
Ports	22,997	40,647	81,113	3%	2%	2%	70%	16,098	28,453	56,779
Airports	6,893	36,138	72,115	1%	2%	2%	30%	2,068	10,841	21,635
Total	766,176	1,572,798	3,138,575	85%	77%	77%	–	429,570	886,164	1,768,374

(Source: CIDC Report 2014)

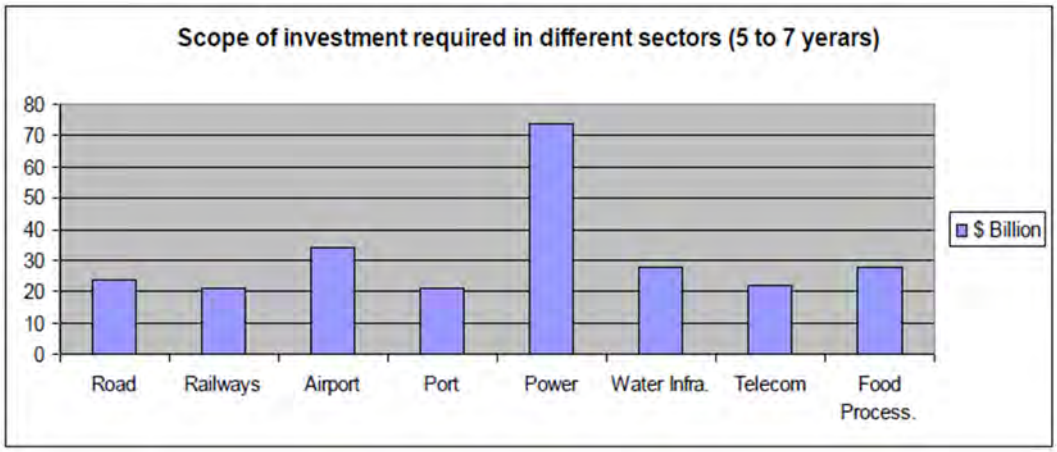


Figure 2.1.1 Demand for investment in infrastructure by sector in the years to come

(Source: CIDC Report 2014)

(3) Japanese government's large-scale infrastructure project support / yen-loans to India

India is the largest recipient country of Japanese yen loans, the total amount of approved loans exceeding 3 trillion yen. Shown below is the overview of major projects (of more than 50 billion yen) among the yen loan agreements signed since 2010.

(i) Delhi Mass Rapid Transport System Project Phase 3

Loan amount: 127.917 billion yen. General Untied Date of Loan Agreement: March, 2012

[Purpose and description]

By constructing in the NCT of Delhi a mass rapid transport system, the project aims to meet increasing transport demand, develop local economy and improve urban environment through the mitigation of traffic congestion and the reduction of traffic nuisance, and ease climate change. This is a yen loan granted to meet the financial requirements for construction works and equipment.

The loaned fund will be used for civil engineering works, electric and communication-related works, and purchase of rail cars.

(ii) Dedicated freight Corridor Project (Phase 2) (II)

Loan amount: 136. 119 billion yen. Special Terms for Economic Partnership

Date of Loan Agreement: March, 2013

[Purpose and description]

Following the Phase I project that constructed the segment Rewari-Vadodara of the Western Dedicated Freight Corridor connecting Delhi and Mumbai (about 1,500 km), the project constructs the segments Dadri-Rewari and Vadodara-Mumbai (550 km). Through the construction of dedicated freight railways, improvement and development of full automatic signal and communication systems, and introduction of

electric locomotives capable of large-volume and rapid transportation, the project aims to meet the rapidly increasing freight transportation demand and improve the efficiency of physical distribution network.

The loaned fund will be used to carry out civil engineering works, purchase rail cars, receive consultancy services (construction management, management improvement, etc.), etc.

(iii) Tamil Nadu Transmission System Improvement Project

Loan amount: 60.740 billion yen. General Untied. Date of Loan Agreement: September, 2012

[Purpose and description]

The objective of the Project is to deliver additional energy, generated at new Thermal Power Plants, to reduce overloading of transmission system for enhanced reliability of power supply network in the state of Tamil Nadu by strengthening transmission system throughout the State, thereby promoting economic growth in the state and the Southern region of India.

(iv) Mumbai Metro Line 3 Project

Loan amount: 71.000 billion yen. General Untied. Date of Loan Agreement: September, 2013

[Purpose and description]

By constructing a mass rapid transit system in Mumbai, the capital of Maharashtra state, the project aims to meet an increasing traffic demand, develop local economy, and improve urban environment. The subway will connect downtown island cities in southern part of the city, Mumbai International Airport, and western suburbs rapidly opening up land for housing, thereby contributing to the alleviation of traffic congestion, reduction of traffic pollution, development of local economy, and improvement of urban environment.

The loaned fund will be used to construct the subway, purchase rail cars, receive consultancy services, etc.

Furthermore, at the meeting held at the end of January 2014 in Delhi, Prime Ministers Abe and Singh agreed on the importance of the development of Chennai-Bengaluru areas and announced that the two countries would enhance mutual cooperation for the Chennai Bengaluru Industrial Corridor (CBIC) project.

Chennai Bengaluru Industrial Corridor (CBIC) project

A Japan-India joint regional development project that, in parallel with Delhi-Mumbai Industrial Corridor, aims to develop roads, ports, and other infrastructures in an integral manner in Chennai and Bengaluru regions in southern India to economically connect two regions where more and more Japanese companies are expanding their business. The two countries agreed to jointly promote the CBIC project in December 2011. Specifically, the initiative intends to develop Ennore Port as the exporting port and jointly promote the improvements of

access roads, development of industrial parks facilitating business expansion, ensuring stable power supply, etc. in the surrounding areas.

Other infrastructure development projects that Japan and India so far agreed to cooperate for the development and promotion include the following:

- A pilot project to install a solar power generation plant in the state of Gujarat;
- A sewage system development project in Guwahati, Assam;
- Assistance to the construction of a coal-fired thermal plant and technological assistance on environmentally-friendly green technologies;
- Technological assistance in the field of recyclable energies;
- A Mumbai-Ahmadabad high-speed railway project;

(4) Local construction companies

Other than the Delhi-Mumbai Dedicated Freight Corridor Project, there is no loan approved in STEP terms in India, most of the yen loan projects being agreed upon as general untied loans. Hence, for Japanese companies to survive price competition in the Indian market, it may be necessary to consider allying with local companies.

Among local contractors, L&T has an overwhelming presence with an annual sale over 1 trillion yen, largely outperforming all other competitors in terms of sales. The annual sales of ten other largest companies are about 100 billion yen on average. L&T is one of the largest conglomerates representing India that, around construction, its core business, has been expanding its business into other fields such as power generation, shipbuilding, heavy machines, and telecommunication. Inside India, L&T deploys its business building on its well-established engineering expertise and a sound financial base and has won many contracts on a PPP or BOT basis in public works projects for road, railway, airport, etc.

Table 2.1.3 shows the composition of local construction companies.

Table 2.1.3 Composition of local construction companies, classified by number of employees

No. of people emplyed by the agency	No. of Agency/Contractors	Percentage	Category
1～200	appx. 27,000	96.4%	small
200～500	appx. 800	2.86%	medium
500～	appx. 200	0.74%	major

(Source: CIDC Report 2014)

2.2 Legal system relating to occupational safety and health

(1) Overview

India has numerous labor laws such as those prohibiting discrimination and child labor, those that aim to guarantee fair and humane conditions of work, those that provide social security, minimum wage, right to organize, form trade unions and enforce collective bargaining. For years, the government debated amendments to the Contract Labour Act and the Industrial Disputes Act but the proposals have been put in deep freeze fearing protests from trade unions. India is considered to be a highly regulated and amongst most rigid labor law countries in the world. Rigid labor laws in India have been criticized as the cause of low employment growth, large unorganized sector, underground economy, use of casual labor and low per capita income. These have led many to demand reforms for labor flexibility in India.

India is one of the world's fastest growing economies, with estimated annual GDP growth of 8%, driven by huge expansion in industries such as chemicals, manufacturing and textiles. However, while India has had legislation on occupational health and safety for many years, large sections of the estimated 465 million-strong workforce are not covered by health and safety law, and safety inspection and enforcement remain small-scale and piecemeal. As a result, work-related injury and ill health remain enormous problems.

The constitution of India contains specific provisions on the occupational health and safety of workers, including a duty on the government to direct its policies towards ensuring "the health and strength of workers, men and women, and the tender age of children, are not abused". However, despite this, health and safety laws currently only cover four industry sectors: factories, mines, ports and construction, and in many cases, only apply to workplaces of a certain size.

The principal health and safety acts in India have their roots in the Factories Act 1948. The Act applies to factories involved in manufacturing activities that consume power and employ ten or more people, and to non-power consuming factories employing more than 20 people. In essence, it places a general duty on factory owners to ensure, as far is reasonably practicable, the health, safety and welfare of their staff, through steps such as the provision of safe plant and systems of work, and suitable information, instruction, training and supervision. It also contains specific duties on issues such as registering factories, maximum working hours, working temperature, machinery guarding, fire safety and sanitation. In addition, the Act prohibits the employment of children under 14 in any factory, requires factories employing more than 1,000 people to appoint internal safety officers and requires factories with more than 500 workers to appoint welfare officers.

The Act is enforced by local factory inspectorates in India's 28 states, who also have the power to set their own additional rules under the legislation.

Some major health and safety legislations in India include:

・Factories Act, 1948

Factories Act has been enacted to regulate the working conditions in factories and to ensure provisions of

the basic minimum requirements for safety, health and welfare of the workers as well as to regulate the working hours, leave, holidays, employment of children, women etc.

・The Dock Workers (Safety, Health & Welfare Act) Act, 1986

The Act covers the health, safety and welfare aspects of the loading and unloading of cargo, and is enforced by Inspectorates of Docks Safety at India's 11 major ports.

・The Mines Act, 1952

The Act includes requirements for ensuring the health and safety and welfare of workers in coal, metal and oil mines.

・Workmen's Compensation Act, 1923

The Workmen's Compensation Act compensates a workman for any injury suffered during the course of his employment or to his dependents in the case of his death. The Act provides for the rate at which compensation shall be paid to an employee. This is one of many social security laws in India.

・The Child Labour (Prohibition and Regulation) Act, 1986

The Act prohibits the employment of children under 14 in certain specified hazardous processes, including construction work.

・The Plantation Labour Act, 1951

The Act requires the provision of welfare facilities and arrangements on plantations of five hectares or more where 15 people are employed, including medical facilities, drinking water, sanitation, maximum working hours and rest periods.

In addition, the Indian construction industry is subject to certain health and safety rules. In particular, the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996 sets out health, safety and welfare requirements for construction companies ("establishments") employing 10 or more workers on projects costing more than Rs 10 lakh (one million rupees, approximately £11,300). This includes a requirement to register the construction business with the relevant authorities, to appoint a safety officer and establish a safety committee where 500 workers or more are employed. Breaches of the Act's health and safety provisions can result in a fine, imprisonment of up to three months, or both.

Meanwhile, the Building and Other Construction Workers' Welfare Cess Act 1996 allows state governments and Union Territories to impose a 1% levy (cess) on construction projects costing more than Rs 10 lakh to fund state welfare schemes providing financial assistance to workers and their families in the event of accidents.

In terms of the overall strategy for occupational safety and health and its enforcement, a range of bodies are involved, a fact which pressure groups say undermines the law's effectiveness and makes it difficult to coordinate efforts in this area.

In particular, the central government and the Ministry of Labour oversee the formulation of national policy and legislation, while the Labour Departments of India's 28 States and seven Union Territories are responsible for implementing and enforcing the Factories Act through their factory inspectorates.

Meanwhile, the Directorate General, Factory Advice Services and Labour Institutes (DGFASLI) – an agency of the central government – advises on the formulation of national health and safety policies for factories and docks and liaises with the state factory inspectorates on implementation of the Factories Act. DGFASLI also enforces health and safety legislation in India's 11 major ports, though its Inspectorates of Docks Safety.

Responsibility for health and safety in mines, meanwhile, rests with the Directorate General of Mines Safety (DGMA), and state governments are responsible for enforcing the Plantation Labour Act 1951.

(2) Future of the legal system on occupational safety and health

According to DGFASLI, the MoLE had under its control 44 acts related to occupational safety and health at the time of this study (October 2015), but currently is planning to consolidate these laws into a few groups of laws. One of such ideas consists combining seven acts related to safety and working conditions including BOCWA, Factory Act, Mine Act, Dock Safety Act, and Workers Act into one single act. They say this is one of the priority projects the government is working on at the instruction of PM Modi.

(3) Boundary of responsibility between the primary contractor and subcontractors

The primary contractor is held responsible by law for making sure that the construction workers, in particular low-wage workers, on his their construction site are properly offered social security and paid wage.

Table 2.2.1 Indian laws, regulations, ordinances, etc. regarding occupational safety and health (Source: ILO)

Title	Type of Legislation R, D, O: Regulation, Decree, Ordinance L, A: Laws,Act
Oil Mines Regulations, 2011 (G.S.R. 876E).	R, D, O
Rules for Manufacture, Use, Import, Export and Storage of Hazardous Micro Organisms, Genetically Engineered Organisms or Cells Amendment (G.S.R. 1(E))	R, D, O
Civil Liability for Nuclear Damage Act, 2010 (No. 38 of 2010).	L, A
Plantations Labour (Amendment) Act, 2010 (No. 17 of 2010).	L, A
Workmen' Compensation (Amendment) Act (No. 45 of 2009).	L, A
Explosives Rules, 2008 (G.S.R. 907(E)).	R, D, O
The Indian Boilers (Amendment) Act (No. 49 of 2007).	L, A
Dangerous Machines (Regulation) Rules, 2007 (GSR 505 (E)).	R, D, O
Rules for Manufacture, Use, Import, Export and Storage of Hazardous Micro Organisms, Genetically Engineered Organisms or Cells Amendment (G.S.R. 616(E)).	R, D, O
Atomic Energy (Radiation Protection) Rules, 2004 (G.S.R. 303).	R, D, O
The Municipal Solid Waste (Management and Handling) Rules (S.O. 908(E)).	R, D, O
The Noise Pollution (Regulation and Control) Rules, 2000 (S.O. 123E).	R, D, O
Atomic Energy (Factories) Rules 1996 (G.S.R. 253).	R, D, O
Dock Workers (Safety, Health and Welfare) Regulations, 1990.	R, D, O
Rules for Manufacture, Use, Import, Export and Storage of Hazardous Micro Organisms, Genetically Engineered Organisms or Cells (G.S.R. 1037(E)).	R, D, O
Manufacture, Storage and Import of Hazardous Chemicals Rules (S.O. 966(E)).	R, D, O
Hazardous Wastes (Management and Handling) Rules, 1989.	R, D, O
Dock Workers (Safety, Health and Welfare) Act, 1986. Act No. 54 of 1986.	L, A
Mines Rescue Rules 1985.	R, D, O
The Bhopal Gas Leak Disaster (Processing of Claims) Act 1985.	L, A
The Workmen's Compensation (Amendment) Act 1984. No. 22.	L, A
Dangerous Machines (Regulation) Act, 1983 (No. 35 of 1983).	L, A
Insecticides Rules, 1971.	R, D, O
The Insecticides Act (Act No. 46 of 1968).	L, A
Maharashtra Factories (Amendment) Rules 1967.	R, D, O
Metalliferous Mines Regulations, 1960 (G.S.R. 337).	R, D, O
Coal Mines Regulations, 1957 (S.R.O. 34019).	R, D, O
Indian Electricity Rules, 1956 (S.R.O 1455).	R, D, O
The Plantations Labour Act 1951 (No. 69 of 1951).	L, A
Factories Act 1948 (No. 63 of 1948).	L, A
Employer's Liability Act 1938 (No. 24 of 1938) [as amended, with comments and references to cases].	L, A
Factories Act, 1934 (Act XXV of 1934).	L, A
Indian Boilers Act (No. 5 of 1923).	L, A
Indian Electricity Act (Act No. 9 of 1910).	R, D, O

2.3 Administration relating to labor safety and health

India is a federal union of states comprised of the National Capital Territory of Delhi, six states directly ruled by the central government called union territories, and 29 *states* with their own governments. The administration services related to OSHM are also shared between the central government and state governments. Since this study primarily looked into the national OSHM services by the central government, discussion below deals with India's OSHM-related services at the national level.

(1) Ministry of Labour and Employment (MoLE)

The Ministry of Labour and Employment (MoLE) is part of the central government. Other than dealing with the country's labour policies in general, the ministry is responsible for OSHM-related lawmaking and social security issues. Figure 2.3.1 illustrates the organization of the MoLE and the National Safety Council, a non-profit organization in the OSHM field.

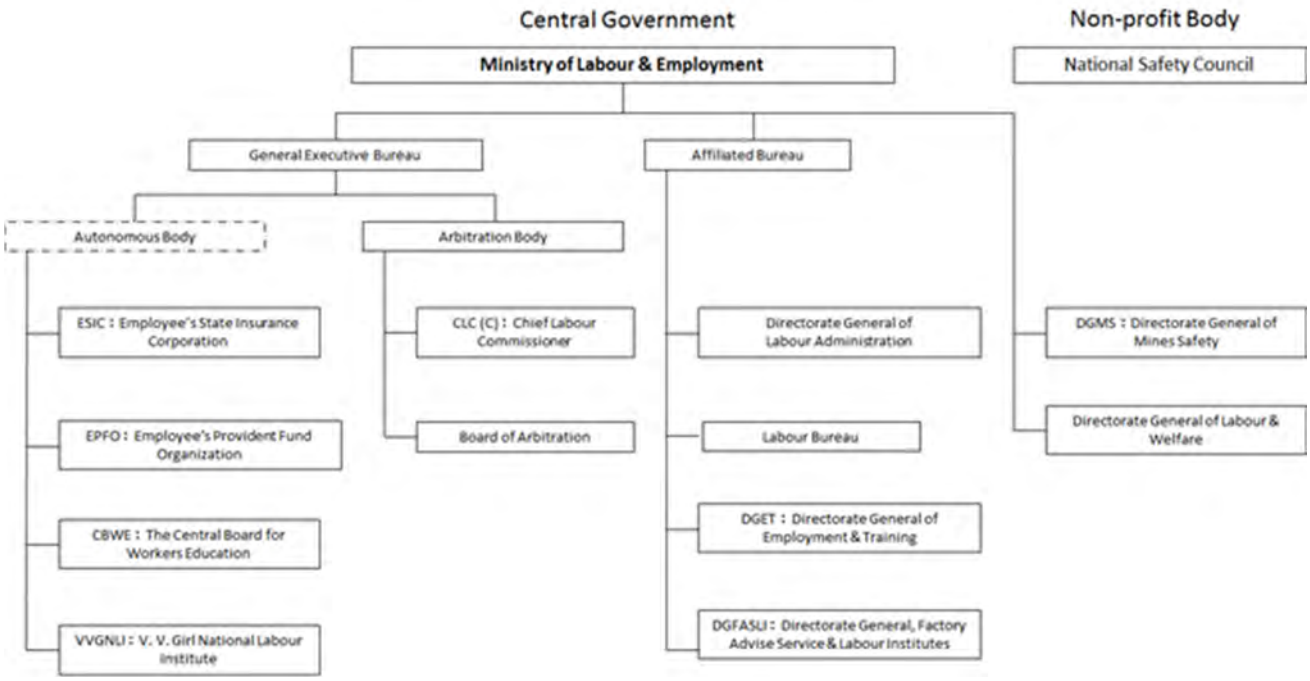


Figure 2.3.1 Organization of the MoLE and NSC

The MoLE is one of the oldest ministries in the Indian government. Its mission is to protect the interest of working people, especially of low-income workers, at work and develop and implement various policies aimed to improve labor conditions, create environment contributing to develop healthy workplace to improve productivity at work. As of October 2015, the ministry governed 44 OSHM-related laws and regulations, thereby controlling the country's labour policy nationwide.

Specifically, the MoLE is responsible for: (i) making labor-related laws and regulations; (ii) promoting various labor policies; (iii) deploying OSHM-related activities; (iv) solving workers' social security problems; (v) making laws and regulations for women and children; (vi) responding to labour-management issues, (vii) promoting workers' education; (viii) managing labor- and employment-related data; (ix) responding to issues arising from workers' emigration abroad; and (x) promoting international cooperation on labour- and

employment-related issues.

(2) National Safety Council (NSC)

One of the largest non-profit organizations in India, the NSC was set up on March 4, 1996 by the MoLE. Headquartered in Mumbai, the council has as mission to generate, develop, and sustain and support autonomous activities related to health, safety, and environment (HSE) across the country.

NSC's Vision:

- Serving society by creating a preventive culture, scientific mindset and organized approach to HSE issues;
- Deploy various activities based on the belief that HSE issues are effectively addressed if their intrinsic relationship with quality and productivity is well demonstrated.

Major activities:

- Conducting specialized training courses, conferences, seminars & workshops all over the nation;
- Conducting studies such as safety audits[*1], hazard evaluation (HAZOP survey), and emergency management planning & risk assessment;
- Conducting risk assessment and other surveys;
- Conducting safety awareness surveys among workers;
- Designing and developing HSE promotional materials & publications, such as safety posters, guidance cards, safety calendars, safety diaries;
- Supporting organizations carrying out various campaigns e.g. Road safety week, Safety Day, Fire Service Week, World Environment Day
- Cooperating for the organization of national and international conferences, such as World Congress on Safety and Health at Work and Asia-Pacific Occupational Safety and Health Organization (APOSHO) Conference.
- Publicly commending safety achievements;

*1 Safety inspection

Safety inspection consists in evaluating the degree of safety improvement at various industrial facilities such as petrochemical and chemical facilities, oil factories, cement factories, power plants, fertilizer plants, medicine and pesticide dozing facilities and plants, pulp plants, hotels, and hospitals.

2.4 Qualification system relating to labor safety and health

In this study, we visited Regional Technical Institute at Faridabad Branch Office of the Directorate General, Factory Advise Service & Labour Institutes (DGFASLI), an organ under the MoLE in charge of OSHM-related educational and training activities, etc. and gathered information on various educational and training activities conducted by the MoLE.

(1) Educational, training, and qualification activities conducted by DGFASI

Headquartered in Mumbai, DGFASLI has branch offices in Kanpur, Chennai, and Kolkata. Each branch office has a regional technical institute and a central technical institute operates in Mumbai. The branch office in Faridabad opened in 2009. Each branch office deploys educational and training activities in one of four regions dividing the country, each covering multiple states. Faridabad Branch Office is in charge of the northern region covering Haryana, Punjab, Himachal Pradesh, Jammu, and Kashmir states and Delhi Metropolitan Area.

(i) Qualification, Education and Training Activities

Each Branch Office conducts various surveys and safety inspections and plans and runs various educational and training courses related to OSHM. Typical training courses include a one-year program called Diploma Industrial Safety, whose graduates are qualified as safety officers. Other than year-round programs, short-term, purpose-driven programs are also offered for the fields of safety, health, and medicine (by work type for the safety field).

Specifically, there are courses in the field of the Building and Other Construction Workers Central Act (regulations on employment and labor conditions) and the Factories Act where those who complete those programs are qualified as safety officers in each field. The instruction of these training courses is ensured by members of the MoLE including DGFASLI or, in some cases, by outside instructors.

(ii) Safety Inspection

Safety inspection is conducted by safety officers who are dispatched only upon the request of the owner of a construction (building) work site in operation, and not dispatched on the DGFASLI's own initiative. On the other hand, the Office of Chief Labour Commissioner (CLC(C), who works as arbitrator in labour safety issues, inspects workplace on their own initiative. The Office of CLC has its own factory inspectors who inspect factories on their own initiative and check whether the Building and Other Construction Workers Central Act (regulations on employment and labor conditions) (BOCWA) are complied with in at workplace.

The BOCWA prescribes both technical aspects and benefit aspects of safety at work. The technical aspects are supervised by factory inspectors and the benefit aspects by labor inspectors. The DGFASLI and CLC each have their labor department with labor inspectors and factory inspectors assigned. An organization governs the occupational safety in the construction industry in India is the BOCWA and what governs that in the manufacturing industry is the Factories Act. This means that the central government's inspection of

construction sites is ensured by the DGFASLI.

(iii) Promotion of implementation of laws and regulations

They say that they carry out activities to promote the implementation of laws and regulations such as the Factories Act, and the BOCWA at workplace by dispatching safety officers to workplace, but the central government's authority is limited to advisory services and has no authority to enforce laws and regulations, which is ensured by state governments.

(2) Educational and training activities by the NSC

The National Safety Council (NSC) mentioned also organizes nationwide some specialized training courses, meetings, seminars, workshops, etc. related to OSHM.

2.5 Safety standards, guidelines & manuals

Currently in India, comprehensive legislation on occupational safety and health is implemented in four fields, namely (i) mine development, (ii) factory work, (iii) port projects, and (iv) construction (including building). The Directorate General, Factory Advice Service and Labour Institutes (DGFASLI) and Directorate General of Mines Safety (DGMS) discussed earlier are in charge of the technical aspects in the development of laws and regulations on OSHM in factories, ports, and mining projects in the fields they each control. Thus, in addition to various activities for OSHM conducted by DGFASLI and DGMS in the above four fields, National Safety Council (NSC) launched in 1966 also contributes to the improvement of OSHM by publishing guides and manuals on OSHM in addition to the various activities discussed in 2.3.

(1) OSHM guidelines published by NSC

Table 2.5.1 shows the guidebooks and manuals on OSHM published by the National Safety Council (NSC). As to OSHM in general, the Council publishes the following Health, Safety and Environment (HSE) guidebooks:

- HSE Guide Volume-I (General)
- HSE Guide Volume-II (Chemical, Construction & Transportation Safety)
- HSE Guide Volume-III (Health & Environment)

Table 2.5.1 Guidebooks and manuals published by NSC

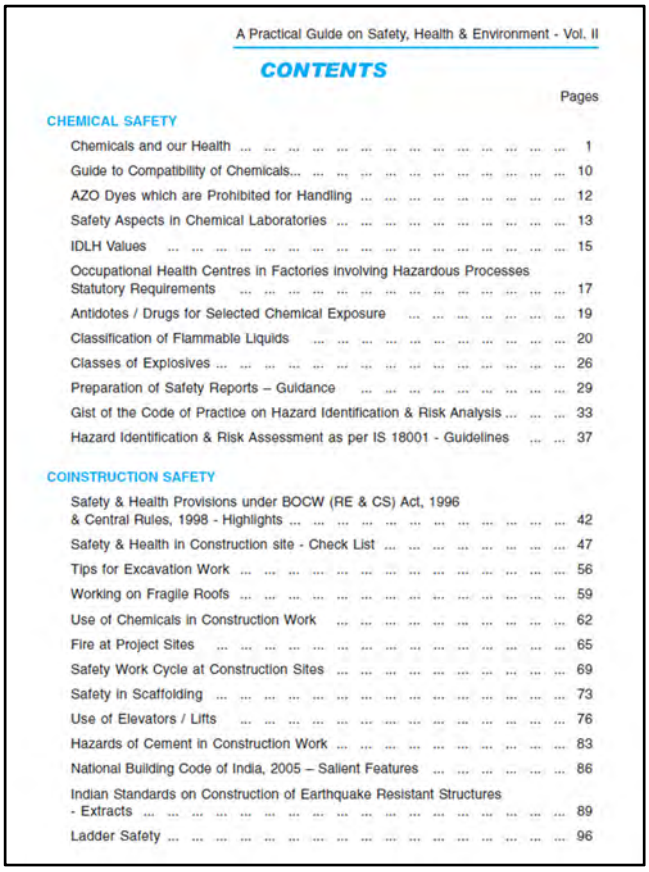
SAFETY PUBLICATION
NSC's Publications
HSE Guide Volume-I
HSE Guide Volume-II (Chemical, Construction & Transportation Safety)
HSE Guide Volume-III (Health & Environment)
Environmental Protection Information Package
Guidelines for the Preparation of Cyclone Emergency Management Manual for Coast-based Industrial Installations
POKET GUIDES
Statutory
Summary of the Hazardous Wastes (Mgmt & Handling) Rules 1989, as amended in Jan 2000 & in May"03
Statutory norms on Fire Safety under the Factories Act, the Petroleum Act and the Explosives Act
Highlights on OSH Building & Other Const.(BOCW) Rules
Hazardous Waste Mgmt & Trans boundary Rules
Overview of statutory provisions (BOCW Rules)
Mechanical Safety
Safety in Welding & Gas Cutting operations
Safe use of Lifts
Electrical Safety
Electrical Safety
Good Practices in electrical wiring for fire safety
Chemical Safety
Packaging & Labeling of Hazardous Chemicals
Using LPG safely
Safe Handling of hazardous chemicals
Safe use of Natural Gas
Fire Safety in Transportation of hazardous goods
Safe use of CNG
Fire Safety in Chemical Laboratories
Health & Higiene
Food Safety
HIV Aids at the Workplace
Stress Management at the workplace

Environment Management
Energy Conservation
Hazardous waste management
Corporate Environmental Reporting
Product Design Based on Life Cycle Assessment
Guidelines on Water Conservation in Industry
Guidelines on Environmental Impact Assessment
Management of Noise at workplace and in outside environment
Environmental Impact Assessment (EIA)
Guidelines on Transportation of hazardous wastes
Rainwater harvesting
Energy Conservation Building Code 2007-Guidance to eco friendly buildings
Guidelines for Environmental Management of Waste Summary
National Environment Policy 2006
Emergency Management
Fire Safety
Electrical Fire
Response to Hazmat Fire
Fire Safety in public places
Fire Safety in high rise buildings
Fire Safety in temporary occupancies
Fire safety at Project sites
Fire Prevention for Motor Vehicles
Fire Safety in Chemicals Warehouses
Handling of Chemical Fires
Elements for Comprehensive Fire Safety Audit
Case Study on Fire Incidents
Road Safety
Vehicular Pollution
Defensive Driving
Tips on road safety
Others
Housekeeping
Work Permit System
Commuting to workplace safely
Preventing Slips, Trips & Falls
Home Safety
Safety while working at height

Many guidebooks are also available by type of work. NSC has published various guidebooks, downloadable on its website for charge, including instructions on handling machines (machinery and materials), handling electricity, fire, hazardous materials, traffic safety on workplace, workers' health and hygiene, emergency response, environmental considerations to be given on construction sites and their peripheries (See Table 2.5.1).

Table 2.5.2 shows the table of contents of Chemical, Construction & Transportation Safety (HSE Guide Volume-II). As subjects related to work on construction sites, the guide includes instructions on excavation work, work on unstable roofing of structures/buildings, work handling chemical substances, response to a fire, cycle of safety work, work on scaffolding, work using lifts, work using ladders, etc.

Table 2.5.2 An example of OSHM guide (handling chemicals, construction site work, traffic safety on construction sites, etc.) (Table of Contents)



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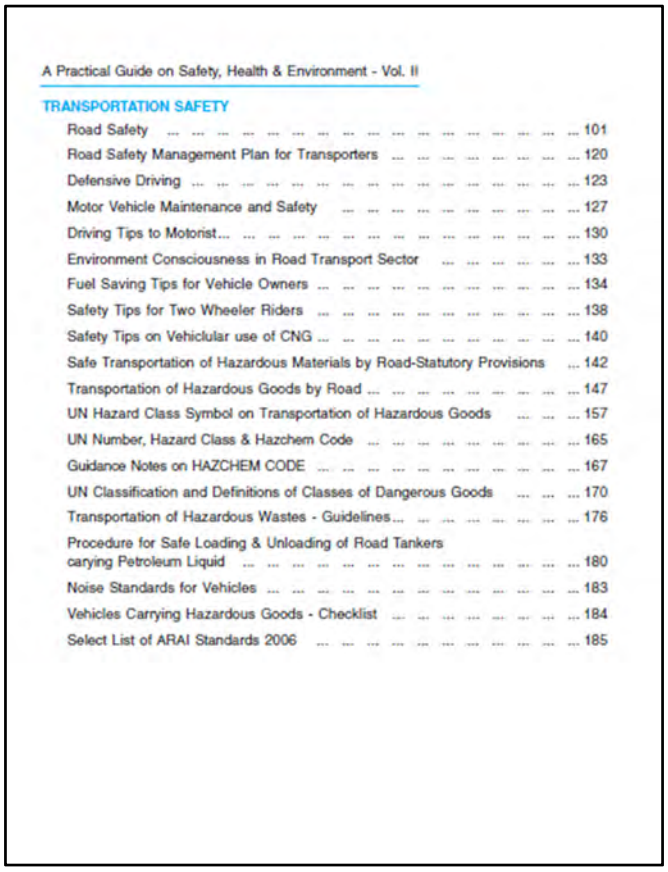

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TRANSPORTATION SAFETY

Further, many guidebooks are offered also in areas other than the four fields we saw at the beginning of this section. For example, in the field of railway projects, the subject of this field study, Manual for Standards and Specifications issued by the Ministry of Railways by type of object of construction prescribes various provisions intended to ensure safety in each stage of construction of structures and facilities concerned. Further, Railway Board, an organ under the ministry, also publishes Indian Railways Permanent Way Manual (IRPWM) which gives safety precautions to be taken in various stages of construction.

Shown in the next page are two examples from Manual for Standards and Specifications issued by the

Ministry of Railways. Example 1, which is part of a manual on railway station infrastructure development projects in Public Private Partnership (PPP) format, requires the operator to comply with relevant laws and regulations and the NSC regulations mentioned above.

[Example 1]

MANUAL FOR STANDARDS AND SPECIFICATIONS FOR RAILWAY STATIONS, June 2009

7.5 Safety Requirements during Construction

1. The Concessionaire shall comply with all Safety and industrial health legislation including, without limitation, The Rules and Regulations of the National Safety Council of India. The Concessionaire shall be fully responsible for the safety of the project site, his personnel, contractors' and subcontractors' personnel, public, and all persons directly or indirectly associated with the project, or on or in the vicinity of the project site.

Excerpts from 228pp of the Manual

[Example 2]

MANUAL OF SPECIFICATIONS AND STANDARDS FOR EPC CONTRACT 2014

1. General

1.14 Safety during Construction

1.14.1 The Contractor shall develop, implement and administer a surveillance and safety program for providing a safe environment on or about the Project, and shall comply with the safety requirements set forth in the Agreement.

1.14.2 Before taking up any construction work, the Contractor shall prepare a Traffic Management Plan for each work zone and furnish it to the Authority's Engineer for comments duly incorporating the following:

(i) Designate a Site Safety Team headed by a qualified Safety Officer.

(ii) Traffic safety devices as per IRC:SP:55 with the following specifications:

a) Signage of retro-reflective sheet of high intensity grade.

b) Delineators in the form of cones/drums (300 to 500 mm dia and 1000 mm high) made of plastic/rubber having retro reflective red and white band, at a spacing of maximum 5 m along with a reflective tape (red and white band) to be tied in between the gaps of cones/drums. A bulb/flasher using solar energy is to be placed on the top of the cone/drum for night delineation.

c) Barricades using iron sheet (plain) with adequate iron railing/frame painted with retro-reflective paint in alternate black and white (or yellow and black) strips. Warning lights at 5.0 m spacing shall be mounted on the barricades and kept lit in the dark hours and night.

(iii) Sprinkling of water for dust control at work zones, haul roads and plant/camp sites.

(iv) Noise/Pollution suppression measures at work zones haul roads and plant/camp sites.

(v) Mechanical, electrical and fire safety practices.
(vi) Safety measures like PPE (Personal Protection Equipment) for workers engaged.
(vii) First Aid and Emergency Response Arrangements i.e. First aid Box, Ambulance, paramedical staff, alarms, etc.
(viii) Safety training/awareness programs.
(ix) Formats to maintain the accident records/emergency response provided during accidents.
(x) A penalty scheme for violations in provision of adequate traffic control devices and proper traffic management should be proposed by the Contractor. In case of default, the amount of penalty shall be paid by the Contractor to the Authority.
(xi) A compensation scheme including insurance cover for third party for works/road users and road side residents in case of death/injury/damage to the vehicle/property resulting from accidents on the Project, irrespective of the person at a fault should be proposed by the Contractor.

1.14.3 The Contractor shall also be responsible for ensuring compliance of all labour laws and regulations including those relating the welfare of workers engaged both directly and indirectly on the Project, besides their occupational safety and health.

Regarding Example 2, we see similar instructions in "Public Private Partnership in Urban Rail Systems, Manual of Specifications and Standards" published by the Ministry of Railways and "Elevated Mass Rapid Transit System through Public Private Partnership, Manual of Specifications and Standards" published by the State Government of Andhra Pradesh.

(2) Dedicated Freight Corridor Projects

Regarding the Delhi-Mumbai Dedicated Freight Corridor Construction Project, the subject of this study, we learned through interviews with the owner that they have an onsite safety management plan developed based on Chapters 11 to 13 of Indian Railways Permanent Way Manual (IRPWM).

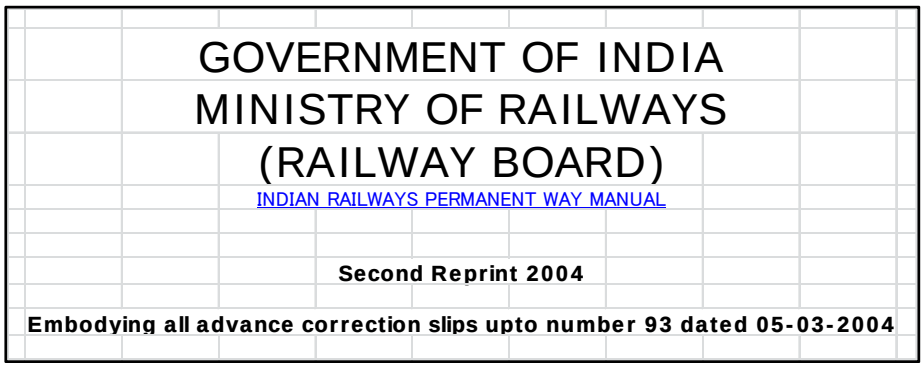

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)
INDIAN RAILWAYS PERMANENT WAY MANUAL
Second Reprint 2004
Embodying all advance correction slips upto number 93 dated 05-03-2004

Figure 2.5.1 A manual on safety guidelines for DFC projects (IRPWM)

Table 2.5.3 shows the table of contents of Chapters 11 to 13 of IRPWM. Chapter 11 gives instructions on vehicles used on construction sites; Chapter 12 on how to use vehicles carrying materials[1] and how to conduct related operations; Chapter 13 on procedures for getting permits and authorization for works in proximity of existing tracks, notification to the owner before starting work, etc.

[1] Vehicles carrying materials: Vehicles carrying materials necessary for the installation of railway tracks, such as ballast.

Table 2.5.3 Subjects dealt with in Chapters 11 to 13 of IRPWM

CHAPTER XI THE WORKING OF TROLLIES, MOTOR TROLLIES AND LORRIES	CHAPTER XII WORKING OF MATERIAL TRAINS AND TRACK MACHINES	CHAPTER XIII PROCEDURE FOR OBTAINING SANCTION AND CARRYING OUT WORKS AFFECTING SAFETY OF THE RUNNING LINE AND FOR OPENING NEW WORKS
– General Instructions	– Rules for working	– Reference to rules
– Distinction between Trolly, Motor Trolly and Lorry	– Material Train	– Works requiring sanction of C.R.S. and notice there for
– Certificate of competency	– Economical working	– Application for sanction of works
– Officials permitted to use Trollies, Motor Trollies and Lorries	– Restrictions in running	– Documents to accompany application
– Responsibility for safe working	– Brake-vans and Shelter wagons	– Submission of Safety Certificate
– Efficient brakes	– Ordering of Material trains	– Deviations from plans approved by C.R.S.
– Attachment to Trains Prohibited	– Issue of' Fit-to-run ' certificate'	– Applications for running of new types of locomotives and/or rolling stock and for increase in speed
– Working on track circuited Sections and section provided with treadls	– Official-in-charge of Material train	– Notification to Railway officials when opening works
– Numbering of trollies /Motor Trolies/ Lories	– Equipment	– Works arising out of accidents including breaches
– Conveyance of Trollies/ Motor Trollies/ Lorries by Trains –	– Testing of brake power	– Opening of new lines
– Trollies, Motor Trollies and Lorries not in use	– Working in Block Section	
– Conveyance of non-railway officials	– Pushing of Material	
– Trolly-permits for private sidings	– Procedure to be followed while pushing back	
– Military officers using trollies in Ordnance depots	– Running on Ghat Section and descending grade	
– Trolly refuges and observation posts	– Passage over points	
– Equipment for Trolly/Motor Trolly/Lorry	– Speed of material trains	
– Signals for Trolly/Motor Trolly/Lorry	– Stabling of a material train	
– Working of Trollies	– Reporting deficiencies and damages	
– Working of Motor Trollies	– Warning to workers on material trains	
– Working of Lorries	– Engine Crew's hours of duty	
– Working of Cycle Trollies and Moped Trollies	– Loading at Ballast depots	
– Working of Rail Dolleys	– Working trip	
	– Operation of Hoppers	
	– Training out materials and daily reports of working	
	– Charges for material train working	
	– Register of Engineering vehicles	
	– Working of Track maintenance machines	

In DFC projects, Chapter 16 of the Contract Agreement includes 90 pages of detailed SHE Requirements as requirements from the owner. These are the requirements the contractor must meet in the execution of onsite works, i.e., the guideline to follow in the execution of the project.

Chapters regarding the owner's requirements on OSHM in DFC projects

PART I SHE FRAMEWORK
PART II SHE MANAGEMENT
PART III LABOUR PROTECTION
PART IV SAFETY
PART V OCCUPATIONAL HEALTH AND WELFARE
PART VI ENVIRONMETAL AND SOCIAL MANAGEMENT
PART VII PENALTY AND AWARDS

2.6 Workmen's compensation and insurance

(1) Compensation and insurance related to occupational accidents (general situation in India)

Summarized below is the results of the survey on India conducted in 2014 by JCOSHA (Japan Construction Occupational Safety and Health Association), information provided by the MoLE and other agencies during this study, and the provisions of laws and regulations regarding occupational safety and health described in section 2.2 of this study.

i) Insurance covering injuries, deaths, etc. of workers

a) Obligation or not to subscribe to insurance

The Workmen's Compensation Act of 1923 requires the employer to compensate workers.

Further, for low-wage workers who are employed by plants and other places of business concerned employing 10 or more workers for powered manufacture and are paid a monthly wage of 15,000 rupees or less (7,500 rupees or less as of October 2009), the employer must have them covered by insurance of ESIC (The employer must register their business at ESIC). For other workers, the company must have them covered by health/injury insurance of their choice. The Workmen's Compensation Act does not apply to workers under the Employees' State Insurance.

In the Dedicated Freight Corridor Project Phase II, the contractor (SLT, a Sojitzu-L&T joint venture) employs hundreds of engineers, so L&T have them covered by the ESIC's insurance.

b) Names of various insurances and overview

Employees' State Insurance
An insurance run by Employee's State Insurance Corporation (ESIC) under the Employees' State Insurance Act, 1948, based on premiums paid by employers and workers. It aims to compensate the insured with cash benefits and compensation for the loss of life, medical expenses for the treatment of occupational injuries and sicknesses. Further, the insurance pays maternity benefits to female workers and survivor's annuity to bereaved family.

c) Insurant and insured

The worker subscribes to the insurance and gets covered in his/her own name. However, in the construction industry, the project owner is held responsible for ensuring that all workers are subscribed to the ESIC insurance and pay premiums. Subcontractors hence submit to the owner monthly reports on their workers'

subscription and payment of premiums. Generally, it is the contractor (the construction company) who handles the insurance matters.

d) Payment of premiums

In case of ESIC insurance, the employer pays a little more than and the worker a little less than the half of the insurance premium (As of October 2009, the employer paid 4.75 and the worker paid 1.75% of the total wage of the worker).

ii) Out-of-court settlement upon the occurrence of an occupational accident or disaster

The amount of compensation is determined according to the degree of disability: A minimum of 90,000 rupees must be paid for permanent disability and of 80,000 rupees for death (The Workmen's Compensation Act)(as of 2014).

(2) The insurance policies SLT subscribed to in the DFC Project

The insurance policies that the contractor (SLT, a Sojitzu-L&T joint venture) subscribes to in the execution of the Dedicated Freight Corridor Phase II Project surveyed in this study are as follows:

(i) Construction insurance (Defined in section 18.2 of the GC and the PC)

Name : Contractor All Risks Policy
Insured : Sojitzu-L&T Consortium
Duration : August 30, 2013 to August 29, 2017 + Defect liability period (2 years)
Coverage : Physical damage on all facilities, equipment, and materials being constructed or worked on
Amount insured: 250 million INR/case

Construction insurance:
An insurance designed to compensate the insured for loss caused to the object covered by an unforeseen, sudden accident on a construction site, such as loss from fire and explosion, loss from theft, and loss from operational errors.

(ii)Professional Indemnity Insurance (Defined in section 18.5 of the PC)

Name : Professional Indemnity Insurance
Insured : Sojitzu-L&T Consortium
Duration : September 19, 2013 to September 30, 2022
Coverage : Loss from errors committed in design and construction works
Amount insured: 250 million INR/case
* Duration: The above duration concerns only the construction work part. For the design part, the

insurance retroacts to June 7, 2013. The insurance expires three years from the end of the defect notification period.

Professional Indemnity Insurance:

An insurance designed to compensate the loss that an association or a professional expert with a high level of expertise, skills, and techniques and a high social reputation may suffer by assuming legal professional indemnity liability while executing its/his work as part of its/his professional scope of work.

(iii)Insurance related to occupational accidents (Defined in section 18.4 of the GC)

Name : Compensation for worker's accidents
Insured : Sojitzu-L&T Consortium
Duration : March 31, 2015 to March 30, 2016 (Renewed annually)
Covered : All workers working onsite, including subcontractors' workers and security staff;

Compensation for worker's accidents:

Insurance designed to compensate the worker or bereaved family with insurance benefits for his/her injury, sickness, disability, or death suffered in the process of work or on the way to and from the site.

(iv) Insurance related to plants and machinery (Defined in section 18.2 of the GC and the PC)

Name : Contractors Plant and Machinery Insurance
Insured : L&T and its affiliates
Duration : April 1, 2015 to March 31, 2016 (Renewed annually)
Covered : Plants and machinery

Construction Plant and Machinery Insurance

An insurance designed, when construction machinery and other equipment covered that have been operational suffer loss upon the occurrence of an unforeseen, sudden accident (excluding when they reveal not covered), to compensate the insurant for expenses necessary to repair and restore these machinery, etc. to the initial status.

Note:

The amount of compensation paid by the Indian Railway to bereaved families in fatal accidents is 600,000 INR (as of 2012).

Chapter 3 Field Study - Dedicated Freight Corridor (Phase 1) II

3.1 Project Outline

3.1.1 Project

(1) Project Name: Dedicated Freight Corridor (Phase 1) II

(2) L/A: Signed on 31 March 2010

(3) Objectives: The Japanese ODA loan project (the Project) will focus on constructing approximately 920 kilometers track of the Western Corridor between Rewari in Hariyana and Iqubalgarn in Gujarat, connecting major cities in the states of Gujarat, Rajasthan and Haryana, as well as introducing electric locomotives capable of high-speed, high-capacity transportation. By meeting the high rate of growth expected in freight transportation and optimizing distribution networks, the Project will make a far-reaching contribution towards India's economic development.

(4) Location: States of Hariyana, Rajasthan and Gujarat (The project to be studied is CTP-1/2 in a length of 626.2km between Rewari in Hariyana and Iqubalgarn in Gujarat)

(5) Employer: Dedicated Freight Corridor Corporation of India Ltd. (DFCCIL)

(6) Design/Construction Supervision:

NK Consortium (Nippon Koei Co., Ltd., Oriental Consultants Co., Ltd., Japan Transportation Consultants, Inc., Nippon Koei India Pvt. Ltd., Oriental Consultants India Pvt. Ltd., RITES, Ltd)

(7) Contractor: CTP-1/2 – Sojitz - Larsen & Toubro Consortium (SLT)

(8) Contract Price: JPY 111,649,063,999 (equivalent to Japanese Yen)

(Exchange Rates: INR-JPY1.6672, US$-JPY89.2155, Euro-JPY119.0855)

(9) Construction Period: 30 August 2013 – 24 August 2017 (48 months)

(10) Quantities:

Table 3.1.1 Quantities (Contract CTP-1/2)

Item	Quantity
Length	626.2km
Excavation	3,769,760m^3
Embankment	23,665,895m^3
Ballast	7,616,488m^3
Blanket	5,807,631m^3
Medium/Small Concrete Structures	561,002m^3
Major Concrete Structures	400,001m^3
Rail Supply (80%)	168,000mt
Sleeper Supply (80%)	2,330,000nos.
Rail laying	1,389km
Ballast Supply (80%)	1,389km

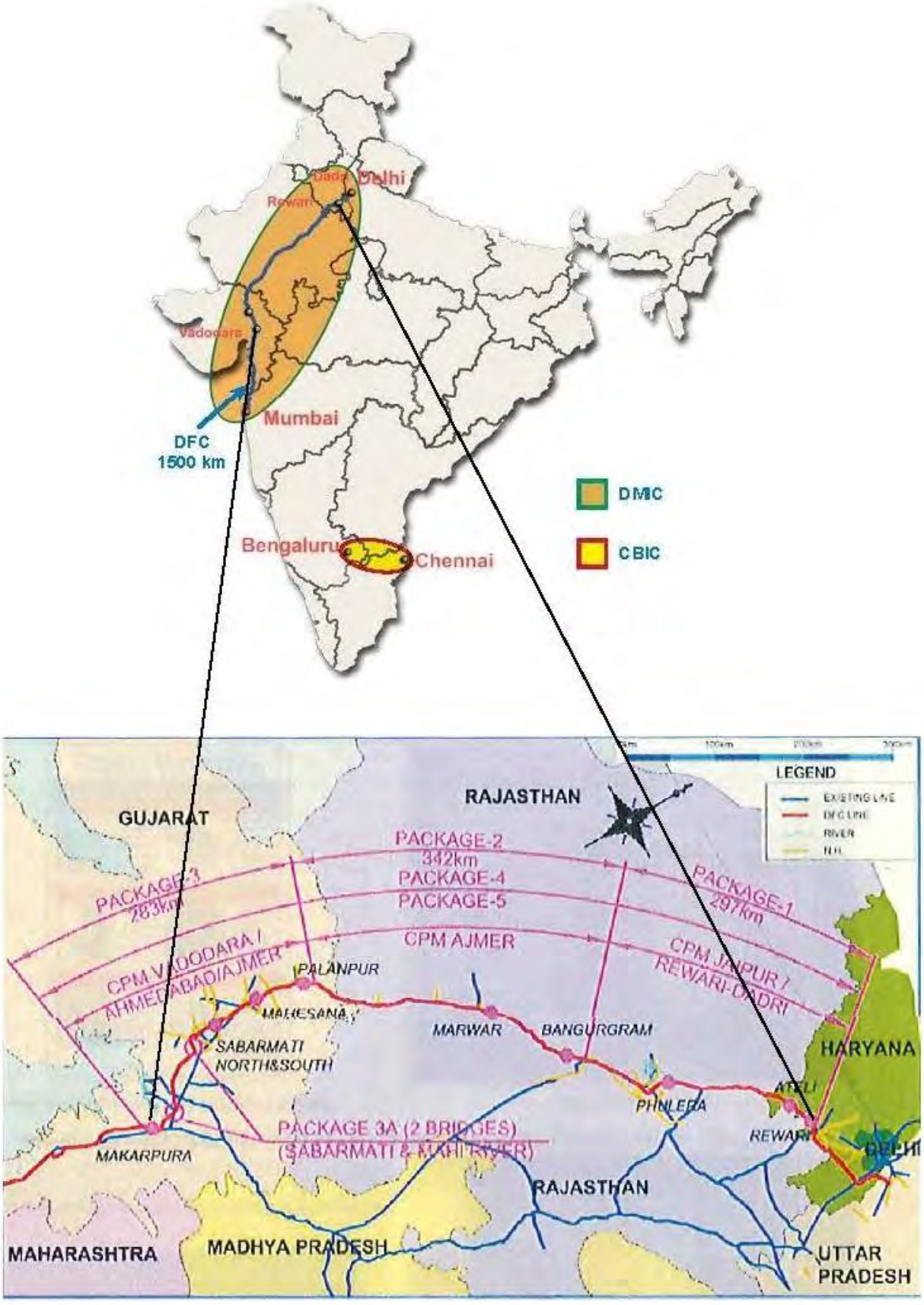


Figure 3.1.1 Project Location

3.1.2 Natural and Social Environment

(1) Natural Conditions

The DFC alignment in the Western Corridor CTP-1/2 starts from Rewari District, Haryana and runs through the western foot of Aravalli Range which is categorized one of the oldest mountains originated in the Pre-Cambrian era and located from Gujarat to Delhi lying south west to north east in northern part of India. The project runs through 3 states (Haryana, Rajasthan & Gujarat). The majority (85%) of project is located in Rajasthan.

Table 3.1.2 Natural Environment Features along the DFC Alignment in Western Corridor

State	Geomorphological Feature	Area along the DFC	DFC Length
Hariyana	Haryana is located in the northern part of India having the smallest land area of 44,210 km^2 among all Indian states. Most of area is covered by alluvial plain and Shivalik Hills at the north western part of the state. The altitude of the plain is approximately 210-270 m and there is an international river flowing thorough Nepal and Bangladesh, Yamuna River at the east part of the state.	DFC alignment in the Western Corridor crosses the northern part of Aravalli Range with a tunnel. DFC alignment in the Eastern Corridor passes through 2 districts in the northern part of the river bank of Ganga River.	71.2km (11.4%)
Rajasthan	Rajasthan is located in the north west of Indo sub-continent having 342,239 km2of land area. Aravalli range lies covering Mount Abu (1,722 m ASL) at south western border to Khetri at north eastern border in the state. Also, the Thar Desert is located in the area of the western to north western part of Rajasthan.	The DFC is planed to pass 7 districts at the western foot of Aravalli Range which originated in Pre-Cambrian Era. Rocky hilly area in dry climate. The alignment passes the highest place (approx.500m) in the entire corridor.	535.0km (85.4%)
Gujarat	Gujarat is located in the north western part of India bordering Pakistan and having 196,000 km^{2}of land area. The state has the longest coastal line among all states in India and its length is 1,596 km. The entire area is topographically flat. There are many big rivers such as Tapi River and Narmada River flows into the Arabian sea.	The area connects two regions, Aravalli Range and Konkan area along the western Ghart. DFC alignment passes through 12districts. From the border with Rajasthan, the elevation is decline toward Maharashtra.	20.0km (3.2%)
Total			626.2km

(Source: The Feasibility Study on The Development of Dedicated Freight Corridor for Delhi-Mumbai and Ludhiana-Sonnagar in India)

The alignment located in topographically flat or slightly sloped area passing the highest elevation of approximately 500 m Above Sea Level (ASL) in the middle of Rajasthan. The elevation of the study area is approximately 200 m ASL at the end point of the western railway in Delhi. The distinguished topographic feature associated with geology in Aravalli can be observed only a part of entire stretch near Ajmer where the railway crossing the Aravalli Range. In Ajmer, this is an old mining site of hard rocks such as metamorphic schists, quartzites, marbles and gneisses of the Pre-Cambrian age with associated acid and basic intrusive rocks according to Water Resource Department in Rajasthan.

The DFC alignment passes through agricultural land, and the general vegetation types are tropical dry deciduous forest or tropical thorn forest in Gujarat, Rajasthan and Haryana.

The annual climate of Jaipur, the capital city of the state of Rajasthan is divided into four seasons, i.e. winter (December – February), summer (March – May), monsoon season (June – September), transition period (October, November). Summer in Jaipur is extremely hot (Max. 40-47℃), while winter is very cold (min. 4-9℃, sometimes below zero). The project area belongs to monsoon climate and has most annual rainfall within the monsoon season between August and September.

Table 3.1.3 Climate at Jaipur

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ave. Max Temp. (℃)	22.5	25.7	31.5	37.2	40.5	39.4	34.3	32.4	33.3	33.6	29.2	24.5
Ave. Min Temp. (℃)	8.2	11.0	16.2	21.8	25.9	27.3	25.3	24.6	23.3	19.1	13.5	9.3
Ave. Precip. (mm)	5.5	4.9	4.2	8.2	18.7	68.8	220.8	194.8	71.4	20.1	5.3	3.8

(Source: Indian Meteorological Department HP)

(2)Social Environment

The population within each district directly affected by the DFC Project varies from 0.9 million for the district in Haryana to more than 10 million for that in Rajasthan and Gujarat.

Table 3.1.4 Socio-economic Indicators of Districts Affected by DFC Project in Western Corridor

Section	State	District	DFC Project's Railway Alignment		Area and Population			Average annual growth in Population: 1991-2001 (%)			Proportion of SCs & STs in the total population: 2001 (%)		Per capita rural & urban income & market size: 2006 (Rs Crore)		
			Parallel	Detour	Area (Sq. Km)	Population	Urban Population (%)	Rural	Urban	Total	Ratio of SCs to the total population	Ratio of STs to the total population	Market Size (Rs Crore)	Per capita income in urban areas (Rs)	Per capita income in rural areas (Rs)
Ahmedabad - Rewari	Haryana	Rewari	-	28	1,582	858,378	19	2	4	2	19	4	2,245	50,724	31,222
		Mehendragarh	48	-	1,859	886,283	14	2	3	2	16	2	1,943	43,902	25,880
		Sub-Total	48	28	3,441	1,744,661	-	-	-	-	-	-	4,188	-	-
	Rajasthan	Alwar	1	-	8,380	3,418,055	15	3	3	3	18	8	7,232	56,962	27,516
		Sikar	75	14	7,732	2,548,559	20	2	2	2	15	3	5,036	30,468	28,295
		Nagaur	7	-	17,718	3,153,641	18	2	3	3	20	0	6,134	34,178	26,754
		Jaipur	64	16	11,143	6,117,522	51	2	4	3	15	8	16,218	60,282	26,170
		Ajmer	83	19	8,481	2,450,013	40	2	2	2	18	2	6,002	44,644	33,776
		Pali	200	-	12,387	2,017,452	21	2	2	2	18	6	5,108	60,827	32,680
		Sirohi	60	-	5,136	969,718	17	3	2	3	19	25	1,851	50,299	23,738
		Sub-Total	490	49	70,977	20,674,960	-	-	-	-	-	-	47,581	-	-
	Gujarat	Banas Kantha	38	36	10,757	2,814,450	12	2	3	2	11	8	5,881	47,880	24,501
		Patan	13	-	5,730	1,263,414	20	1	1	1	10	1	3,231	57,977	27,843
		Mahesana	27	56	4,383	1,947,540	23	1	2	1	8	1	5,463	65,287	29,473
		Gandhinagar	-	20	2,163	1,493,301	38	1	4	2	9	1	6,649	98,331	42,061
		Ahmadabad	5	30	8,087	6,555,762	81	1	3	2	11	1	25,976	62,897	34,050
Mumbai - Ahmedabad		Kheda	-	27	4,219	2,151,572	20	1	1	1	5	2	5,443	59,986	26,920
		Anand	-	56	2,941	1,975,197	29	1	2	1	5	1	6,348	60,031	37,386
		Vadodara	49	21	7,550	3,988,646	46	2	2	2	6	27	15,218	88,854	25,457
		Bharuch	36	24	6,527	1,494,482	26	2	2	2	5	32	4,287	56,490	31,879
		Surat	7	38	7,657	6,140,589	65	2	6	4	3	28	21,192	56,972	34,407
		Navsari	41	-	2,209	1,309,702	27	1	1	1	3	48	4,668	71,489	41,101
		Valsad	70	-	3,035	1,623,151	31	2	5	3	3	55	4,722	67,833	27,651
		Sub-Total	286	308	65,258	32,757,806	-	-	-	-	-	-	109,078	-	-
	Maharashutra	Thane	140	-	9,558	10,210,113	76	2	2	2	3	29	5,848	36,975	42,823
		Sub-Total	140	-	9,558	10,210,113	-	-	-	-	-	-	5,848	-	-
		TOTAL	964	385	149,234	65,387,540	-	-	-	-	-	-	166,695	-	-

Source: 1) Haryana/Rajasthan/Gujarat/maharashtra Development Report, Vol. 1 and 2, 2007, Planning Commission, India
2) "India at a Glance 2006-07, Performance, Facts, and Figures, Haryana/Rajasthan/Gujarat/Maharashtra", Dorling Kindersley (India), 2007
3) Censusl of India 2001, Registrar General and Census Commissioner, India

(Source: The Feasibility Study on The Development of Dedicated Freight Corridor for Delhi-Mumbai and Ludhiana-Sonnagar in India)

3.2 Contract Provisions on Project Management Procedure

3.2.1 Stakeholders

The General Conditions of Contract used in this project is “FIDIC Yellow Book (Plant and Design Build 1999), wherein the project organization consists of 3 parties, i.e. the Employer, the Engineer and the Contractor.

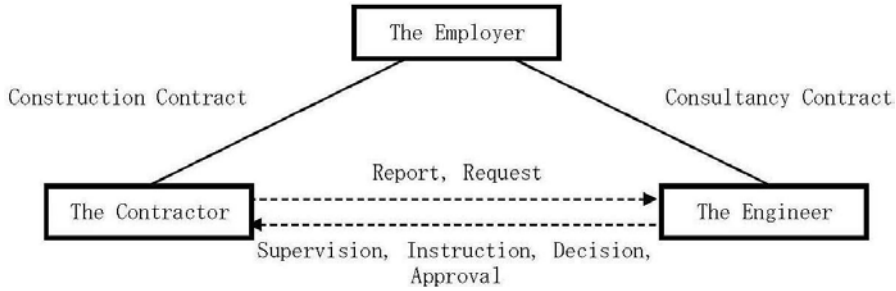


Figure 3.2.1 Three Parties Structure

3.2.2 Framework of Management of Construction Work in the Project

The framework of operation and management of construction work in ODA projects usually constitutes a hierarchy shown below. The same framework applies to this project.

Figure 3.2.2 Framework of operation and management of construction work in ODA projects

In this study, bearing the above in mind, it is defined that safety in construction projects consists of two components, “Safety of Works” and “Occupational Safety and Health”, with a view to analyzing the information on the project to describe the operation and management procedure.

The reasons of highlighting “Safety of Works” are; (1) The cause of the Can Tho bridge accident occurred in 2007 in Vietnam is attributable to technical problems related to design & construction of temporary structures; and (2) To highlight the differences between ODA projects and projects in Japan summarized in Table 3.2.1 above.

Table 3.2.1 Management of Safety for Construction Work

Management of Safety for Construction Work		Japan	ODA Recipient Countries (in case ODA projects)
Safety of Works	Dominant Framework	Contract	Contract
	Referee	Employer	Engineer (Consultant)
Occupational Safety and Health	Dominant Framework	Laws & Regulations	Laws & Regulations / Contract
	Referee	Competent Agency (Labor Standard Inspection Office)	Engineer (Consultant)

(Source: Consultant)

Management of each safety component in construction projects is summarized in the following table:

Table 3.2.2 Management of Safety in Construction Projects

Safety of Works	Occupational Safety and Health
1. Contract Provisions	1. Legal Responsibilities
2. Design Review System	2. Involvement of Competent Authorities
3. Method Statement Review System	3. Contract Provisions
4. Quality Assurance / Management System	4. Application of OSH Management System
5. Risk Management	5. Safety Management System
6. Contractor's All Risks Insurance	6. Workmen's Compensation Insurance
7. Others	7. Others

(Source: Safety Management in Infrastructure Projects in Developing Countries)

3.2.3 Construction Contract

(1) Contract Documents

This is a design and build contract. The construction contract documents consists of General Conditions of Contract (FIDIC Yellow Book (Plant and Design-Build 1999)), Particular Conditions of Contract, Employer's Requirements, Specifications, Data Book, Reference Drawings, etc., wherein safety/quality-related matters are mainly described in Employer's Requirements and Specifications.

(2) Employer's Requirements

The structure of the Employer's Requirements in this project is similar to that of Delhi Metro projects which have been implemented since Year 2001), and the project requirements are comprehensively and systematically delineated.

Main provisions on safety and quality are arranged in the Employer's Requirements as follows:

Figure 3.2.3 Provisions on Safety/Quality in the Employer's Requirements

(3) Specifications

Though the specifications for certain items contained herein are the Employer's minimum and specific requirements, there are quite detailed descriptions on safety, which indicates the level of Employer's demand on safety is high. The Contractor shall further develop these specifications and the specifications for the other items to the detailed specifications giving due considerations to the Employer's Requirements, requirements of Design Criteria, relevant provisions of various Codes and Standards, various Indian Railway Rules, best engineering practices etc. as applicable and shall submit the same to the Engineer for his consent and approval of the Employer as part of the Technical Design Package and the Construction Design Package during the Design Phase.

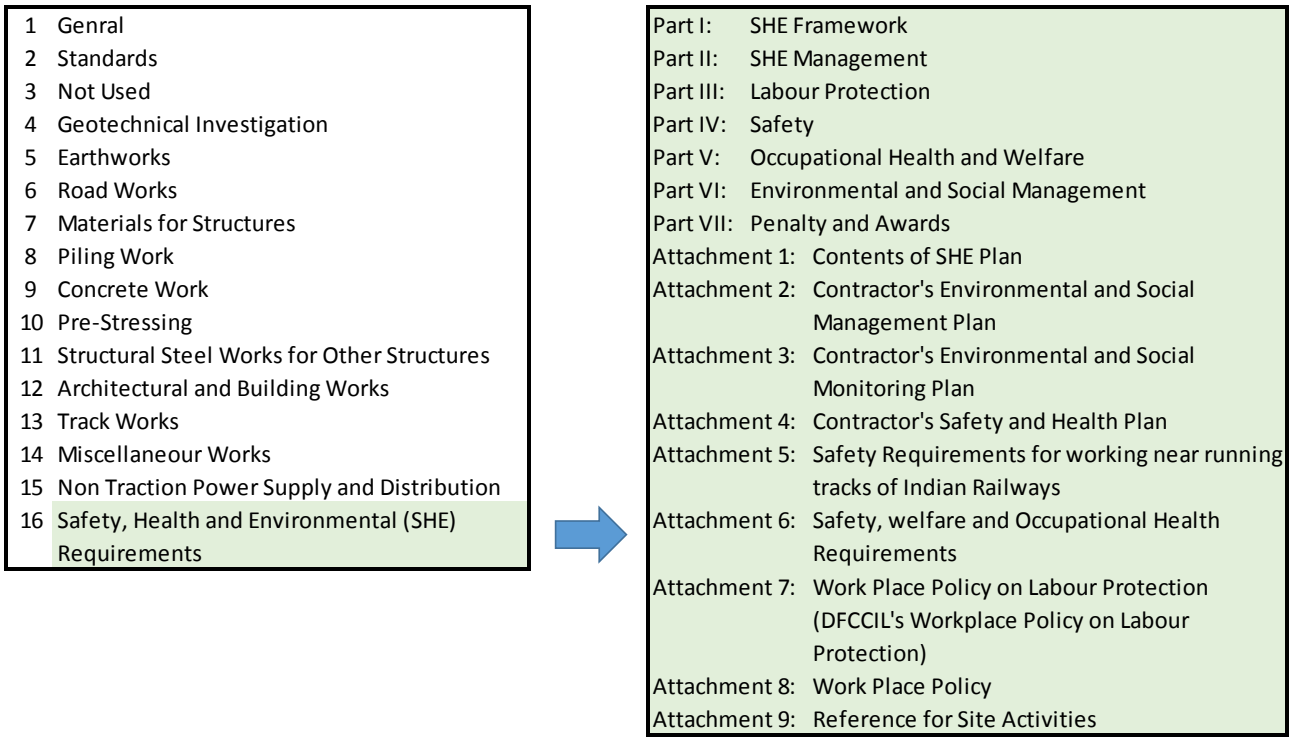


Figure 3.2.4 Provisions on Safety in Specifications

(4) Provisions on Safety of Works in the Employer's Requirements and Specifications

a. Design Procedure

The Employer's Requirements requires the design be prepared/approved in five stages:

① Inception Report
② Technical Design
③ Construction Design
④ Field Change Notice (in case requiring a design change on site)
⑤ As-Built Documents

The design submittals required at each stage are summarized in the table below:

Table 3.2.3 Design Submittals

Submittals		(1) Inception Report	(2) Technical Design	(3) Construction Design	Field Change Notice	(4) As-Built Documents
Technical Drawings	Final Alignment Plan and Profile Drawings		●	●●		■■
	Cross Section Alignment Drawings		●	●●		■■
	Alignment Verification Report		●			
	Railtrack Formation Plan and Profile Drawings		●	●●		■■
	Cross Section Railtrack Formation Drawings		●	●●		■■
	Structural Drawings for Railtrack Structures		●	●●		■■
	Drainage System Drawings		●	●●		■■
	Drawings and Documents Relating to Interface	○	●	●●		■■
	Structural drawings for the Building Works	○	●	●●		■■
	MEP drawings for the Building Works	○	●	●●		■■
	Track Installation Map and List		●	●●		■■
Works Specification			●	●●	●●	■■
Design Manual		●				
Design Submission Programme		●				
Technical Design Report			●	●●		■■
Hydrologic Report			●			
Station and IMD Depot Planning Report		●				
Track Schematic Drawings and Schedule		●				
Track Work Installation Planning Report		●				
SHE Documents		○	●	●●		■■
Testing and Commissioning Report			●			
Construction Method Statement		○	●	●●	●●	
Construction Sequence Statement				●●		
Temporary Works Design Report			●	●●		
Safety Risk Assessment				●●	●●	
Project Organization Plan		●		●●		
Document Control Procedure		●				
Construction Programme			●	●●	●●	
Working Drawings	**Shop Drawings**			●●	●●	
	Fabrication Drawings			●●	●●	
	Temporary Works Drawings			●●	●●	
	Re-bar Drawings including Cutting/ Bending and Reference Schedules			●●	●●	
Operation and Maintenance Manuals						■■

(Source: Employer's Requirements)

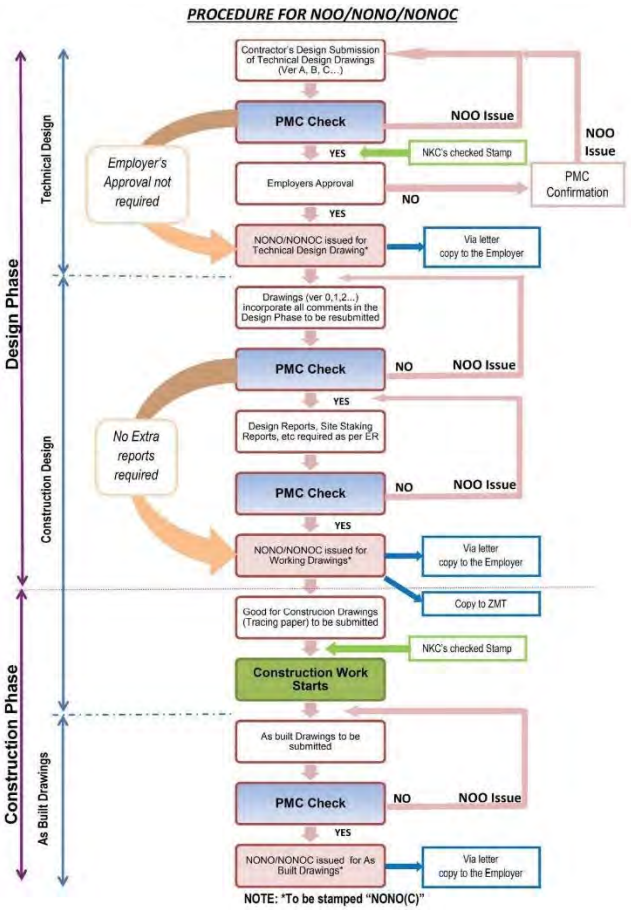


Figure 3.2.5 Design Approval Procedure
(Source: PMC Inception Report)

b. Role of Design Team in Safety Management

To best utilize the mechanism of this design-build contract, the role of design team is specified in the Employer's Requirements and Specifications. Typical examples are extracted below:

Specifications: SHE Management - Role of Design Team in Contractor's Organization

<Role of Design Team in Safety, Health and Environment>
In this design-build Contract, the Contractor has a design Team in his project organization and the Design Team's primary role includes to minimise the risk to health and safety of those who are going to construct, maintain, clean, repair, dismantle or demolish the structures and others like adjoining road users/general public, who might be affected by the work.

<General Philosophy>
When considering health and safety in the Design Team's work, they shall be expected to do what is reasonable at the time the design is prepared.

<Hierarchy of Risk Control>
The Design Team shall need, so far as reasonably practicable, to avoid or reduce risks by applying a series of steps known as the hierarchy of risk control or principles of prevention and protection.

<Duty to Provide Health and Safety Risks in the Drawing itself>
In case of situations where the Design Team has carried out the design work and concluded that there are risks, which were not reasonably practicable to avoid, detailed information shall be given about the health and safety risks, which remain.

<Engineer's Consent>
Every structure like scaffold, false work, launching girder, earth retaining structures etc. shall have its design calculations included in the method statements in addition to health and safety risks. The Engineer

Employer's Requirements – Appendix 9: Temporary Works <Technical Design Submission>

(1) Employees' camp
(2) Offices, parking areas, warehouses, storage areas, and medical care services
(3) Water supply, sewerage, sewage treatment and disposal, power supply and illumination, communication services (basically mobile phones and land phones), and fire fighting services
(4) **Temporary construction works including support systems for deep excavations, cofferdam and the support, concrete formworks and its support, temporary bridges and staging and so on**
(5) Access routes including temporary road works to all locations necessary to be reached in the course of construction in the Site and the Work Areas including public road diversions
(6) Equipment pools and mechanical workshops
(7) The detailed plan for operation of the borrow areas/quarries as detailed hereinafter incl. approach roads
(8) The Stockpile areas as detailed hereinafter including approach roads
(9) Concrete batching & mixing plant and crushing plants, including cement storage
(10) Fabrication Yard, Casting Yard including casting bed, lifting, curing and stacking Fabrication Yard, Casting Yard including casting bed, lifting, curing and stacking calculations and drawings
(11) Transporting, handling & launching system for the precast concrete elements/steel fabricated elements
(12) Material testing laboratories
(13) Explosives magazines – their proposed locations and operation plan
(14) Security and safety arrangements
(15) Layout and drawings for offices for the Employer's and the Engineer's staff
(16) Project sign boards and diversion boards

c. Safety Management of Works adjacent to the existing railway

The project is located generally in parallel with/adjacent to the existing railway. Hence, the contract documents draws both consultant's and contractor's attention to the safety management requirements for the works adjacent to the existing railway from points of occupational safety & health as well as safety of works:

Figure 3.2.6 Works adjacent to the existing railway (photos taken on 23 October 2015)

<Re. Occupational Safety and Health>

Specifications - 47. Work adjacent to Railways

47.1 Protection of Live Railways
47.1.1 The Contractor shall design to install the temporary fencing / barricades for protection of the existing Indian Railway (IR) lines where the construction activities of all Works adjacent to the line are taking place. The fencing / barricades shall be installed as indicated in the Employer's Drawings and the fencing may be movable and reusable whereas it is stable enough not to lean and infringe the structure gauge of the IR lines. The fencing pole / barricades shall be colored to enhance visual precautionary effects. The Contractor shall submit the design of the temporary fencing / barricades to the Engineer for consent.

47.1.2 Whenever work is to be conducted in close proximity to the live railways, the following measures shall need to be addressed:
i) The rules provided in the Railway's manual shall be followed.
ii) No persons are allowed to encroach onto the railway unless specific authority has been given by the owner.
iii) Adequate protection in accordance with the railway owner's requirements shall be followed. (Provision of Block Inspectors, Flagmen and Lookouts)
iv) All persons shall wear high visibility clothing at all times.
v) Any induction training requirements of the railways shall be strictly observed.
vi) Special care shall be taken to ensure safety of the travelling public, safety of existing railway and other structures located nearby, etc.

47.2 Securement of Train Operation
47.2.1 Where the work to be executed is in proximity of the running railway track, the Contractor shall be required to observe all precautions and carryout all works that may be necessary to ensure the safety of the running track/trains etc. without imposition of any speed restriction thereon as may be directed by the Engineer. The Contractor shall ensure that the materials are not stacked close to the railway track, which may endanger the safety of trains and workmen.

<Re. Safety of Works>

Employer's Requirements – Construction
Safety Requirements for Working Near Running Tracks of Indian Railways

7.1 Operational Safety
Where the work to be executed is in proximity of the running railway track, the Contractor shall be required to observe all precautions and carryout all works that may be necessary to ensure the safety of the running track/trains etc. without imposition of any speed restriction thereon as may be directed by the Engineer. No claim whatsoever shall be entertained for either any inconvenience caused to the Contractor or for the re-scheduling of the operations or for any other reasons on this account. The Contractor shall ensure that the materials are not stacked close to the railway track, which may endanger the safety of trains and workmen.

7.2 Where the Schedule of Dimensions of Indian Railways for the running tracks of IR are likely to be infringed by the Contractor, the following safety measures shall be ensured

7.3 Excavation Affecting Existing Tracks
While doing excavation near the vicinity of the existing tracks including for bridges and other structures, special care has to be taken to ensure that formation of the existing Railway line is not excavated, for that matter any activity involved in construction / execution of the project shall not endanger the safety of existing running line of Indian Railways. If excavation or any other activity involving working and or modification and or alteration of the existing permanent way then, before execution of such work, the Contractor shall prepare a drawing clearly indicating such alternation / modification of the existing permanent way, and the protection measure intended to be taken by the Contractor to ensure safety of the existing running line. The effectiveness of design of such protection measures is the sole responsibility of the Contractor and the Contractor shall indemnify the Engineer / Employer towards the losses incurred due to failure of such protection measure. These protection measures duly indicating the extent of alternation / modification to the existing formation shall be incorporated in the design and drawing submitted during preliminary design submission as per the Contract. Such work shall not be undertaken unless and until these drawings are consented by the Engineer.

7.4 The Contractor shall indemnify the Engineer / Employer against any damage to the existing tracks / structures / utilities etc. caused by the actions of the Contractor or his Sub-contractors, and shall make good the same, as directed by the concerned authorities, at his own cost and shall also pay any penalty(ies) / demurrages if levied by the concerned authorities.

3.3 Contractor's Plans

3.3.1 Quality Assurance

A well-designed project management system is imperative for this kind of huge project. Such management system is described in the Contractor's project quality assurance plan. The following project quality assurance plan was submitted by the Contractor and approved by the Engineer.

Table 3.3.1 Composition of Contractor's Project Quality Assurance Plan

Project Quality Assurance Plan
Introduction
1.0 Scope
1.1 General
1.2 Field of Application
2.0 Normative Reference
3.0 Terms, Definition & Abbreviation
4.0 Quality Management System (QMS)
4.1 General Requirement
4.2 Documentation Requirement
5.0 Management Responsibility
5.1 Management Commitment
5.2 Customer Focus
5.3 Quality Policy
5.4 Planning
5.5 Responsibility, Authority & Communication
5.6 Management Review
6.0 Resource Management
6.1 Provision of Resources
6.2 Human Resources
6.3 Infrastructure
6.4 Work Environment
7.0 Product Realization
7.1 Planning of Product Realization
7.2 Employer Related Processes
7.3 Design and Development
7.4 Purchasing
7.5 Production and Service Provision
7.6 Control of Monitoring and Measuring Devices
8.0 Measurement, Analysis & Improvement
8.1 General
8.2 Monitoring & Measurement
8.3 Control of Nonconforming Products and Customer Complaints
8.4 Analysis of Data
8.5 Improvement

3.3.2 Safety

The Contractor prepared a safety, health and environmental plan based on the contract provisions (Employer's Requirements, Specifications) and L&T's internal management plan.

Table 3.3.2 Composition of Contractor's Safety, Health & Environment Plan

Safety, Health & Environment (SHE) Plan
I. Title Pages
II. Amendment Record Sheet
III. Abbreviations
IV. Contents
01. Project Highlights
02. SHE Policy
03. Site SHE Organization Chart
04. Roles & Responsibilities
05. SHE Committee / Site SHE committee
06. SHE Training
07. Sub-contractor Evaluation, Selection and Control
08. SHE Inspection
09. SHE Audit
10. Accident Investigation And Reporting Procedure
11. Occupational Health Measures
12. Labor Welfare Measures
13. Risk Assessment and Mitigation Measures
14. Safe Work Procedures
15. Work Permit System
16. List of standard job specific PPEs to be used in the site
17. Maintenance of Regime for construction Equipment and Machinery
18. Traffic Management
19. Housekeeping
20. Environmental Social Management Plan
21. Emergency Management
22. Visitors & Security Arrangement
23. SPECIAL RAILWAY TRACK CONSTRUCTION MACHINERY
24. SHE Forms, Formats & Reports

3.3.3 Method Statement

For each part of works the Contractor submits a method statement to the Engineer in advance, and starts the work after getting the Engineer's approval to it. A typical composition of method statement in this project is shown below. Although the currently available method statements are concise and made in order, the contents look too general for use for each particular works. Furthermore, those lack for visual information which makes it hard for site staffs to understand the contents and sequence of works.

Table 3.3.3 Typical Composition of Method Statement (for bridges)

Method Statement (bridges)
1. Preamble
2. Scope of Works
3. Reference
4. Assumptions
5. Materials
6. Staff Responsibilities
7. Precast Yard / In-situ Work
8. Construction Methodology for Different Types of Structures
9. Quality, Safety, Health & Environment (EHS)
10. Conclusion
11. Inspection and Test Plan

3.3.4 Conformance of Project Documents with the Safety Guidance

As shown in Figures 3.2.3 & 3.2.4 and Tables 3.3.1 – 3.3.3, the contract documents and the corresponding Contractor's plans contain comprehensive information on safety (both "safety of works" and "occupational safety & health") and fulfills the requirements of "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects".

3.4 Site Visit

Information collection/dissemination including site visits was conducted by the following schedule.
Since the Study Team had made a hypothesis based on the preliminary analysis of rebar cage accidents that there may be deficiencies/insufficiencies in the communication (including procedures and paper works), information collection was conducted focusing on verification on such hypothesis.

Table 3.4.1 Information Collection/Dissemination Schedule

M	Day		Location	Interviewee	Purpose of Visit
10	17	Sat	Delhi	SLT Representative	Explanation (study outline, objectives), Interview (general)
				SLT Delhi Office	Explanation (study outline, objectives), Interview (design)
	19	Mon	Delhi	PMC Delhi Office	Explanation (study outline, objectives), Interview (general)
				DFCC HQ Office	Explanation (study outline, objectives),
	21	Wed	Jaipur	DFCC Jaipur Office	Explanation (study outline, objectives), Interview (general)
				PMC Jaipur Office	Explanation (study outline, objectives), Interview (safety)
				SLT Jaipur Office	Explanation (study outline, objectives), Interview (safety)
	23	Fri	Jaipur	Package A (Bhagega)	Site Visit
	24	Sat	Jaipur	SLT Jaipur Office	Interview (design)
	26	Mon	Ajmer	Package C	Site Visit
	27	Tue	Ajmer	DFCC Ajmer Office	Report (study results)
	29	Thu	Jaipur	Seminar	Seminar to site staff of DFCC/PMC/SLC
	30	Fri	Delhi	Seminar	Seminar to DFCC/PMC/SLC management

Note) DFCC: the Employer, PMC: the Engineer, SLC: the Contractor

3.4.1 Project Scale

The total length of CPT-1/2 is as long as 626km which is equivalent to the distance between Tokyo and Okayama in Japan, which is unprecedentedly long as a single ODA loan project. For management purposes, the project is subdivided into four sections (A, B, C & D), the length of which is 140-170km respectively.

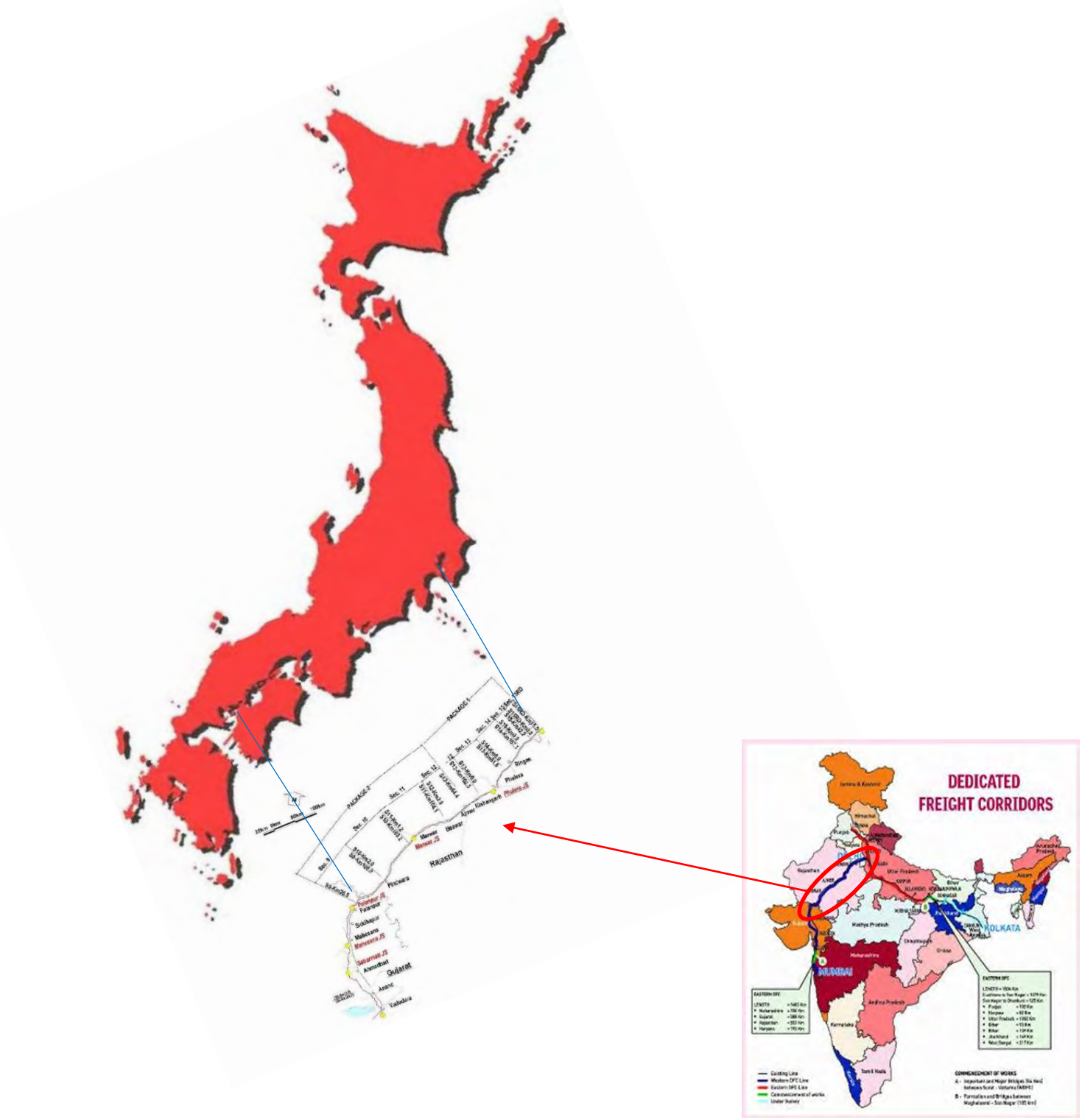
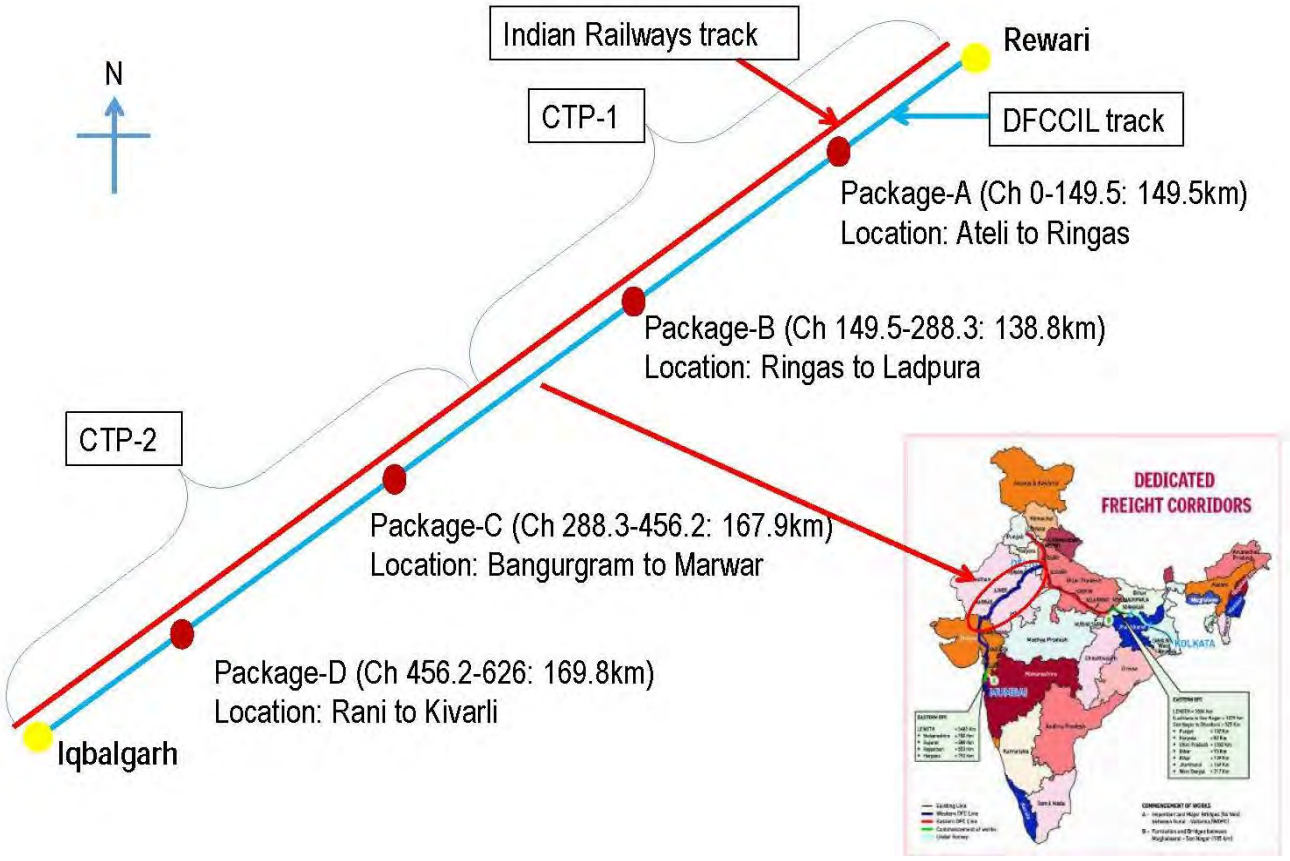
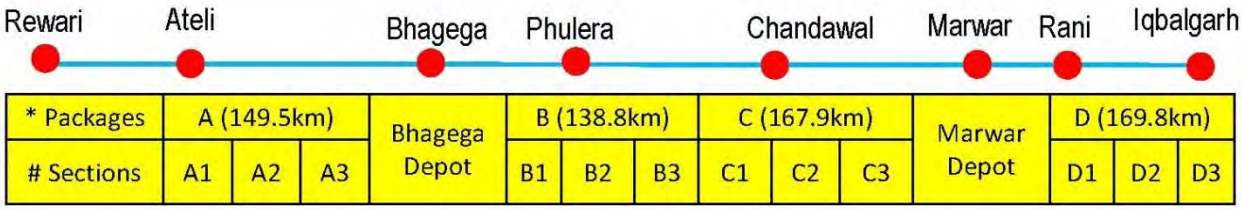


Figure 3.4.1 Scale of the Project (comparizon with the size of Japan)





* Packages	A (149.5km)			Bhagega Depot	B (138.8km)			C (167.9km)			Marwar Depot	D (169.8km)		
# Sections	A1	A2	A3		B1	B2	B3	C1	C2	C3		D1	D2	D3

Type of setup	Total Numbers of location
Pre Cast Yard	8
Batching Plants	17
Quarry	12
Crusher Plants	12
Labour Camps	32
Ambulances	12
Staff Guest Houses	94

Figure 3.4.2 Sectioning of the Project

3.4.2 Construction Schedule

The contract period is 48 months including design, which commenced in August 2013. The project was behind schedule at the time of field study for various reasons as described below:

(1) Design

Late mobilization of the Engineer caused absence of the design review mechanism for the initial 7 months.

The imbalance of the large scale of the project and the short contract period requires a large unit work volume to be implemented. Prior to commencement of construction, the design shall be prepared package by package to go through the approval process as described in Article 3.2.3 (4) a above. The Contractor's design team is struggling to deliver a large volume of approved design to the site in accordance with the required procedure and schedule.

Such approval is granted not only by the Engineer (PMC) but also relevant agencies such as Indian Railways (IR) which is taking time.

(2) Contractor's View

It is taking time for the Design Team to prepare Construction Design Packages (CDP) including not only construction drawings but also method statements, temporary works design, and bar-bending schedules and to obtain the Engineer's approval.

The large-scale/length project is facing difficulties in procurement of resources (machineries, engineers and workers) at each section (A, B, C & D). In particular, too high liquidity of seasonal workers is the biggest concern.

Obstruction like BSNL cable at Viaduct, Land issue, Panther zone, Trees at Section D etc. are affecting the works progress

As work has picked up in majority of work segments, more number of PMC supervision engineers are required to match up the target progress. Work in Section B is getting affected due to above.

Earth work testing on Sunday should be allowed as the progress is going to further increase in coming months.

Depth constraint up to 1.5m for borrow earth excavation in state of Rajasthan.

The project is getting into a crash programme stage to catch up with the target progress.

The construction schedule is shown in Figure 3.4.3.

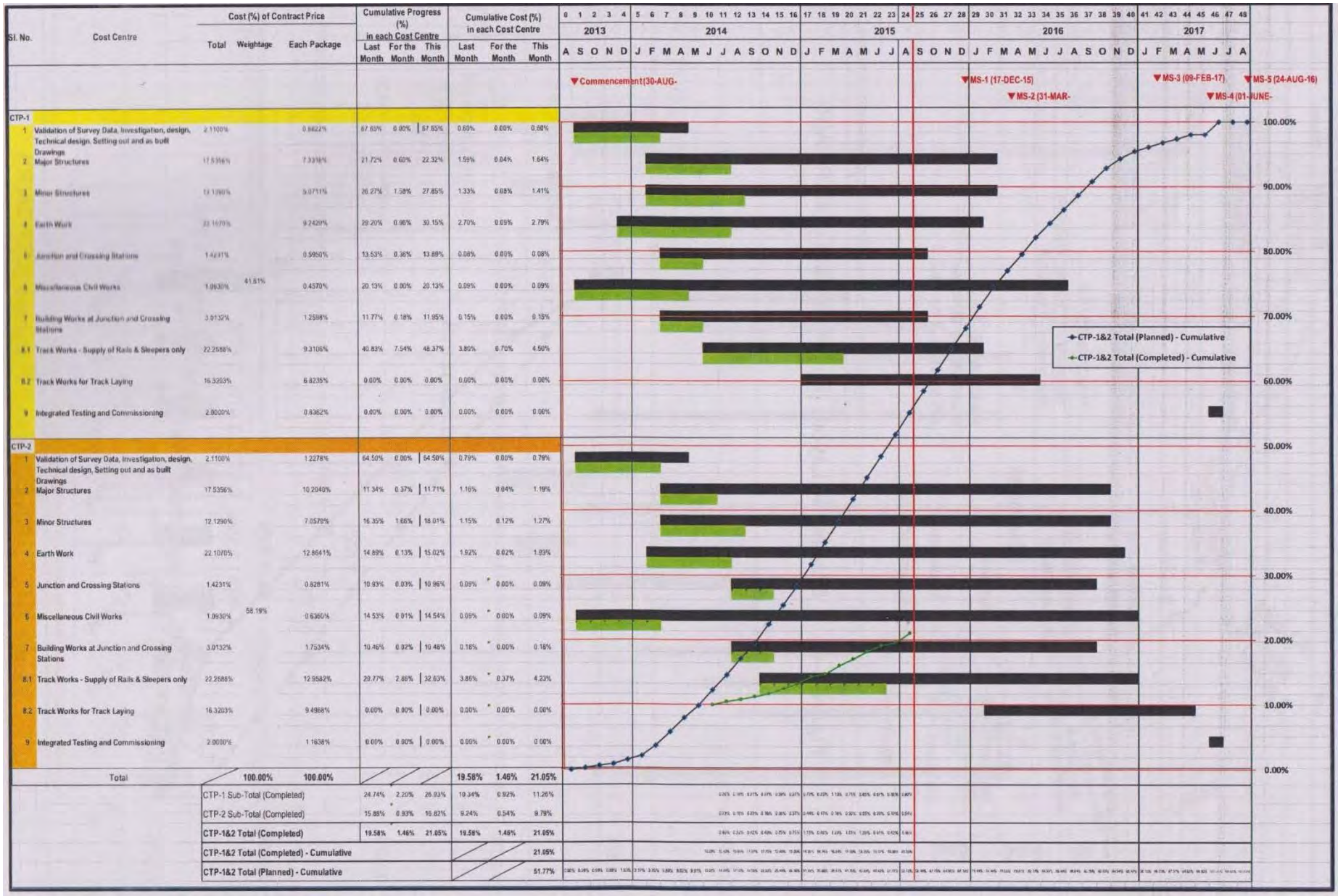


Figure 3.4.3 Construction Schedule (PMC's Monthly Progress Report for August 2015)

3.4.3 Project Organization

To cope with the large project scale, the organization of each stakeholder is also large. For a functionality reason, both the Engineer's and the Contractor's safety management organizations are cross-sectional and constitute matrix organizations with the construction team.

(1) Overall Organization

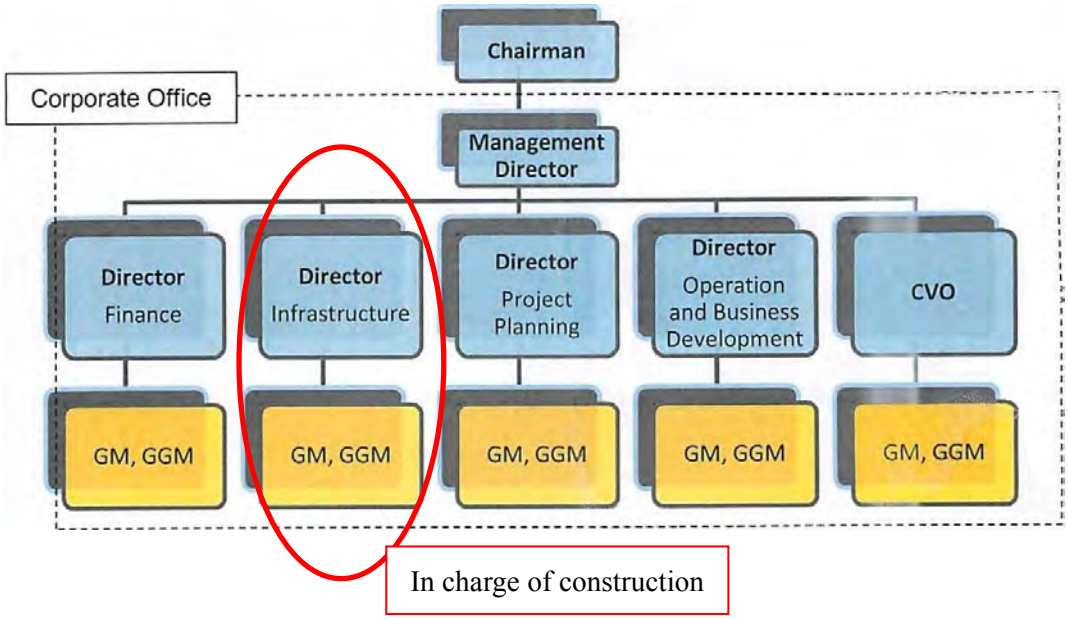


Figure 3.4.4 The Employer's Organization (DFCCIL)

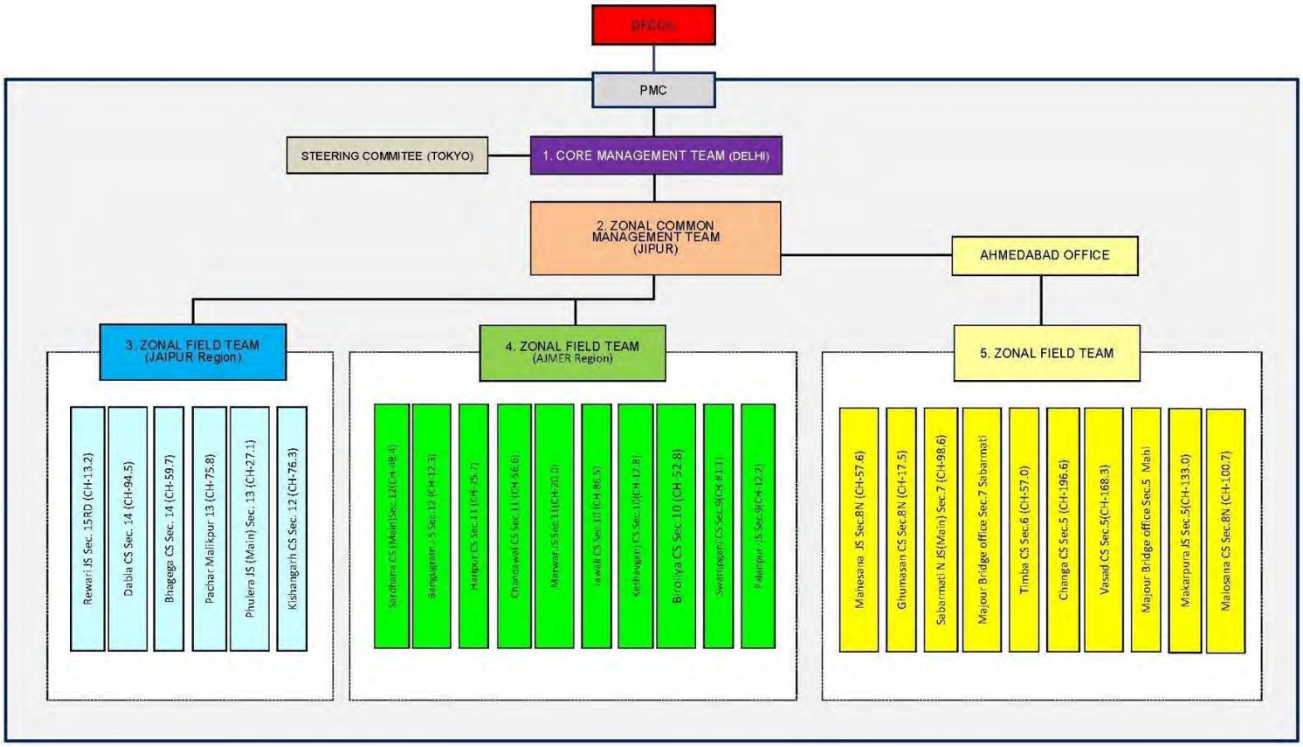


Figure 3.4.5 The Engineer's Organization (PMC) (some 550 staffs)

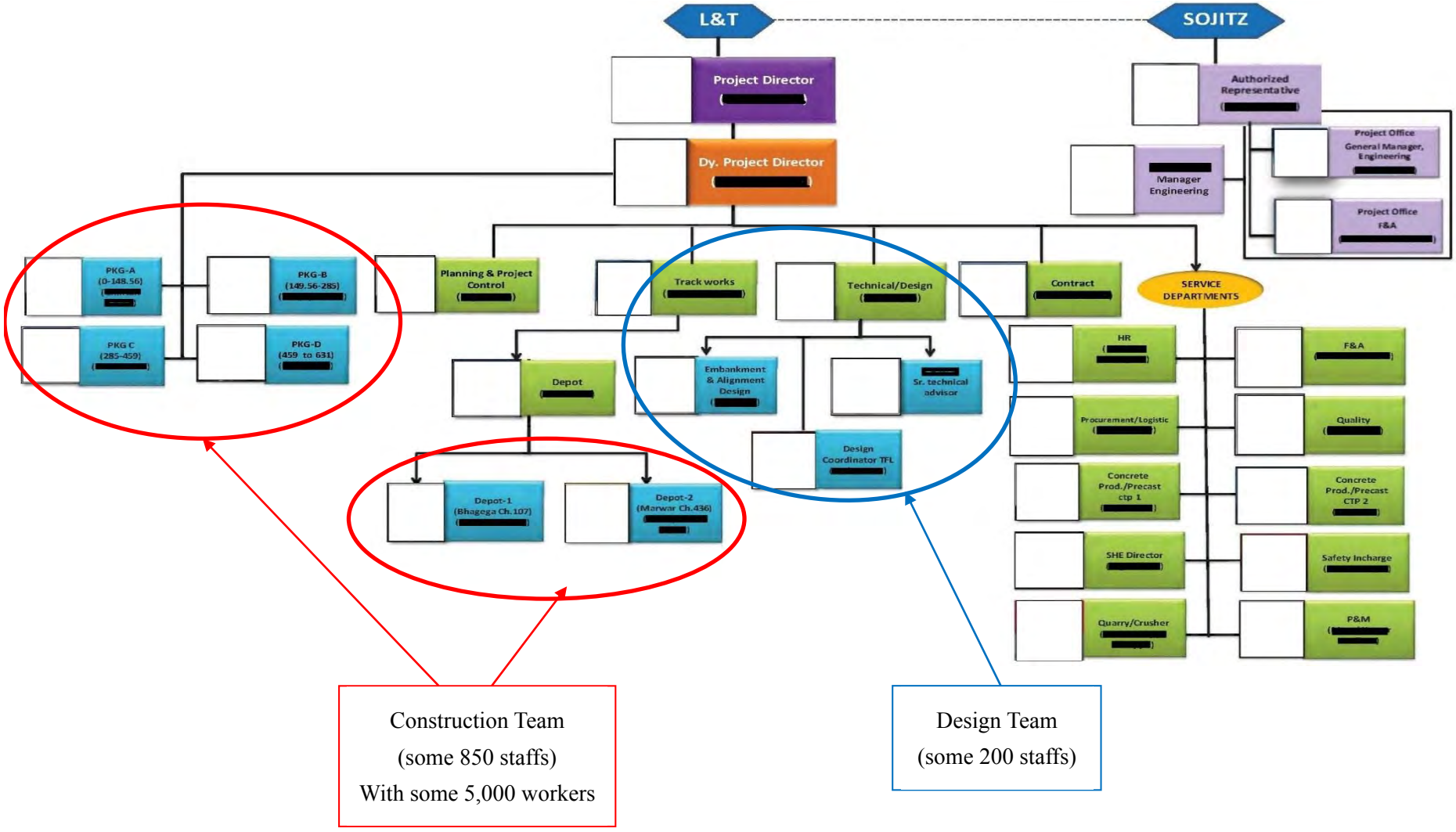


Figure 3.4.6 The Contractor's Organization (SLT)

(2) Safety Management Organization

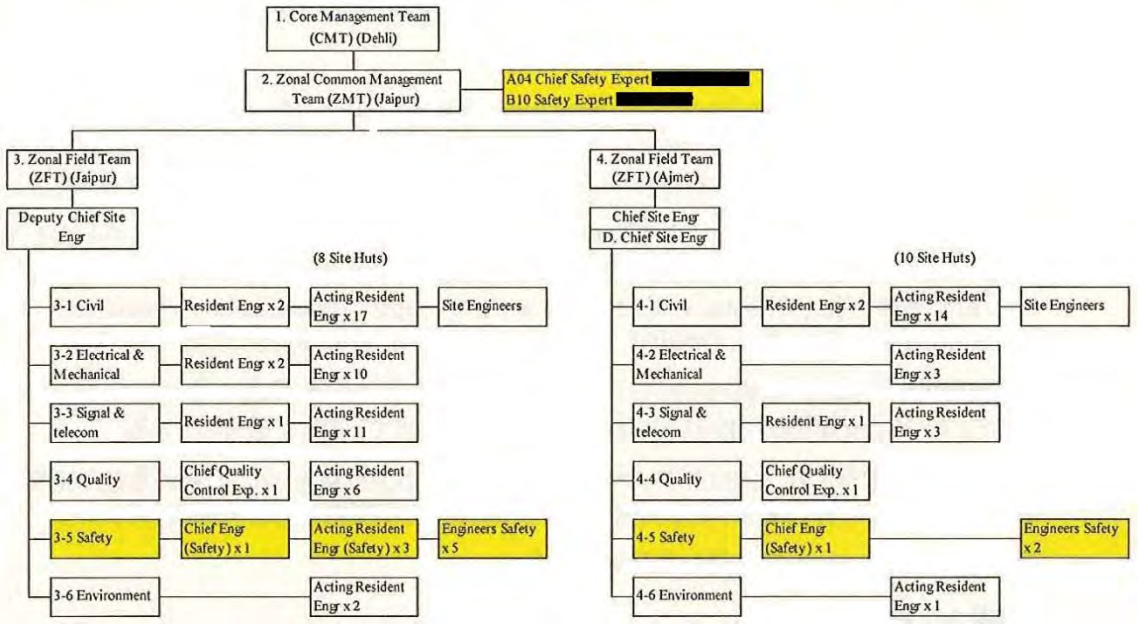


Figure 3.4.7 The Engineer's Safety Management Organization (highlighted in yellow)

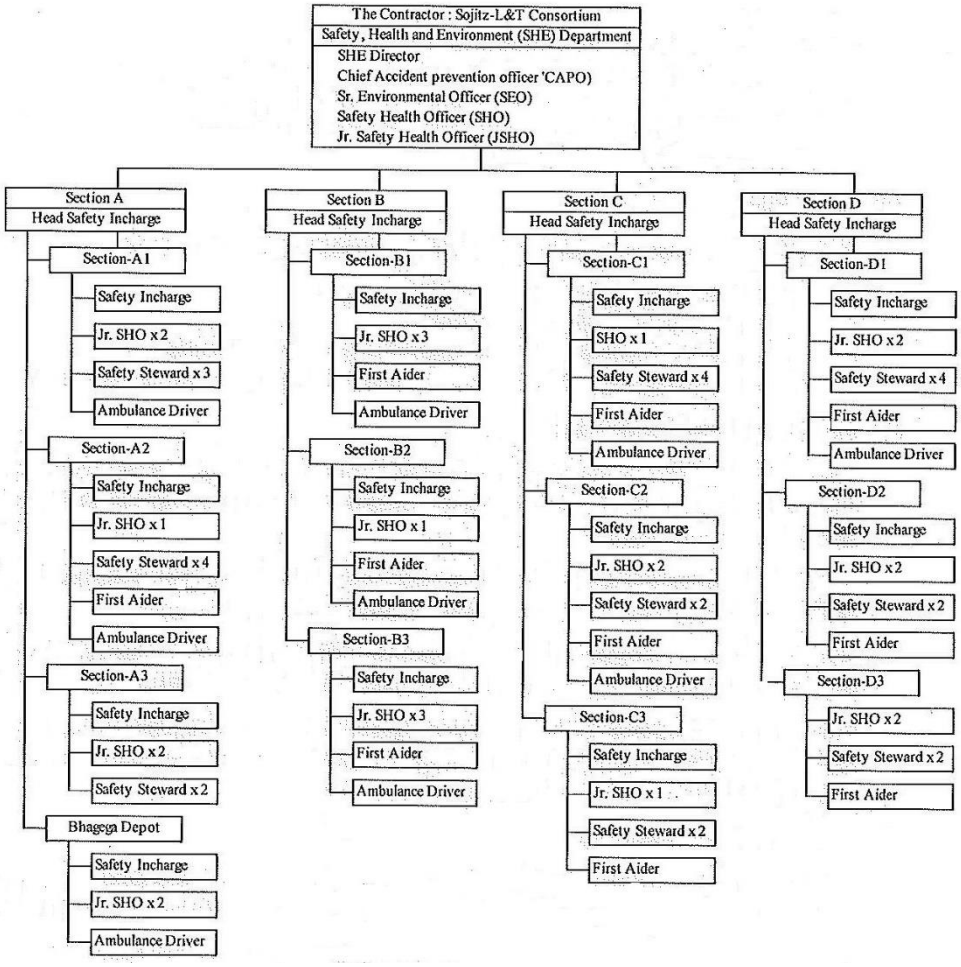


Figure 3.4.8 The Contractor's Safety Management Organization

3.4.4 Safety Management Status

<The Employer>

Table3.4.2 Safety Management conducted by the Employer (DFCCIL) (extract from Questionnaire)

Availability of safety and quality control manuals at the Employer
(1) Names: Contract Agreement for Packages 1 & 2; Contract Agreement PMC WDFC Ph. I; Indian railways Permanent way manual (2) Contents: Frequency of patrolling of sites, etc. indicated in it for officials responsible for Safety; SHE meetings and other safety related meetings for consultation with contractor and engineer provided in contract agreement; The rules and regulations (or manuals) governing safety and quality control included are covered in contract agreement.
Assigned missions of departments in the Employer in charge of safety and quality control, and assigned tasks of the staffs
(1) No. of total staff members at the Employer: 38 persons (2) Name of the safety and quality control department: DFCCIL, Jaipur for their jurisdiction. (3) No. of staff members in the department above: 38 persons <Details of the assigned missions of the department in charge of safety and quality control> (1) Current status of implementation of site patrols: Regular visit by field officials & safety officials. (2) Availability of accident statistics related to all projects under jurisdiction of the Employer: Yes (3) Guidance/instructions for consultants/contractors: SHE and other safety meetings are held regularly as per provisions in the contract agreement/PMC contract agreement, and participated by Employer and interacted with the Engineer and the Employer. (4) Documents on the mandates of the department in charge of safety and quality control: Environment Health & Safety Handbook, Railway Construction Safety Booklet. (5) Others: SHE policy of DFCCIL <Current conditions of implementation of training for staff in charge of safety and quality control> All training modules are organized by the Contractor at regular intervals attended by staff of this office which includes safety induction training to new entrants and employees of sub – contractor, tool box meeting, audio visual safety film presentation, mock drill, fire-fighting and counseling workers on safety precautions while working along IR track. Apart from this, training at Zonal Training Centre, Udaipur for safety is attended by staff at induction level. Various training programs, conferences and seminars on railway safety, OHS at construction sites, accident prevention and quality control conducted by reputed professional institutes and agencies are attended by staff of the employer from time to time. <Information concerning past accidents in construction, etc.> For all accidents, investigation reports have been prepared, details shared with the Employer as well as the Contractor, necessary corrective/ preventive measures implemented, and consultation/ awareness programs organized by the Contractor and the Engineer also participated by the Employer.
Assignment plan for staff in charge of safety control related to the Japanese ODA loan project
● No. of the total staff members in the Employer : 38 Persons (CPM, Jaipur unit) ● No. of construction management staff: Approximately 24 persons (the Engineer) ● No. of staff members in charge of contractors: 61 persons
Capacity and experience of staff in charge of safety and quality control
More than 50% staff at DFCCIL is from Indian Railways having adequate experience in safety/quality control. All of them have handled more than one assignment and have responsibly handled safety/quality control in railway projects. New inductions to the organization are trained through an elaborate course designed to sensitize and work with these aspects given priority at the highest level.
System of ensuring safety and quality control in the Employer
For ensuring safety, apart from safety experts of DFCCIL, regular visit by field engineers is done. SHE and other safety meetings are held regularly as per provisions in the contract agreement and PMC contract agreement. These are participated by the Employer.
Preventive action procedure
The responsibility lies with the Contractor as per contract agreement. However, the Engineer has a specific task to ensure safety along the IR track, for OHS as well as for general public also.
Framework for emergency response system to accidents
The Contractor has prepared a manual for responding to any emergencies in an accident. Emergency contact numbers have been displayed at all site huts and major construction sites as well. Ambulances have been provided at all major site offices by the Contractor for immediate relief and medical support. A control room has been set up in Ajmer by contractor which functions round the clock and in case of any accident it functions as the nerve centre for all relevant information. All these are as per contractual provisions listed above and contractor's SHE Plan approved by the Engineer. In monthly SHE meetings, SHE Director of contractor briefs about all incidents & accidents in the previous month and also shares the completed enquiry reports. These meetings are attended by the Employer, the Engineer and the Contractor.
Method adopted by the Employer to confirm training programs in safety and quality control provided by contractors for workers
More than 50% of staff in DFCCIL is on deputation from Indian Railway and therefore have adequate knowledge and experience of safety and quality control procedures and rules. For new entrants joining DFCCIL, they are given induction and orientation training on safety. Thereafter they are sent to Indian Railways training school in Udaipur where they are given detailed training in all aspects. Accidents reports are shared with all employees of DFCCIL and meetings held thereafter to discuss the shortcomings and prevention of the same.

<The Engineer>

a. Zonal Common Management Team (ZMT)

ZMT safety staff are implementing the following activities:

- Draw up the Engineer's safety management policy/method
- Discuss with/direct the Contractor's safety officer in charge (SHE Director)
- Attend joint safety patrols and safety meetings
- Inspect safety management conditions on site and direct improvements in weekly safety meetings
- In case of accident, report, investigate the causes and discuss the accident recurrence preventive measures with the Contractor
- Conduct safety induction training to newly assigned engineers

b. Zonal Field Team (ZFT)

ZFT safety staff and site engineers are implementing the following activities:

- Inspect the Contractor's safety management/measures on site
- Attend weekly safety patrols/safety meetings
- Point out unsafe conditions/activities, suggest improvements to the Contractor to discuss
- In case of accident, report, investigate the causes and discuss the accident recurrence preventive measures with the Contractor

c. Safety Management Policy/Activities

There are 14 staffs in PMC's Safety Management Section, including 9 staffs for safety of civil works who are implementing safety management of 922km-long project consisting of CTP-1:297km, CTP-2:342km and CTP-3:283km). Consequently, their tasks are limited to occasional inspection of site management conditions, report observations/suggest improvement in weekly safety meetings and instruct improvements to the Contract in writing. PMC's safety manager is collaborating with the Contractor's SHE Director to encourage the Contractor to proactively prepare safety management plans and implement safety activities. Their collaboration is producing excellent results to set up the Contractor's safety management system, such as a working staff participatory/bottom-up safety activities.

<The Contractor>

a. Safety, Health and Environment (SHE) Team's Safety Management Activities

The core team of SHE consists of 4 staffs including SHE Director is implementing the following activities:

- Draw up various plans in accordance with the contract
  - Daily reporting of total nos. of workmen / Monthly SHE reports
  - SHE Committee meeting minutes / SHE inspection reports / SHE audit reports
  - Monthly audit raring score (MARS) reports
  - External SHE audit / Electrical safety audit
  - Environmental & Social monitoring reports
  - Accident reporting and investigation / Emergency response plan
  - Experts/Agencies for SHE services
- Draw up the Contractor's Safety Management Policy/Method
- Prepare Safety Plan, Traffic Management Plan, Safety Plan in Method Statement, etc.

- Prepare and distribute Environment, Health & Safety Handbook (in English and Hindu)
- Prepare and distribute Safe Driving Handbook (in Hindu)
- Safety Enhancement Month, Road Traffic Safety Week, Railway Safety Week, High-place Work Safety Week
- Safety Straining
- Other Safety Management Activities

b. Safety Management Activities at Site Offices

At each site office, Project Manager, Safety Officer, Site Engineers, etc. are conducting the following safety management activities daily:

- Implement various safety management/measures in accordance with the contract
- Conduct induction training, training of drivers/operators
- Conduct Tool Box Meetings at morning assembly
- Attend monthly/weekly safety patrols and safety meetings
- Rescue/Survival Training, Safe High-place work/Electrical Works Training, etc.
- Other safety management activities

c. Safety Management Status

Though initially the safety activities were implemented by the core SHE team on a top-down basis, presently the system has changed to a participatory/bottom-up method encouraging each staff proactively to work. The SHE team's safety awareness is observed high.

<The Study Team's Observations>

At the 2 sites where the Study Team visited, it was observed that a systematic safety management was being implemented in a well-disciplined manner, including house-keeping, classification of hazardous areas, installation of safety-related notice boards, induction training, PPEs, documentation & filing, etc.

The Study Team sees that, despite various handicaps listed below, the safety management system has been well established and the Contractor's staff's awareness on safety is maintained high:

- Large project scale and long logistic routes;
- The contractor faced with limited suppliers with safety standards well below its own has little or no choice to engage that supplier and change their safety culture to meet the requirements of the contractor and the project. Often this means policing the subcontractor so that they meet legal safety requirements which are a cultural change that would ordinarily take time to implement;
- High turnover of labour and suppliers means that the contractor safety organization is constantly training and advising on the most basic safety requirements making it challenging to move beyond a higher level of safety compliance; and
- Human behavior and attitudes is challenging with a diverse educational and cultural workforce from all parts of India where safety requirements are often limited.

A copy of handout in the presentation on safety management on site made during the field study is appended hereinafter.

3.4.5 Observations on Site

The Study Team visited a site of Section A on 23 October 2015 and Section C on 26 October 2015. Site photos are attached hereinafter.
The points which drew the Study Team's attention are summarized below:

(1) Work Progress and Accidents

Six accidents had occurred at the time of the Study Team's field study at the end of October 2015. The timing of those accidents are plotted on the construction programme. (see Figure 3.4.9).
It is observed that the frequency of accidents increased as the site operation was getting into stride in July 2015. Such phenomenon could be attributable to generation/enlargement of gaps between various factors, such as the management and the site, engineers and workers, engineering and safety, etc.

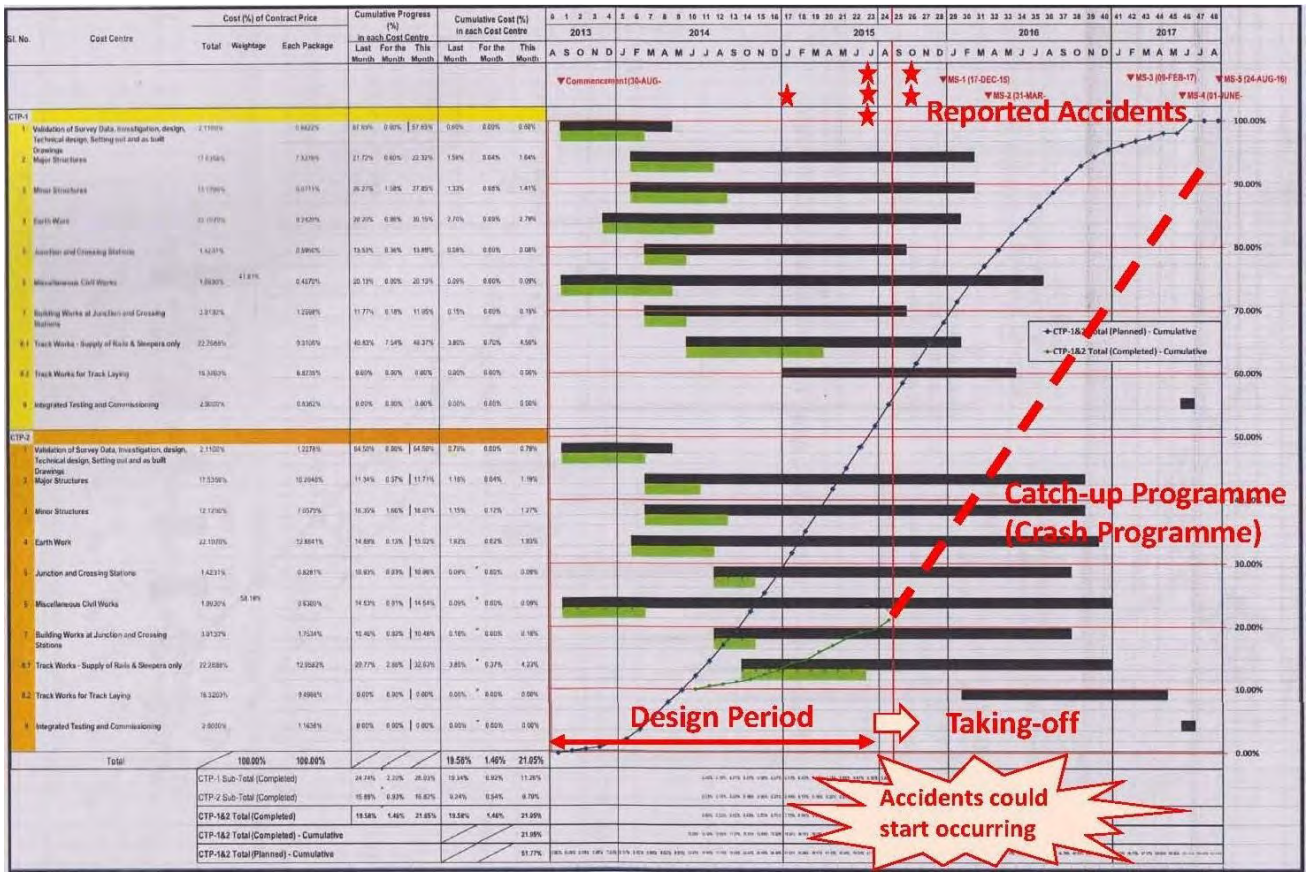


Figure 3.4.9 Work Progress and Accidents

(2) Communication in the Contractor's Organization

Interviews with site staffs and review of documents available on site revealed that communication gaps exist between various teams, which is attributable to the large scale of the project.

- between Design Team/Construction Team/Safety Team (for identification of construction risks)
- between Design Team/Construction Team (on design)
- between Design Team/Construction Team (on construction method and temporary works)
- between Management/Construction Team (on decision-making on design, procurement, etc.)

The Study Team inferred that the above situation is a root cause of 3 rebar cage accidents occurred in July 2015. Since taking prevent measures against recurrence of similar accidents was urgently required, utilizing the opportunity in the seminars on site, the Study Team reported its observations to stakeholders to strongly recommend improvements prior to conducting detailed root cause analysis of the accidents to be done in Japan afterward.

(3) Works adjacent to the Existing railway

As a part of the above observations/recommendations, the Study Team also drew everyone's attention to the issues related to risks related to works adjacent to the existing railway as follows:

Figure 3.4.10 Works adjacent to the Existing Railway (Section A) (1)

Figure 3.4.11 Works adjacent to the Existing Railway (Section A) (2)

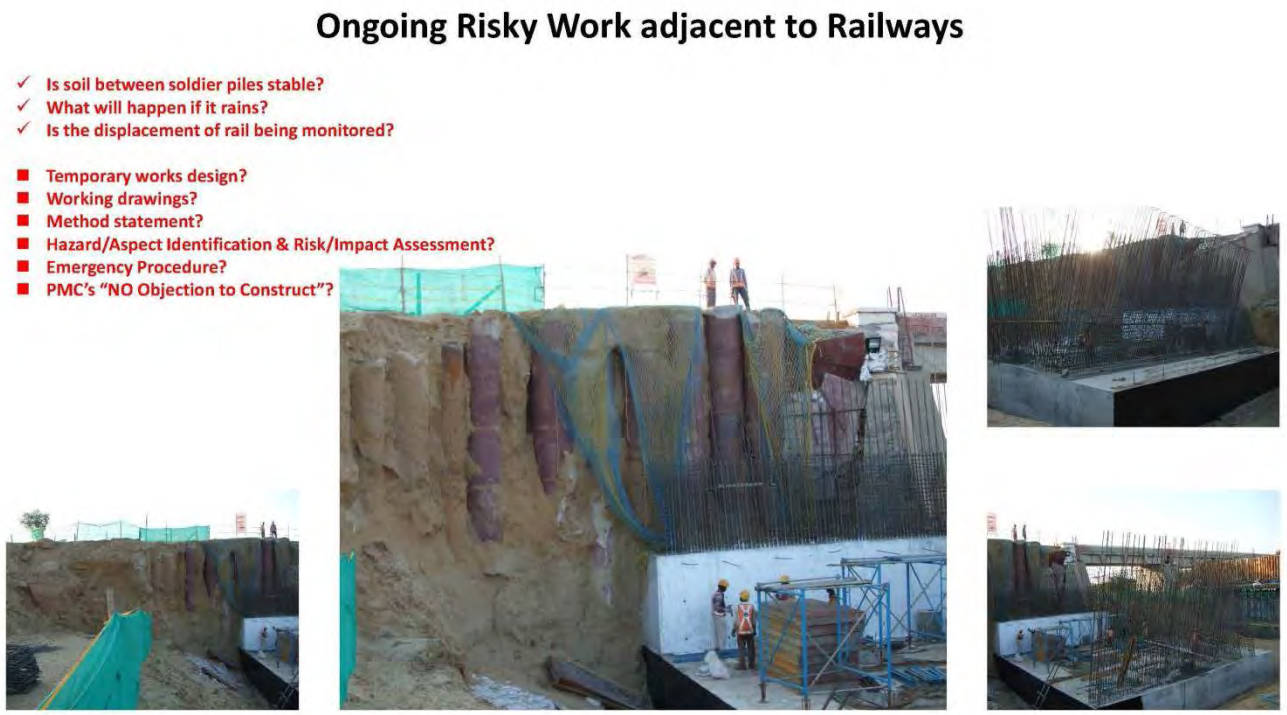


Figure 3.4.12 Works adjacent to the Existing Railway (Section A) (3)

Chapter 4 Analysis of Accidents

4.1 Outline of Accidents

In DFC Project, six accidents have been reported to JICA as shown in the Table 4.1.1 in the period of two years and two months (August 20132 to October 2015: when this investigation was conducted).

Table 4.1.1 List of Accidents to Study

No.	Date/Time	Outline of Accident	Dead	Injured	Third Party
1	2015/01/24 17:30	A truck which was running on the railway embankment with approximately one meter height being used as a project service road in the construction site slipped down and turned over. The driver seemed to have tried to jump off from the truck window but caught between the truck and ground. He was immediately taken to the hospital but confirmed dead.	1	―	―
2	2015/07/17 18:50 頃	The raft concrete of abutment A2 for Bridge No.379 was ready and concreting was about to start, meanwhile heavy wind started blowing. As a result, 9m height and 32mm dia. Vertical steel swung and lead the support pipes and Ct Props to bend and all vertical steel topple down. As the heavy wind blew, workmen who were engaged in vertical erection were moved apart and hence no one was injured.	―	―	―
3	2015/07/20 18:00	Workmen were fixing reinforcement steel for Bridge No.1 box culvert wall. Suddenly, the support given to vertical reinforcement bars got bent which induced in collapse of all vertical reinforcement bars on one side. A few workmen could not move away quickly, and five workers injured and rushed to the hospital.	―	5	―
4	2015/07/27 09:53	Five workers were engaged in fixing reinforcement steel re-bar previously assembled for concrete work on Pier No.52 Viaduct. At about 09:53 without warning, the vertical steel re-bae started to tilt to one side along the length of pier slowly. Three workmen were able to escape without injury. One workman got scraped by the falling bars suffering minor injury. Another worker got caught below falling re-bar and received serious injury to his right shoulder.	―	2	―

5	2015/10/15 12:30	A worker was taking a rest in front of the stationary compaction roller. The compaction roller operator was unaware that the man was sleeping in front of the roller when he was given instruction to move his machine to a new location. The roller operator climbed into the cab without checking around the machine and began to drive forward. The man resting was struck by the compaction roller and expired immediately.	1	—	—
6	2015/10/23 15:30	A worker was cutting in half a used bitumen paint drum using a gas cylinder cutting tool. The used drum was sealed at both ends when he began cutting. The heat from the cutting torch combined with flammable material residue that was confined within the drum released, cutting open the drum. The impact of the explosion caused burns to him. He was later taken to SMS Jaipur where he expired.	1	—	—

Those six accidents can be classified in two categories as shown below. Through the accident analysis, it should be noted that each peculiarity affects the aspect of causes and countermeasures.

Category 1 – Safety of Works: Accident No. 2, 3 & 4

Re-bar structures under erection collapsed in three cases successively in less than two weeks. These accidents are presumed to involve technical matters.

Category 2 - Occupational Safety and Health: Accident No. 1, 5 & 6

Three resulted in fatal accidents, and presumed due to human errors. Two out of three occurred while the study team was visiting the project site.

4.2 Procedure of Analysis of Accidents

(1) Course of Analysis

In the Project, three re-bar collapsing accident and three (3) fatal accidents have occurred as shown in Table 4.1.1. Analysis of accident and planning/applying of countermeasures have been made in the project.

Needless to say, when accidents occur, the management makes great effort to secure safety in the project and takes various measures to prevent accidents. However, it cannot be said that the situation is satisfactorily improved because accidents/near miss incidents are still happening even now. This situation would be happening because pursuit of root causes may have been insufficient, or the causes may have been left without proper countermeasures being taken or the countermeasures may not be efficient.

In this study we applied the Root Cause Analysis which is often used in Nuclear Power Plants, IT companies and some medical organizations for solving problems. The purpose of application of the method is to pursue management and organizational factors and to study countermeasures not reacting to mere phenomenon and results but solving the real problems existing behind the superficial phenomenon.

(2) Root Cause Analysis

1) Necessity of the Root Cause Analysis

The concepts and methods of the root cause analysis are rather new, and there are some definitions regarding “Root Cause Analysis” as shown in the table below.

Table 4.2.1 Examples of definition of Root Cause Analysis

Source	Definition of Root Cause Analysis
A Guide to the Project Management Body of Knowledge（PMBOK）Fifth edition, Chapter 11 Risk Management	A technique which specifies the problems, investigates subsisting causes which lead to the problem and makes preventive measures.
Guideline for the regulatory body to appraise the result of the root cause analysis conducted by business operators Revised 2010/09/03 Revision 1, Nuclear and Industrial Safety Agency, Japan Nuclear Energy Safety Organization	Based on the direct cause analysis, analyze organizational factors and take measures to improve the management system. (Note) The definition was made as state considering many accidents and troubles are happening due to inadequate action by the organization although the reason has already been technically clear.

The root cause analysis was originally developed for the purpose of preventing recurrence of accidents in nuclear power plants. However, there have been very few examples of application of the root cause analysis to accident analysis in the construction industry. There are similarities between construction sites and nuclear power plants as a working place where a lot of people work together as follows;

・They are the fields where both the soft engineering and hard engineering assimilate together.

・They are the fields where human interfaces with machine.

・They are the fields where a Quality Management System (QMS) approved in advance is applied to manage the process.
・They are the fields where the possibilities that organizational factors would lead to the accidents is high.

In the construction industry in Japan, the number of accidents and also the number of victims have been greatly decreased through last three decades owing to improvement of safety awareness and various safety facilities/equipment and so on. However, the decreasing tendency seems to reach the ceiling recently. The phenomenon seems to imply that the traditional methods of analysis and countermeasures would come to its limit for further improvement.
In this sense, it is necessary to direct spotlight on not only to the direct/indirect causes but also to the management and organizational factors behind the accidents.

2) Process of Analysis
The process of the Root Cause Analysis applied in the study is outlined as follows;
a) Determination of accidents for analysis
b) Gathering information (domestically)
c) Understanding of the facts and problematic phenomenon
d) Conducting pre-analysis prior to the site investigation
e) The site investigation and information gathering (locally)
f) Conducting analysis of accidents
g) Extraction and evaluation of management/organizational factors
h) Study for countermeasures and recommendation on safety

3) Selection of Technique for Root Cause Analysis
There are several techniques that can be used as the Root Cause Analysis, such as “Why-why Analysis (5-Why Analysis)”, “Cause Effect Diagram” and “4M5E Matrix Analysis”. Those except for Why-why Analysis have defect that factors tend to diffuse and it becomes difficult to specify the true cause logically.
Why-why Analysis is judged as the most suitable method for the study by the easiness to understand for the people who might be unfamiliar with such an analytic area and its superiority in logical thinking by the relation of the cause and the result.

4) What is Why-why Analysis?
This is a technique of analysis to find out the true causes based on the facts by logically repeating not by inspiration or by the fifth sense. It is necessary to list all factors systematically which lead to the phenomenon.
This technique was originally started form the improvement activities in Toyota Motor Corp. It is a way of thinking to pursue the true cause of the phenomenon or flaws by repeating “Why?” (Figure 4.2.1, 4.2.2)

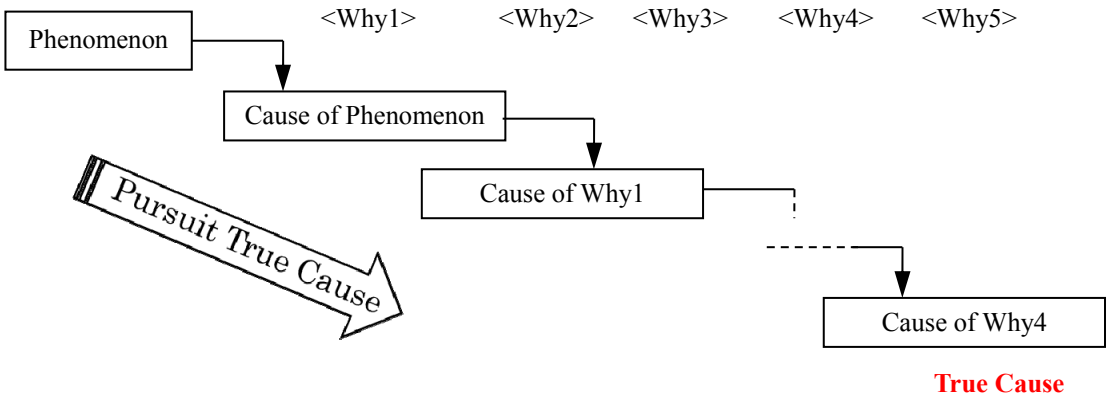
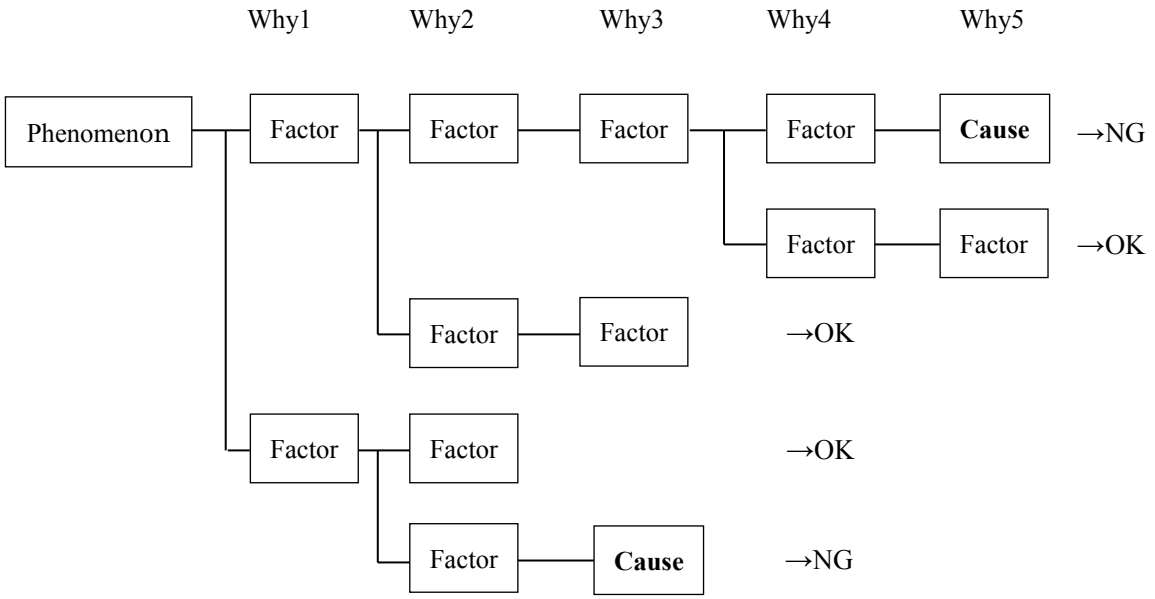


Figure 4.2.1 Technique of Why-why Analysis



OK : Normal Situation (Countermeasure is not necessary)

NG : Abnormal Situation (Countermeasure is necessary)

Figure 4.2.2 Image of Why-why Analysis

5) Combining Value Engineering (VE) with the Root Cause Analysis

If the management/organizational factors are specified, it is expected that the safety of the project will be improved by rectifying the factors. However, the countermeasures derived in general, tend to be too much direct to the phenomenon, in other words, the measures are taken by only just like flipping over the phenomenon, and would result in the situation that the real cause is left as it is.

Here, we decided to apply the theory and technique of Value Engineering in this study in order to clarify the process of occurrence of an accident by the management/organizational factors, and to devise effective countermeasures from the point of view of what is necessary to achieve functions (purposes) to prevent recurrence of the accident.

VE is a theory and technique to improve the value of the object (goods and services). Everything that has some purpose and consumes any resource such as cost has “value”.
VE, first of all, understands the essence of the object an aggregate of necessary functions. And then, based on the understanding of the functions, any and all possible ideas to achieve the function are explored and searched to materializes new measures to achieve the purpose, and finally to improve the value of the object.

Generally speaking, improvement will be achieved in the safety management activities, by clarifying causes of the accident and by eliminating the causes. This is called the Analytical Approach.
In Value Engineering, the Designing Approach is applied, in which the ideal feature of the object (to-be). And using creativity ideas and measures are derived to achieve the ideal feature of the object.
The difference between two approaches is shown below.

a) Analytical Approach (IE: Industrial Engineering, QC: Quality Control and Safety Management, too)

	<Bad result>	→	<The cause?>	⇒	<To eliminate the cause?>
Ex)	Falling.		The handrail was defective.		Reinforce the handrail, etc.

b) Designing Approach (Mainstreams of Improvement Techniques; VE is its representative methods)

	<Bad Result>	→	<What is “to-be”?>	⇒	<To achieve the purpose?>
Ex1)	Falling.		A work without danger.		Work method with no work at height
Ex2)	Falling.		No possibility of falling.	⇒	Totally new facility to prevent falling

(3) Root Cause Analysis and Countermeasure Study Flow

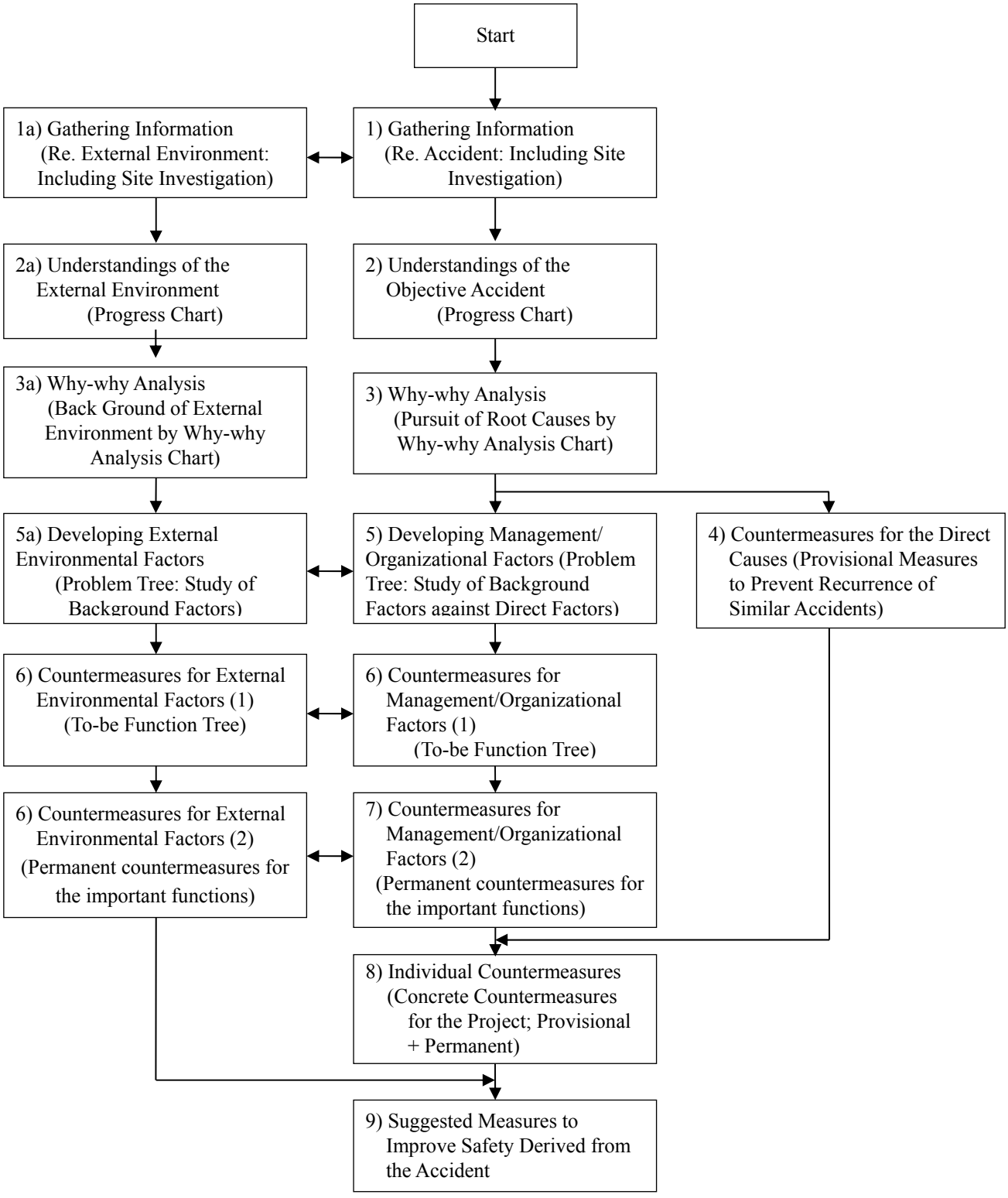


Figure 4.2.3 Flow of Accident Analysis and Study of Countermeasures

4.3 Root Cause Analysis - Individual Accident Analysis

As stated in 4.1, the analysis handles six accidents occurred in DFC project in two categories; (1) Safety of Works and (2) Occupational Safety and Health.

(1) Accidents Related to Safety of Works

No.	Date	Accident	Victim
2	2015/07/17	Re-bar cage accident 1 (Re-bar for raft concrete of abutment collapsed)	Nil
3	2015/07/20	Re-bar cage accident 2 (Re-bar for box culvert wall collapsed)	5-injured
4	2015/07/27	Re-bar cage accident 3 (Re-bar for pier collapsed)	2-injured

(2) Accidents Related to Occupational Safety and Health

No.	Date	Accident	Victim
1	2015/01/24	A truck slipped down the slope and turned over. The driver was crushed by the truck.	1-dead
5	2015/10/15	A worker who was taking a rest in front of a compaction roller was struck and died.	1-dead
6	2015/10/23	A worker who was cutting a drum using cutting torch was killed when the drum exploded.	1-dead

The purpose of Root Cause Analysis can be described in three points as follows;

(1) To clarify management/organizational factors existing behind the accidents together with the direct causes by analyzing accidents from various point of view.

(2) To propose recommendations on safety and to prompt all parties concerned in the project to make effort to prevent occupational accidents by feeding back the result of the study.

(3) To contribute for preventing accident in Japanese ODA construction projects by recommending measures to solve common safety problems in other similar projects.

4.3.1 Accidents Related to Safety of Works

4.3.1.1 Root Cause Analysis of Re-bar Collapse Accident Occurred on 2015/07/17

1) The Accident

[Outline of the Accident] (Following information is based on the accident report submitted to the consultant, NK Consortium (NKC) by the contractor, Sojitz L&T Consortium (SLT) and/or the report submitted to JICA by the consultant.)

The raft concrete of abutment for Bridge No.379 in Package C was ready and concreting was about to start, meanwhile the heavy wind started to blowing; a result 9m height and 32mm dia. Vertical steel swung and lead the support pipes and Ct Props to bend and all vertical steel toppled down. As the heavy wind flow, workmen who were engaged in vertical steel erection work were moved apart and hence no one was injured.

Figure 4.3.1 Vertical Steel for Abutment Wall Collapsed by Strong Wind

2) Causes and Countermeasures of Accident

[Direct Cause]

(1) Inadequate support lead the structure to bend and tumble down due to blowing wind.

(2) Insufficient tying of all nodes of horizontal and vertical re-bars with wires during assembling of bars.

(3) Insufficient provision of temporary horizontal and cross bracing re-bars for assembly of vertical re-bars.

[Countermeasures]

(1) Method statement and drawings for supporting re-bar cage shall be taken approval from Engineer and the same will be implemented at the site.

(2) Frequent checking of the condition of support by site working crew for stability point of view.

(3) Training of site crew for reinforcement of re-bars how to tie and safety.

(4) Daily pep talks to educate all working crew.

(5) Tying of all nodes of horizontal and vertical re-bars with wires.

(6) Provision of temporary horizontal and cross bracing re-bars for assembly of vertical bars.

(7) Training of foremen and re-bar fitters in workshop how to assemble rigidly vertical re-bars using re-bars of 32mm in diameter to prevent fall down of vertical re-bars.

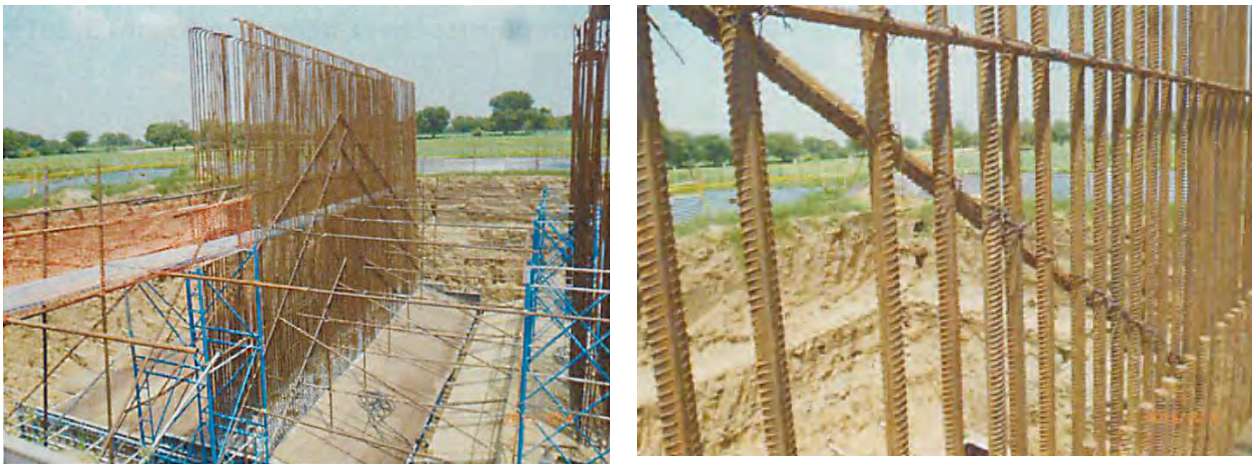


Figure 4.3.2 Situation after Countermeasures Were Applied

3) Root Cause Analysis and Study for Countermeasures

a) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the accident.

b) Why-why Analysis

Pursuit of Root Causes by the Why-why Analysis Diagram

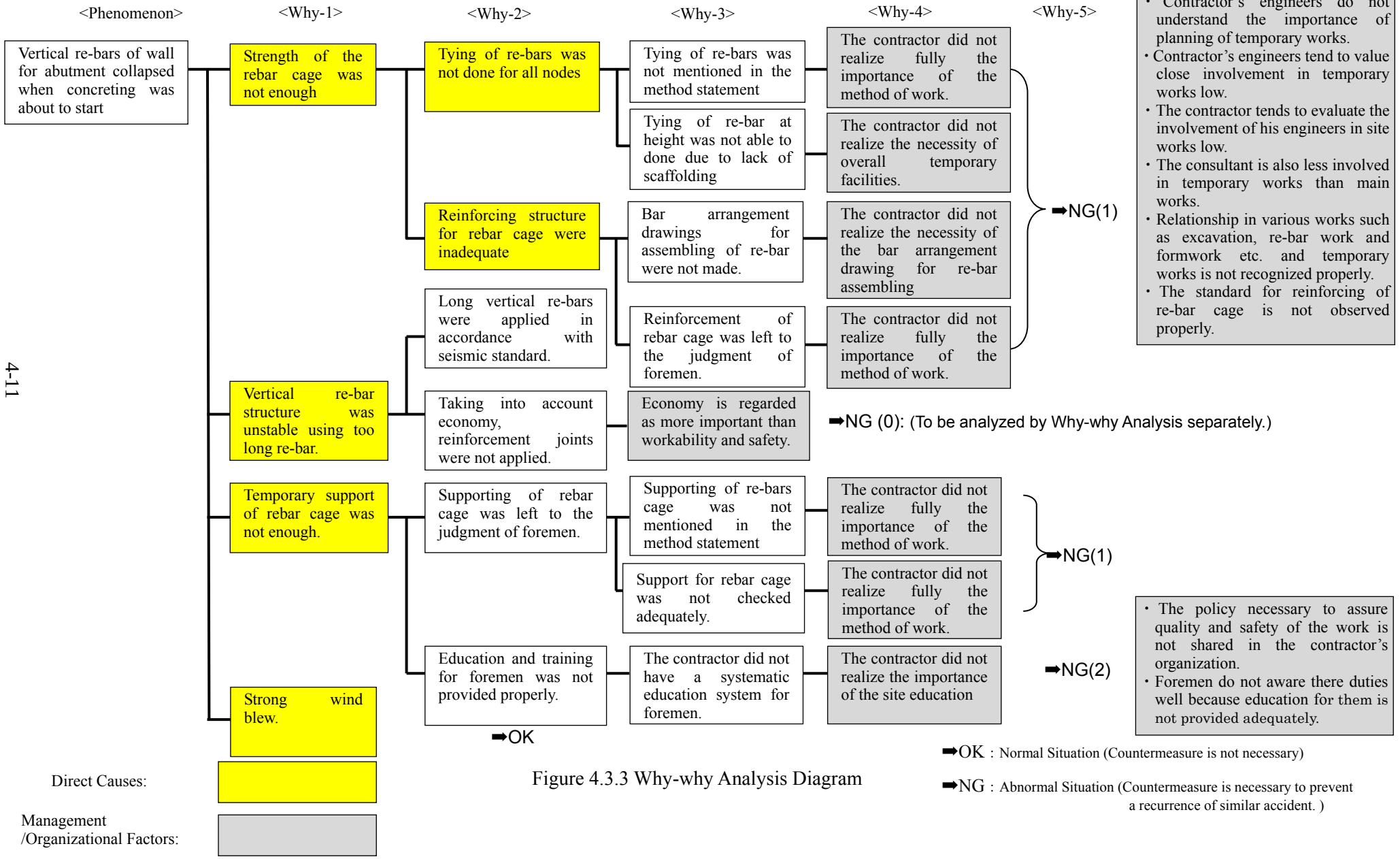


Figure 4.3.3 Why-why Analysis Diagram

c) Countermeasures against Direct Cause

Table. 4.3.1 Provisional Countermeasures to Prevent Recurrences of Similar Accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. Strength of the rebar cage was not enough.	Method statement and drawings for supporting re-bar cage shall be taken approval from Engineer and the same will be implemented at the site.	Place horizontal re-bar as early stage as possible and tie all nodes of horizontal and vertical re-bars with wires firmly.	Provision of temporary horizontal and cross bracing re-bars for assembly of vertical bars.
2. Design of re-bar arrangement was inadequate using too long re-bar.	For re-bar arrangement design, safety and workability must be taken into consideration, applying relatively short re-bars with splicing or couplers.	-	-
3. Temporary support of rebar cage was not enough	Method statement and drawings for supporting re-bar cage shall be taken approval from Engineer and the same will be implemented at the site.	Frequent checking of the condition of support by site working crew for stability point of view.	-
	Training of site crew for reinforcement of re-bars how to tie and safety.	Training of foremen and re-bar fitters in workshop how to assemble rigidly vertical re-bars using re-bars of 32mm in diameter to prevent fall down of vertical re-bars.	Daily pep talks to educate all working crew.
4. Strong wind blew.	No countermeasure is required.	-	-

(Source: Accident Report)

d) Developing Management/ Organizational Factors

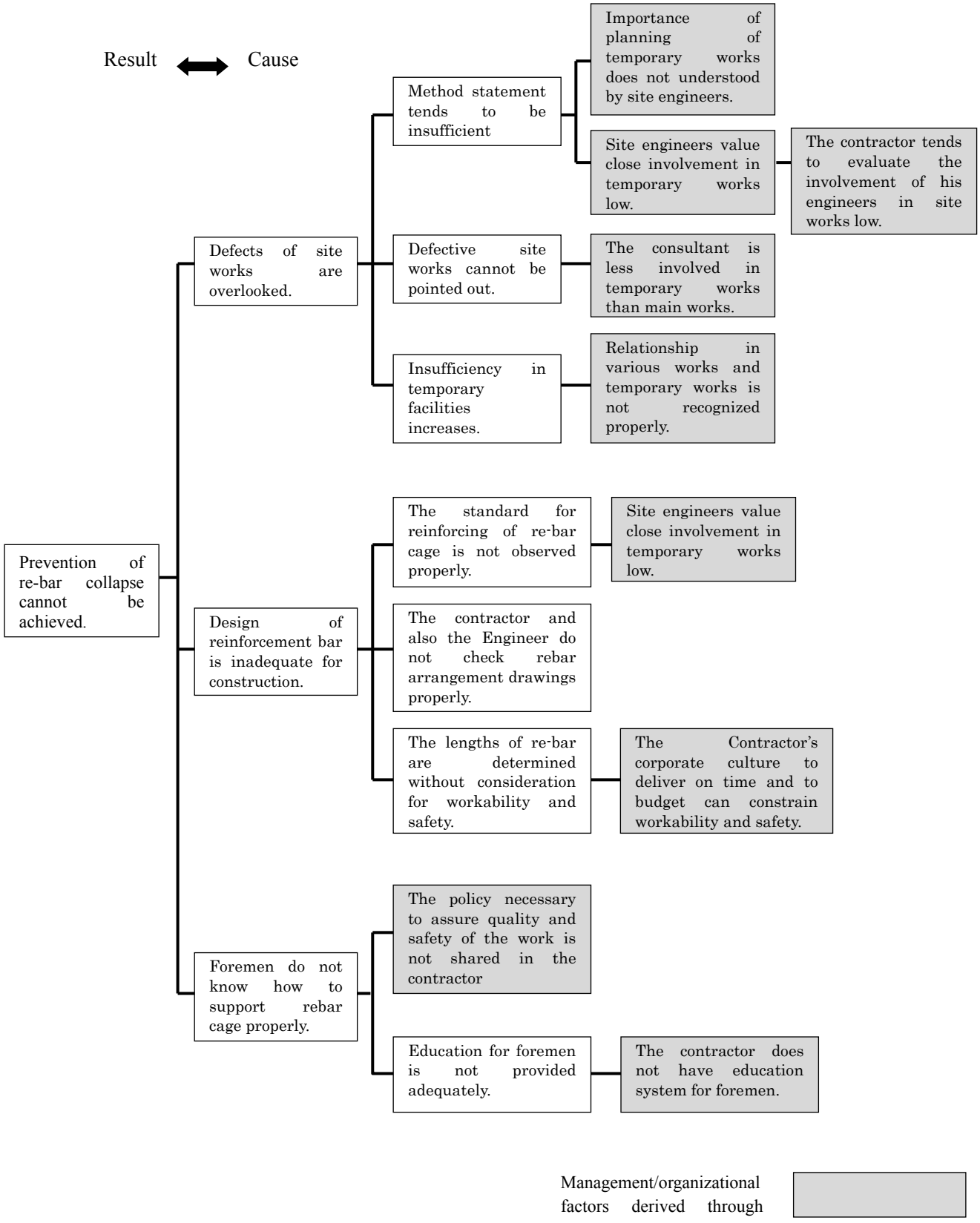


Figure 4.3.4 Problem Tree Leading to the Accident
(Management/Organizational Factors)

e) Countermeasures for Management/Organizational Factors (1)

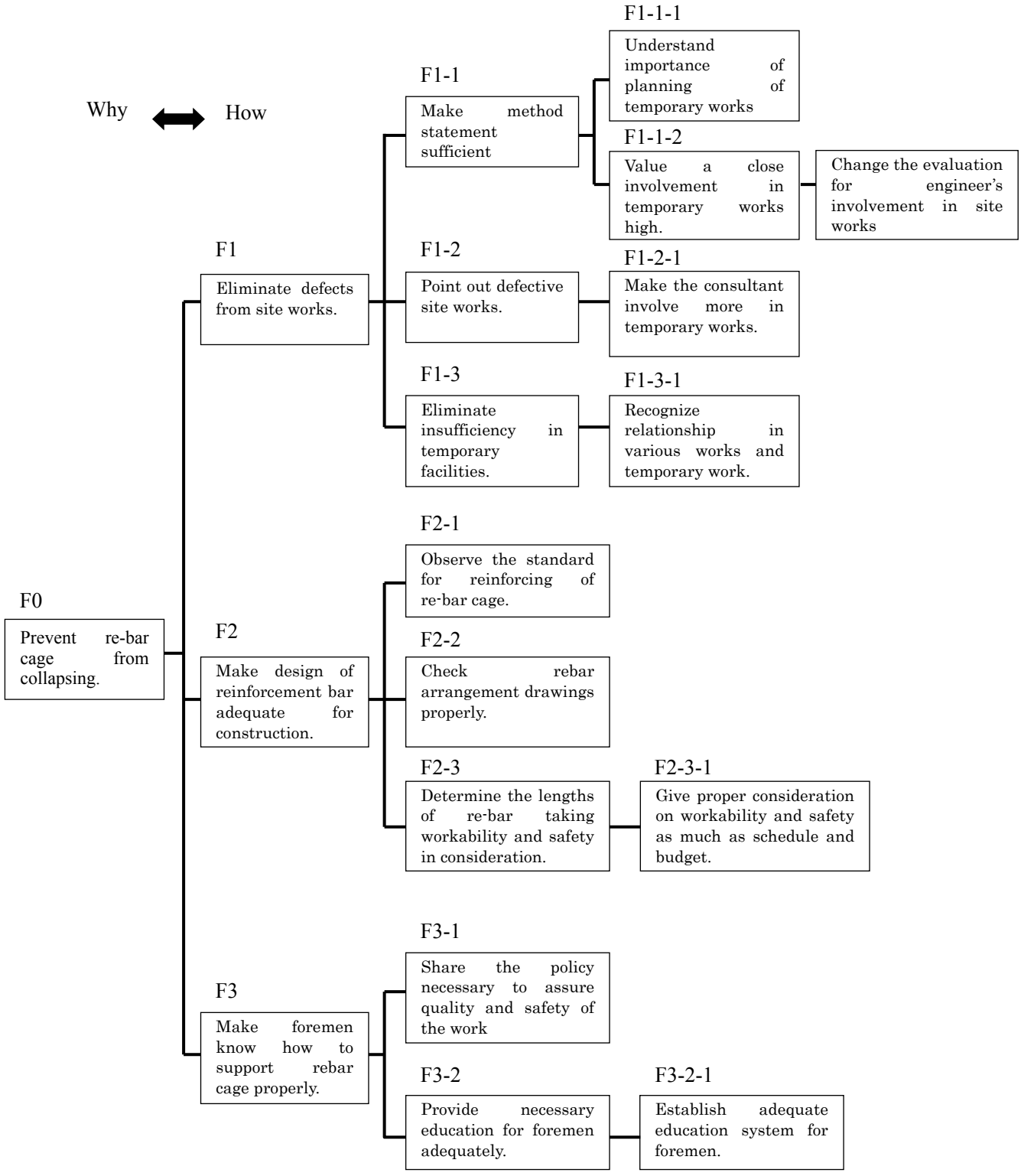


Figure 4.3.5 Function Tree to Prevent Grave Accident (Management/Organizational Factor)

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.3.1.2 Root Cause Analysis of Re-bar Collapse Accident Occurred on 2015/07/20

1) The Accident

[Outline of the Accident] (Following information is based on the accident report submitted to the consultant, NK Consortium (NKC) by the contractor, Sojitz L&T Consortium (SLT) and/or the report submitted to JICA by the consultant.)

Workmen were fixing reinforcement steel for Bridge No.1 box culvert wall. Suddenly, the support given to vertical reinforcement bars got bent which induced in collapse of all vertical reinforcement bars on one side. A few workmen could not move away quickly, and five workers injured and rushed to the hospital.

Figure 4.3.6 Vertical Steel for Side Wall of Box Culvert Collapsed by Strong Wind

2) Causes of Accident

[Direct Cause]

(1) Weakness of some of the supporting pipes (ledgers and bracing) used.

(2) Heavy windy condition.

(3) Insufficient tying of all nodes of horizontal and vertical re-bars with wires.

(4) Insufficient provision of temporary horizontal and cross bracing re-bars for assembly of vertical re-bars.

[Countermeasures]

(1) Providing proper supporting arrangement for the supporting of the rebar cage.

(2) Method statement and drawings for supporting rebar cage shall be taken approval from Engineer and the same will be implemented at the site.

(3) Tying of all nodes of horizontal and vertical re-bars with wires.

(4) Provision of temporary horizontal and cross bracing re-bars for assembly of vertical bars.

(5) Training of foremen and re-bar fitters in workshop how to assemble rigidly vertical re-bars using re-bars of 32mm in diameter to prevent fall down of vertical re-bars.

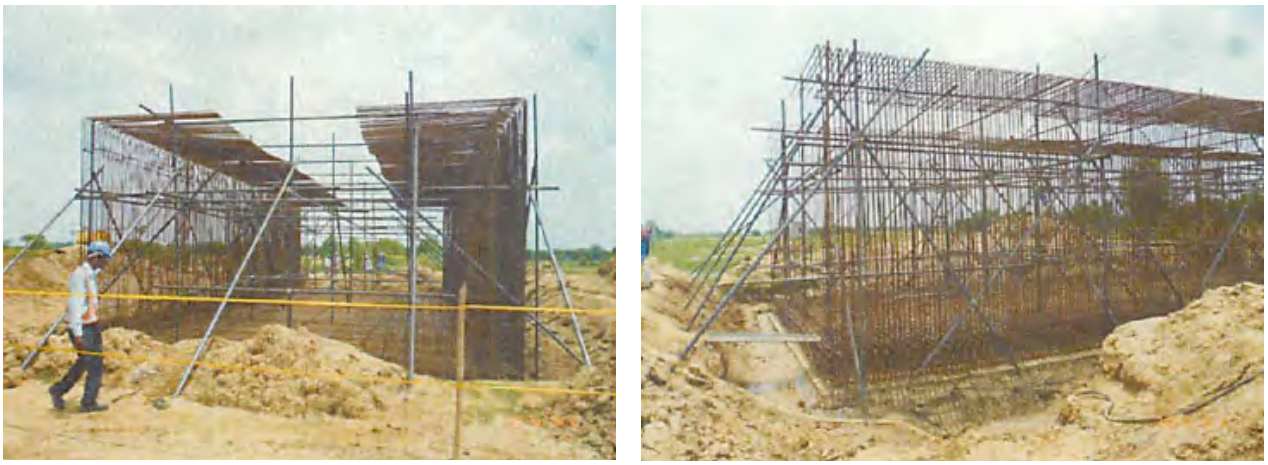


Figure 4.3.7 Situation after Countermeasures Were Applied.

3) Root Cause Analysis and Study for Countermeasures

a) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the accident.

b) Why-why Analysis

Pursuit of Root Causes by the Why-why Analysis Diagram

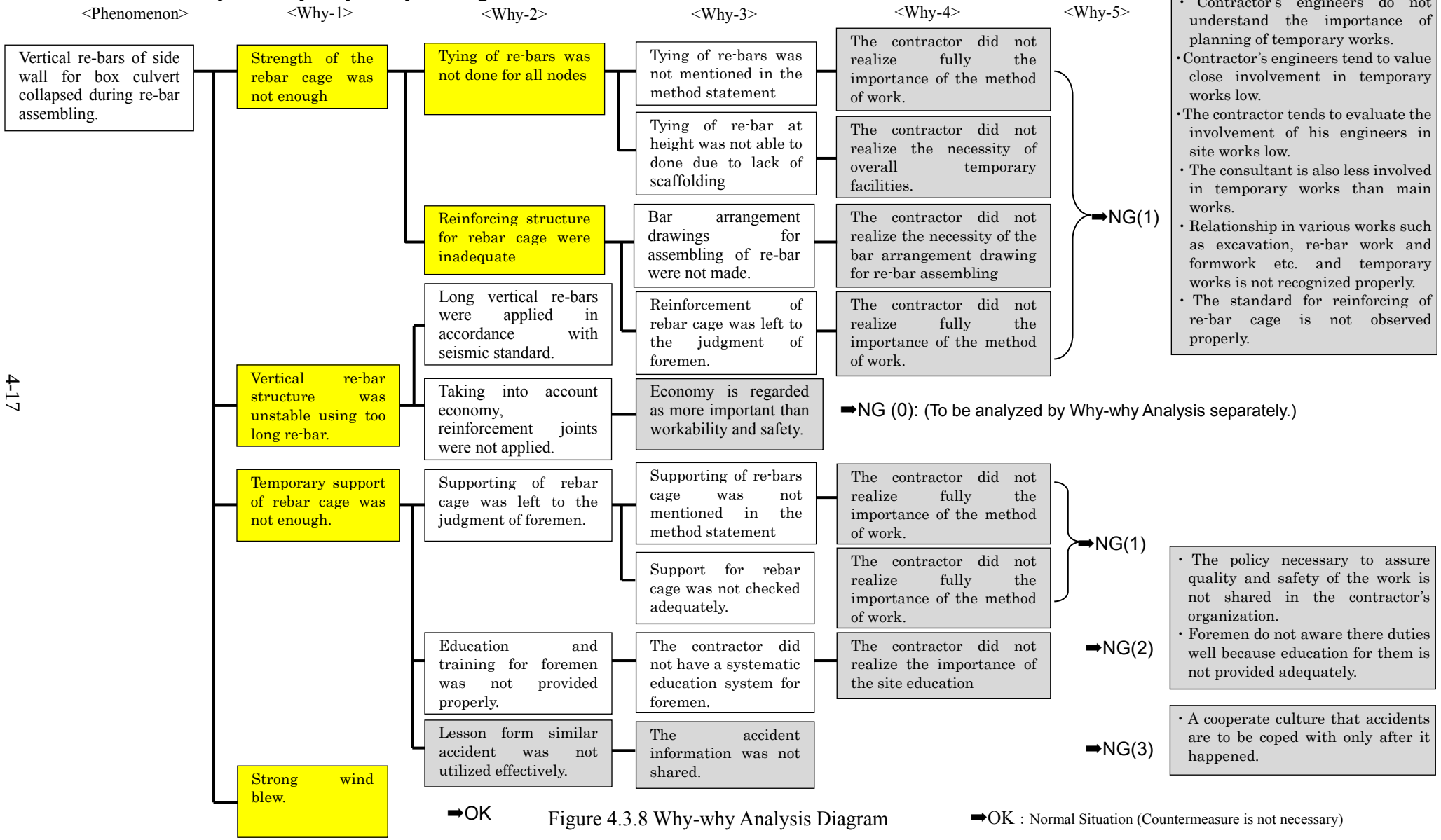


Figure 4.3.8 Why-why Analysis Diagram

➡OK : Normal Situation (Countermeasure is not necessary)

➡NG : Abnormal Situation (Countermeasure is necessary to prevent a recurrence of similar accident.)

c) Countermeasures against Direct Cause c)

Table. 4.3.2 Provisional Countermeasures to Prevent Recurrences of Similar Accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. Strength of the rebar cage was not enough.	Method statement and drawings for supporting re-bar cage shall be taken approval from Engineer and the same will be implemented at the site.	Place horizontal re-bar as early stage as possible and tie all nodes of horizontal and vertical re-bars with wires firmly.	Provision of temporary horizontal and cross bracing re-bars for assembly of vertical bars.
2. Design of re-bar arrangement was inadequate using too long re-bar.	For re-bar arrangement design, safety and workability must be taken into consideration, applying relatively short re-bars with splicing or couplers.	-	-
3. Temporary support of rebar cage was not enough	Method statement and drawings for supporting re-bar cage shall be taken approval from Engineer and the same will be implemented at the site.	Frequent checking of the condition of support by site working crew for stability point of view.	-
	Training of site crew for reinforcement of re-bars how to tie and safety.	Training of foremen and re-bar fitters in workshop how to assemble rigidly vertical re-bars using re-bars of 32mm in diameter to prevent fall down of vertical re-bars.	Daily pep talks to educate all working crew.
4. Strong wind blew.	No countermeasure is required.	-	-

(Source: Accident Report)

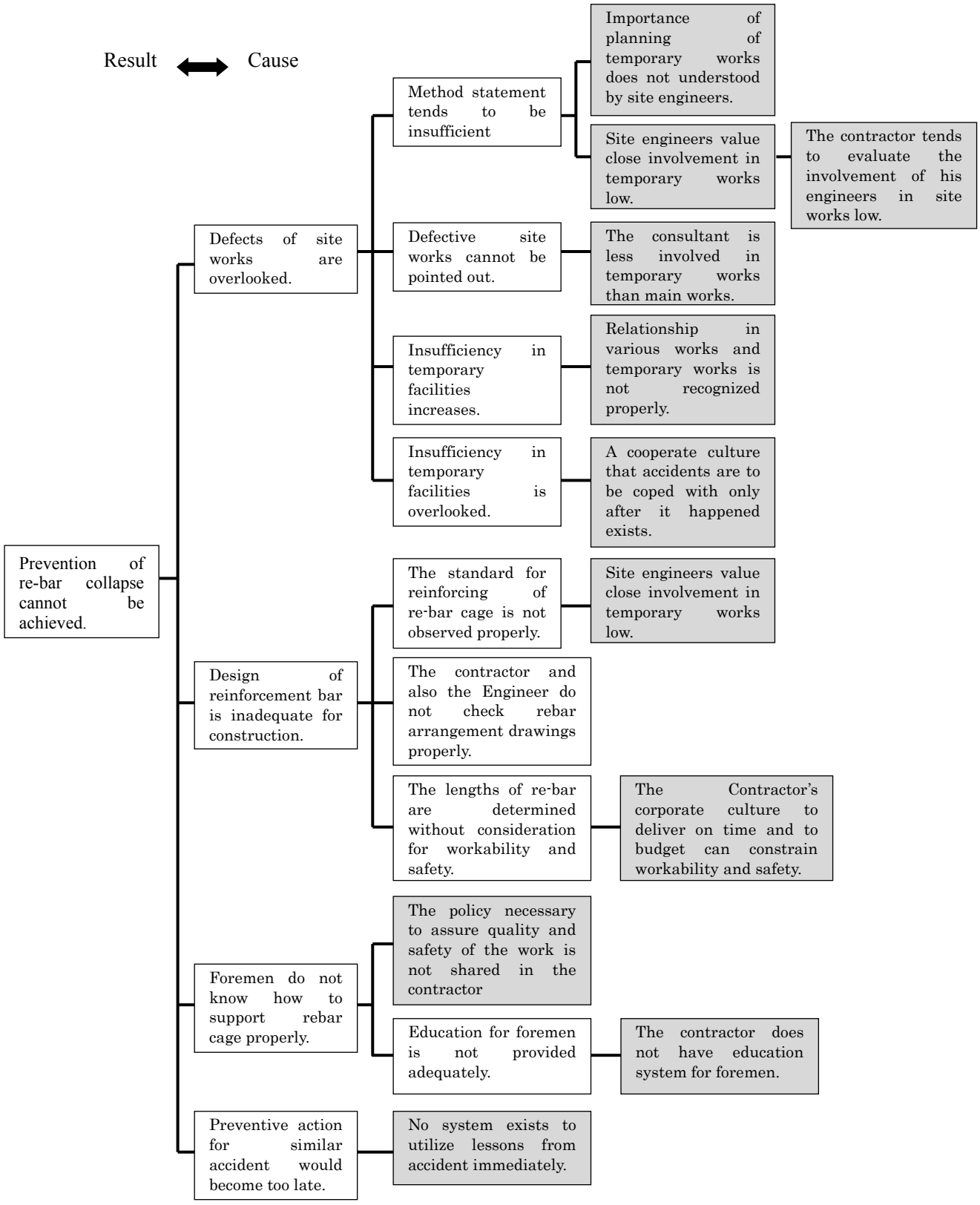


Figure 4.3.9 Problem Tree Leading to the Accident
(Management/Organizational Factors)

Management/organizational factors derived through "Why-why Analysis :

e) Countermeasures for Management/Organizational Factors (1)

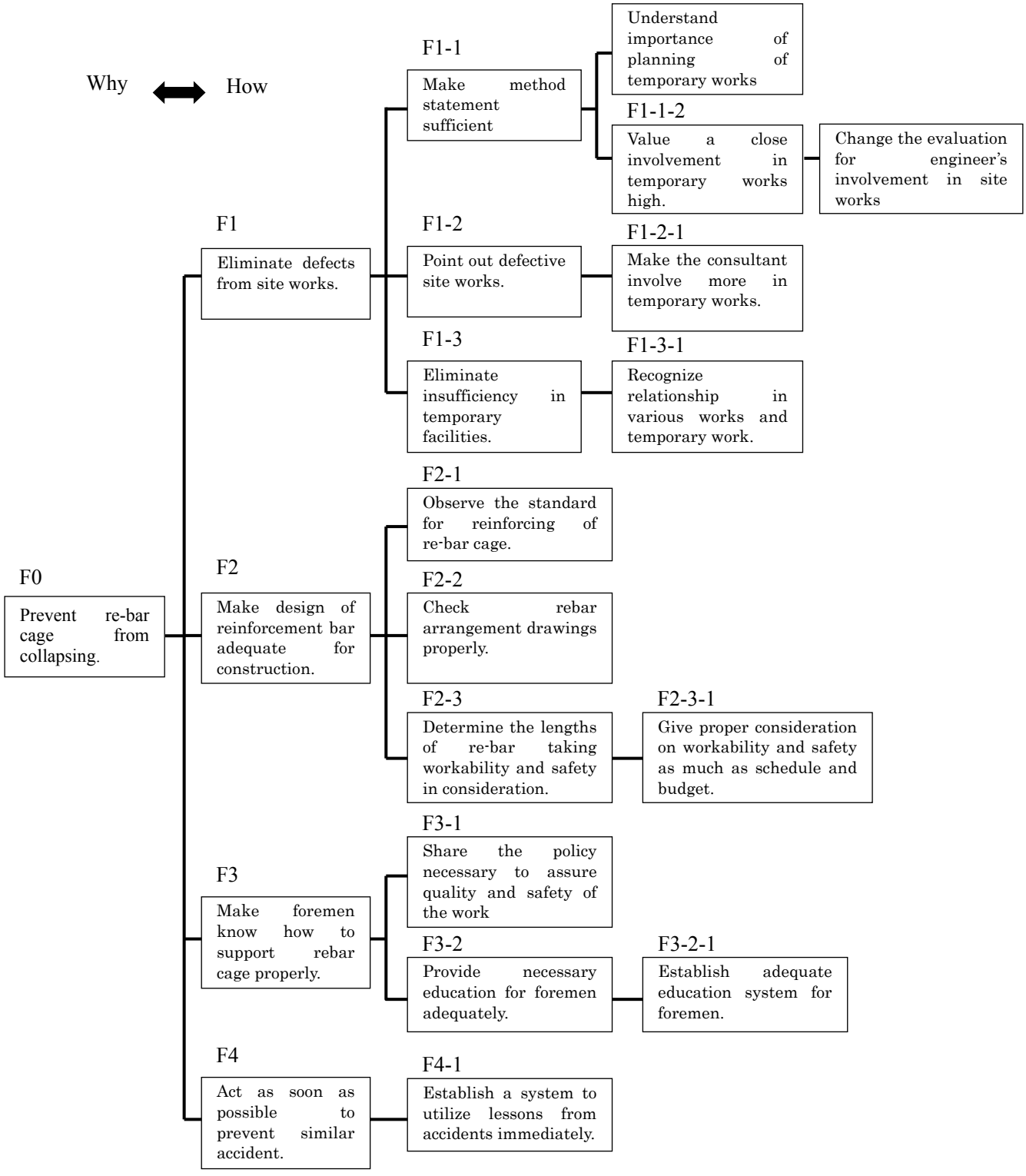


Figure 4.3.10 Function Tree to Prevent Grave Accident (Management/Organizational Factor)

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.3.1.3 Root Cause Analysis of Re-bar Collapse Accident Occurred on 2015/07/27

1) The Accident

[Outline of the Accident] (Following information is based on the accident report submitted to the consultant, NK Consortium (NKC) by the contractor, Sojitz L&T Consortium (SLT) and/or the report submitted to JICA by the consultant.)

Five workers were engaged in fixing reinforcement steel re-bar previously assembled for concrete work on Pier No.52 Viaduct. At about 09:53 without warning, the vertical steel re-bae started to tilt to one side along the length of pier slowly. Three workmen were able to escape without injury. One workman got scraped by the falling bars suffering minor injury. Another worker got caught below falling re-bar and received serious injury to his right shoulder.

Figure 4.3.11 Vertical Steel for Viaduct Pier Collapsed Due to Failed Support

2) Causes of Accident

[Direct Cause]

(1) No check of supporting arrangement prior to start of the work on incident day, for any deviation took place after heavy rain in the night before.

(2) Weather conditions experienced on the site were much heavier than on previous sites.

(3) Structure supported by a single support at either end.

(4) Heavy windy condition.

(5) Insufficient tying of all nodes of horizontal and vertical re-bars with wires

(6) Insufficient provision of temporary horizontal and cross bracing re-bars for assembly of vertical re-bars

[Countermeasures]

(1) Use of couplers of re-bars to make short vertical re-bars or use of L-shape re-bars for bottom of long vertical bars.

(2) Where ever only one support point (bracing pipe clamped with anchor point) is provided at both sides of the pier length, two more additional supporting points should be provided to share the load.

(3) All anchoring points, clamps and bracing pipes shall be rechecked for full tightness and adequacy in strength.

(4) Design/method/procedure for re-bar arrangement and temporary work to correct the current conditions.

(5) Comprehensive discussion of the above 1 & 2 between the Contractor and the Engineer with safety, design, QA/QC and site sections and chief/management.

(6) Joint site investigation for whole site by chief/management levels.

(7) Safety workshops to be carried out at every site hut for workers/engineers/operators of the Contractor and the Engineer.

(8) Assembling of re-bars rigidly with the following;

- Tying of all nodes of horizontal and vertical re-bars with wires, and
- Provision of temporary horizontal sand cross bracing re-bars for assembly of vertical re-bars.

Figure 4.3.12 Situation after Countermeasures Were Applied

3) Root Cause Analysis and Study for Countermeasures

a) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the accident.

c) Why-why Analysis

Pursuit of Root Causes by the Why-why Analysis Diagram

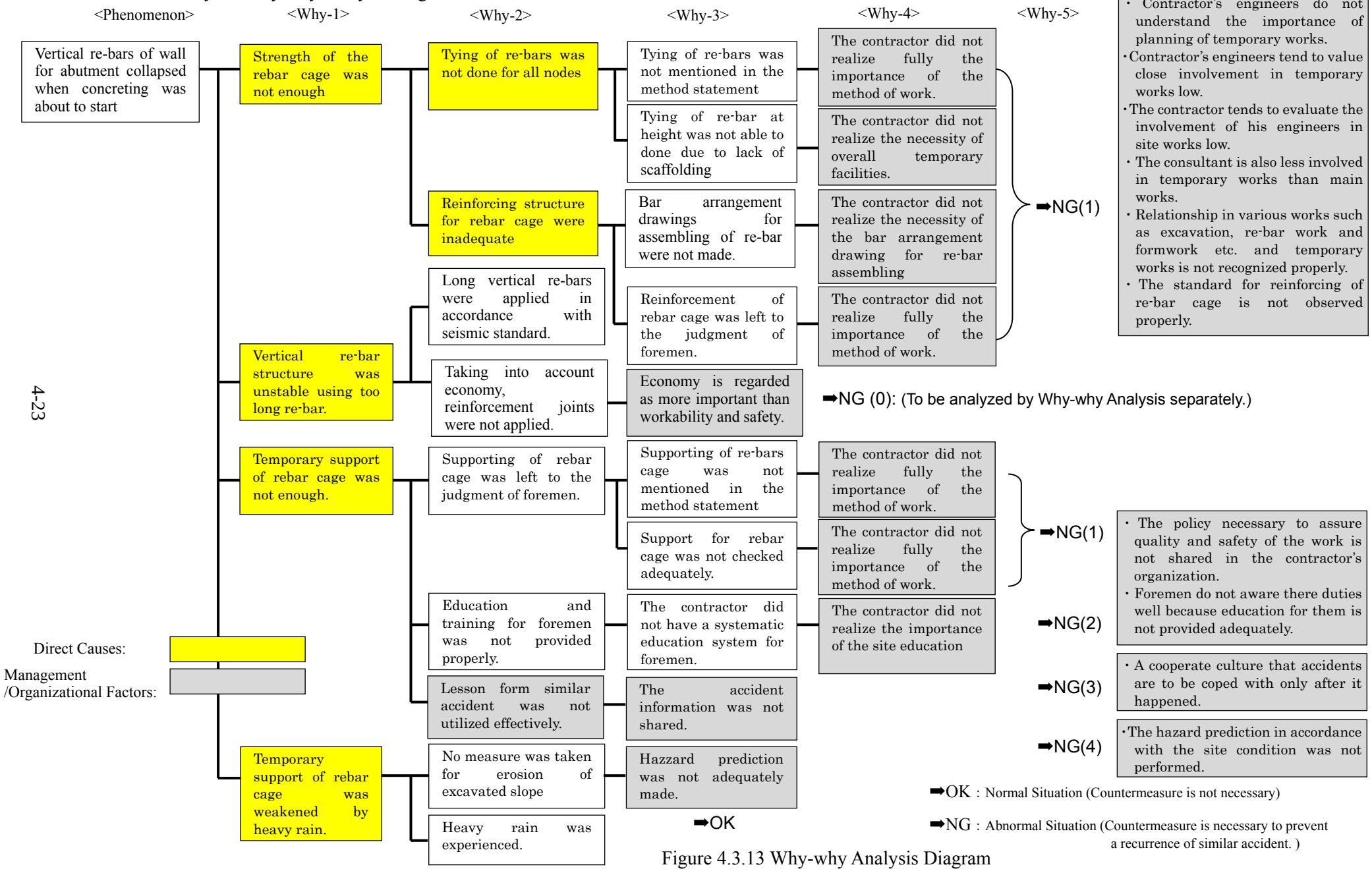


Figure 4.3.13 Why-why Analysis Diagram

c) Countermeasures against Direct Cause

Table. 4.3.3 Provisional Countermeasures to Prevent Recurrences of Similar Accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. Strength of the rebar cage was not enough.	Method statement and drawings for supporting re-bar cage shall be taken approval from Engineer and the same will be implemented at the site.	Place horizontal re-bar as early stage as possible and tie all nodes of horizontal and vertical re-bars with wires firmly.	Provision of temporary horizontal and cross bracing re-bars for assembly of vertical bars.
2. Design of re-bar arrangement was inadequate using too long re-bar.	For re-bar arrangement design, safety and workability must be taken into consideration, applying relatively short re-bars with splicing or couplers.	-	-
3. Temporary support of rebar cage was not enough	Method statement and drawings for supporting re-bar cage shall be taken approval from Engineer and the same will be implemented at the site.	Frequent checking of the condition of support by site working crew for stability point of view.	-
	Training of site crew for reinforcement of re-bars how to tie and safety.	Training of foremen and re-bar fitters in workshop how to assemble rigidly vertical re-bars using re-bars of 32mm in diameter to prevent fall down of vertical re-bars.	Daily pep talks to educate all working crew.
4. Temporary support of rebar cage was weakened by heavy rain.	No countermeasure is required.	-	-

(Source: Accident Report)

d) Developing Management/ Organizational Factors

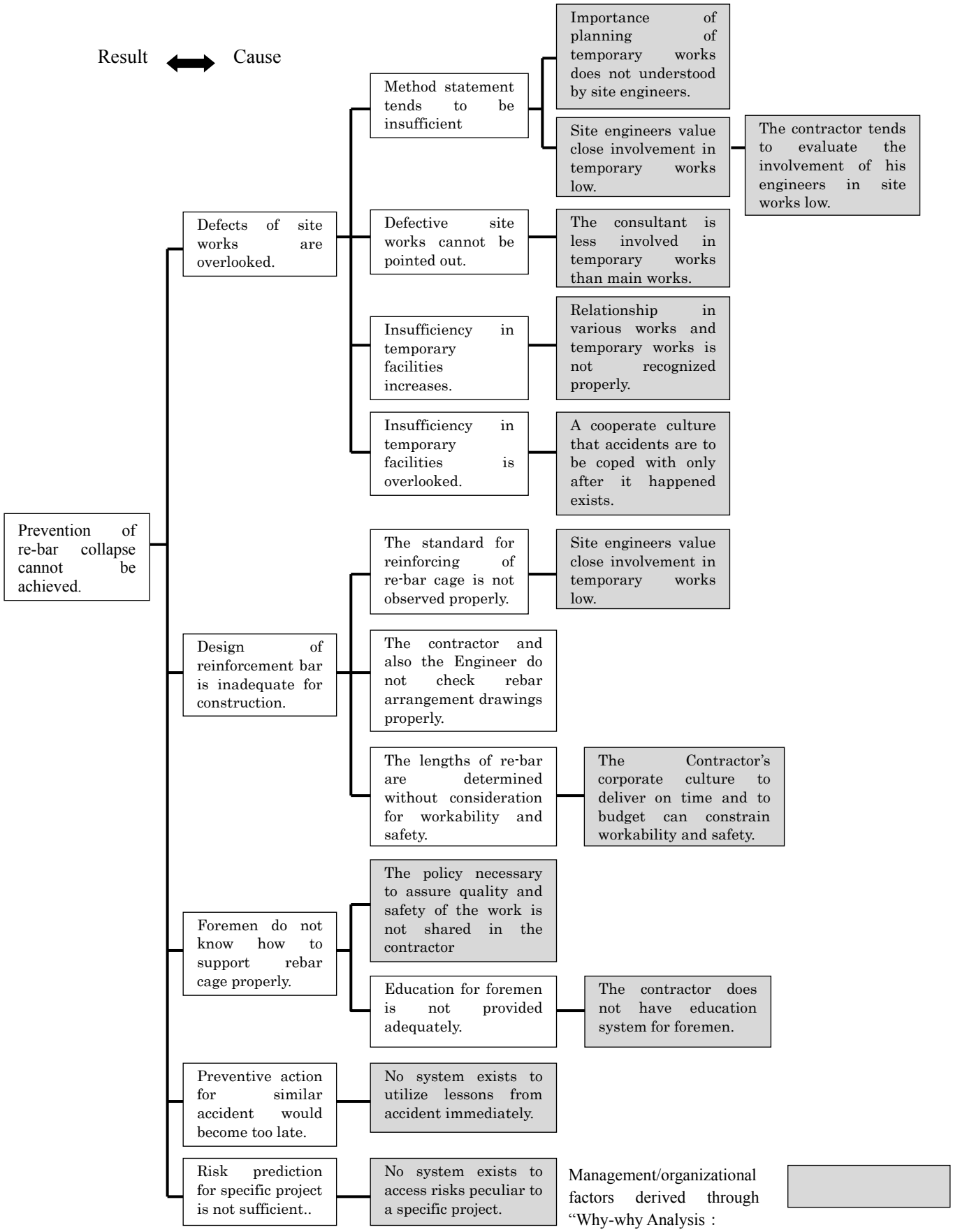


Figure 4.3.14 Problem Tree Leading to the Accident (Management/Organizational Factors)

e) Countermeasures for Management/Organizational Factors (1)

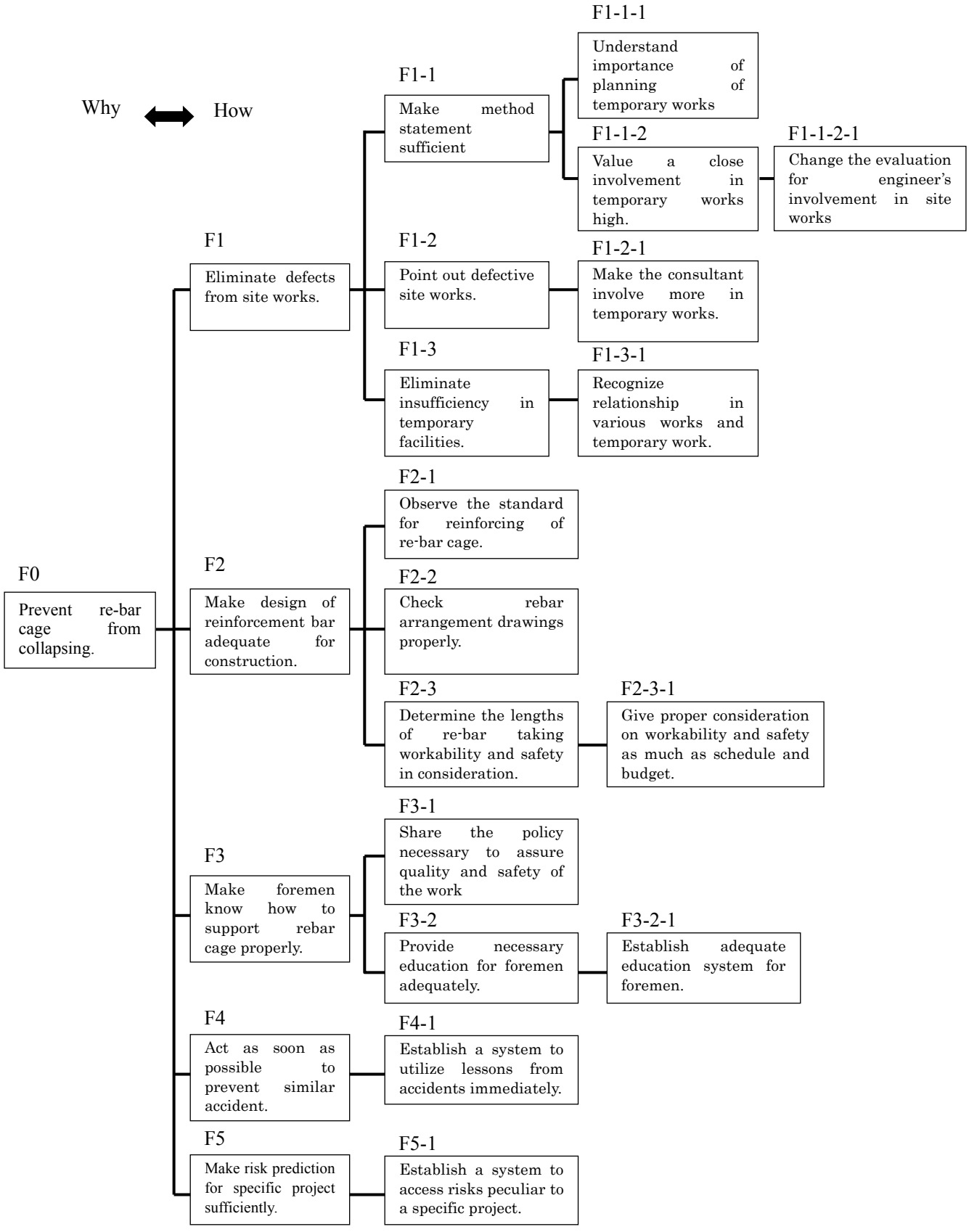


Figure 4.3.15 Function Tree to Prevent Grave Accident (Management/Organizational Factor)

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.3.2 Accidents Related to Occupational Safety and Health

4.3.2.1 Root Cause Analysis of Turning over of a Truck on 2015/01/25

1) The Accident

[Outline of the Accident] (Following information is based on the accident report by the consultant, NK Consortium (NKC).)

A truck which was running on the railway embankment with approximately one meter height being used as a project service road in the construction site slipped down and turned over. The driver seemed to have tried to jump off from the truck window but caught between the truck and ground. He was immediately taken to the hospital but confirmed dead. The assistant driver left the accident site and has been missing.

The victim: Indian, driver, 23 years old, belonging to a material supplier

Figure 4.3.16 Situation of the Accident

2) Causes of Accident and Countermeasures

[Causes]

(The accident report was made right after the accident. The consultant was requesting investigation of the cause from the contractor.)

(1) It was his first time to transport material in the construction site and did not know well the situation such as service road.

(2) Some mechanical failure occurred for the truck and the truck became out of control.

(3) The loaded material (flat bars) was not fixed properly, caused a collapse and lead to lose balance.

[Countermeasures]

(Proposed countermeasure by the contractor in the Incident Investigation Report dated 2015/01/30)

(1) Review and update the operation plan (transportation).

(2) Review risks and development of the entrance management system of construction site without permission.

(3) Review and update the safety plans of entire site.

(4) Notify transportation suppliers and plant suppliers of about all the safety requirements.

(5) Execute checking test of alcohol intake for drivers at site.

(6) Conduct safety education for supervisors, staffs and drivers.

[Lessons from the Accident, Comment by Safety Officer]

(1) The accident occurred at the embankment with approximately one meter height and fifty meters width under conditions of good visibility and little traffic. As the accident site was not considered as dangerous, it is required to review the safety management system for the whole construction site. And also it is necessary to conduct safety management understanding that accidents would occur at any place and at any time.

(2) In this project, three consecutive accidents of truck turn over occurred in November 2104. The Engineer gave an improvement order on 24th of November 2014. As any improvement action was taken, he gave a suspension order for earth work on 9th of December 2014.The Contractor took actions in accordance with the order, and then the suspension order was cancelled. Several near miss incidents occurred, and the fatal accident took place after those incidents. It is very important not to overlook forerunning phenomenon of grave accident.

3) Root Cause Analysis and Study for Countermeasures

a) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the accident.

b) Why-why Analysis

Pursuit of Root Causes by the Why-why Analysis Diagram

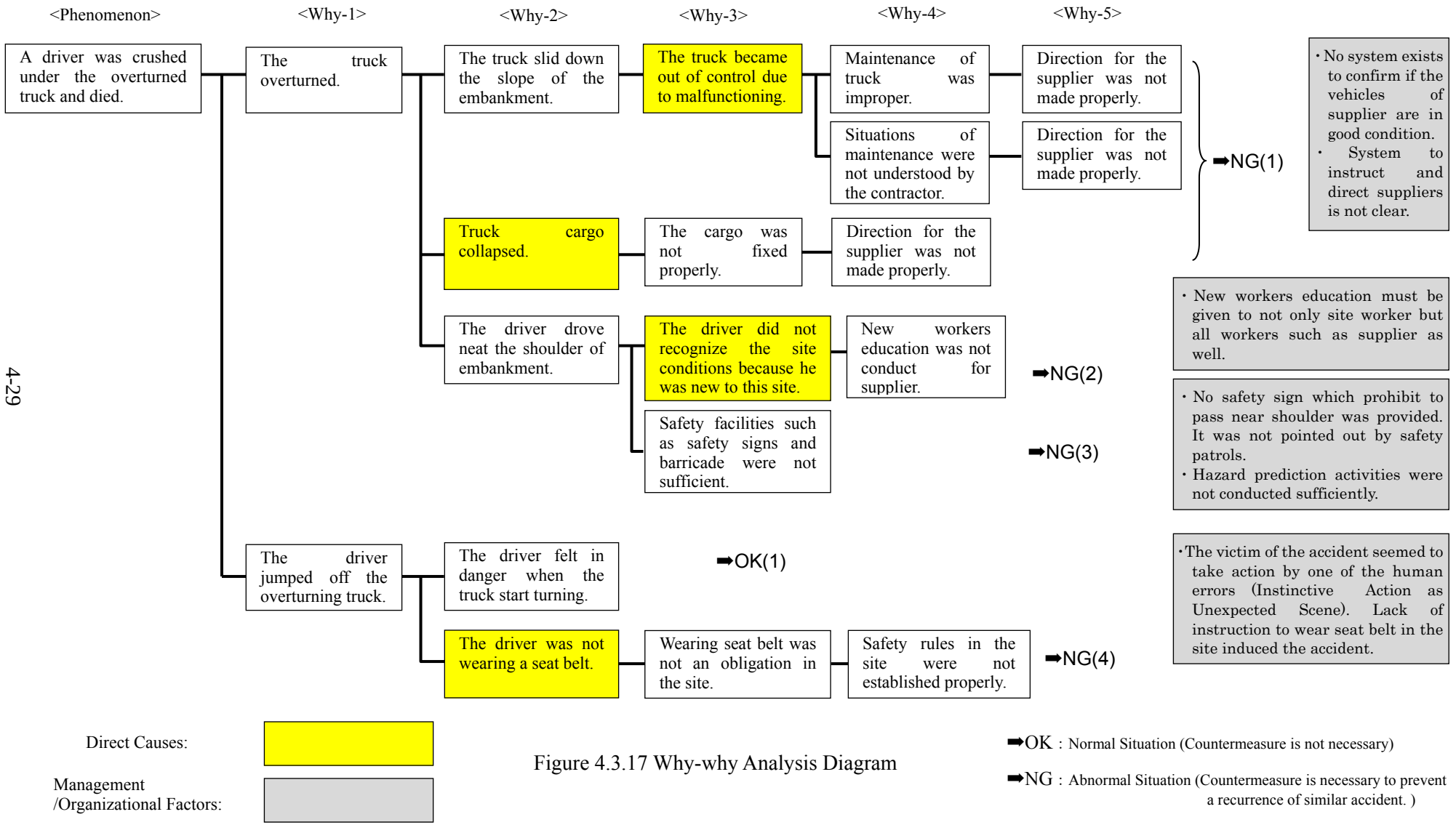


Figure 4.3.17 Why-why Analysis Diagram

c) Countermeasures against Direct Cause

Table 4.3.4 Provisional Countermeasures to Prevent Recurrences of Similar Accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. The truck became out of control due to malfunctioning.	Obtain information regarding maintenance of not only equipment of contractor owned but also supplier's vehicles. When needed, direct improvement without delay.	When inadequate maintenance is found, suspend delivery.	-
2. Truck cargo collapsed.	When a supplies' truck enter the construction site where unleveled temporary road exist, fixation of cargo must be checked at the gate.	Instruct the supplier to fix cargos adequately.	-
3. The driver did not recognize the site conditions because he was new to this site.	Conduct a new workers education for worker of supplier as well.	-	-
4. The driver was not wearing a seat belt.	Oblige truck drivers to wear a seat belt in the site in accordance with the site rule.	-	-

d) Developing Management/ Organizational Factors

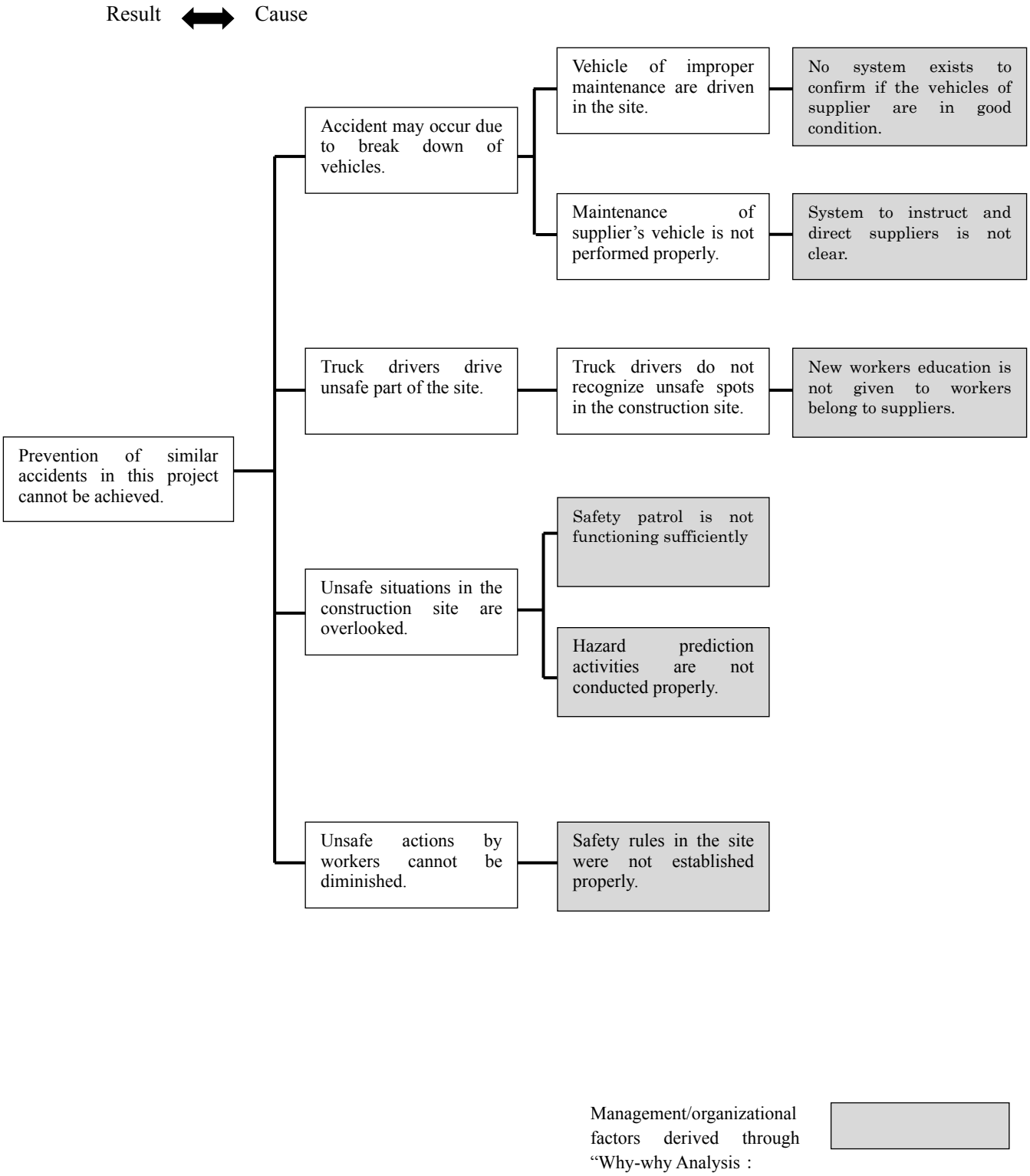


Figure 4.3.18 Problem Tree Leading to the Accident (Management/Organizational Factors)

e) Countermeasures for Management/Organizational Factors (1)

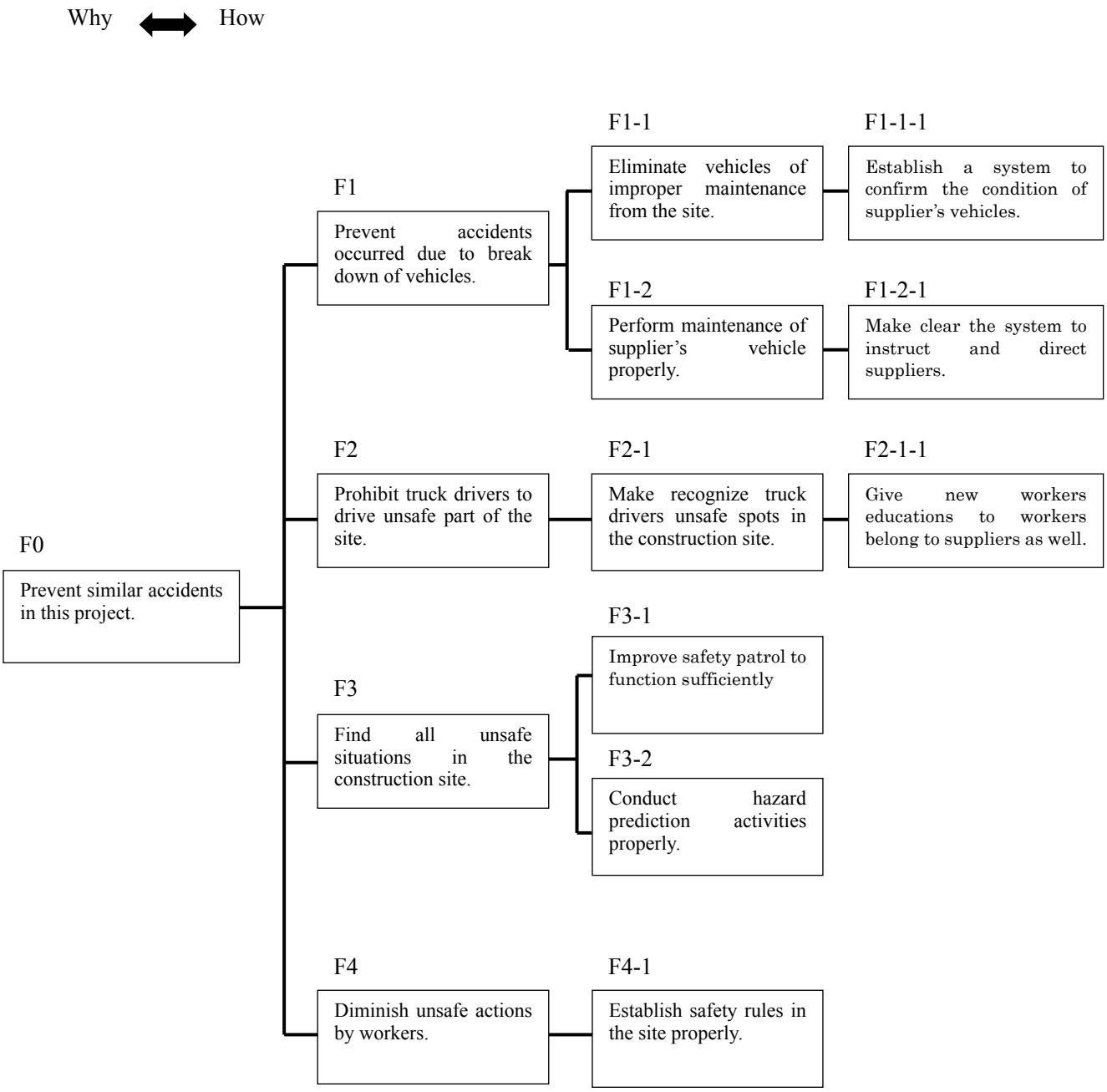


Figure 4.3.19 Function Tree to Prevent Grave Accident (Management/Organizational Factor)

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.3.2.2 Root Cause Analysis of Accident Crushed to Death by Compaction Roller Occurred on 2015/10/20

1) The Accident

[Outline of the Accident] (Following information is based on the preliminary accident report submitted to the consultant, NK Consortium (NKC) by the contractor, Sojitz L&T Consortium (SLT).)

Two small teams were conducting survey work along the embankment at **Ch 5/9** (Near Rewari) – embankment and final preparation work including rolling and weed removal.
The compaction roller on site had completed its work and the operator was among the survey team when one of the two men engaged in weed control took a rest in front of the stationary compaction roller. The compaction roller operator was unaware that the man was sleeping in front of the roller when he was given instructions by his manager by mobile phone to move his machine to a new location. The roller operator climbed into the cab without checking around the machine and began to drive forward. The man resting was struck by the compaction roller and expired immediately.

Figure 4.3.20 Accident Site and the Compaction Roller

2) Causes of Accident

[Direct Cause]

(1) The worker took a rest in front of and slept.
(2) The operator of the compaction roller did not confirm around the equipment was clear and started moving.
(3) There was no shade for workers to avoid the severe sun light.

[Countermeasures] (Immediate actions taken to prevent recurrence: by 24Hr Preliminary Incident Report)

(1) All sections informed and all workers given tool box talk immediately. Mock drills are being delivered to educate all managers and workers.
(2) Bulletins & Posters etc. prepared & management informed to take immediate action.
(3) Contractor engagement and education
(4) Contractor engagement and education

[Others]

(1) In the detailed report, SLT analyzed the accident using Fish-bone Analysis and Why-why Analysis Method.

3) Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

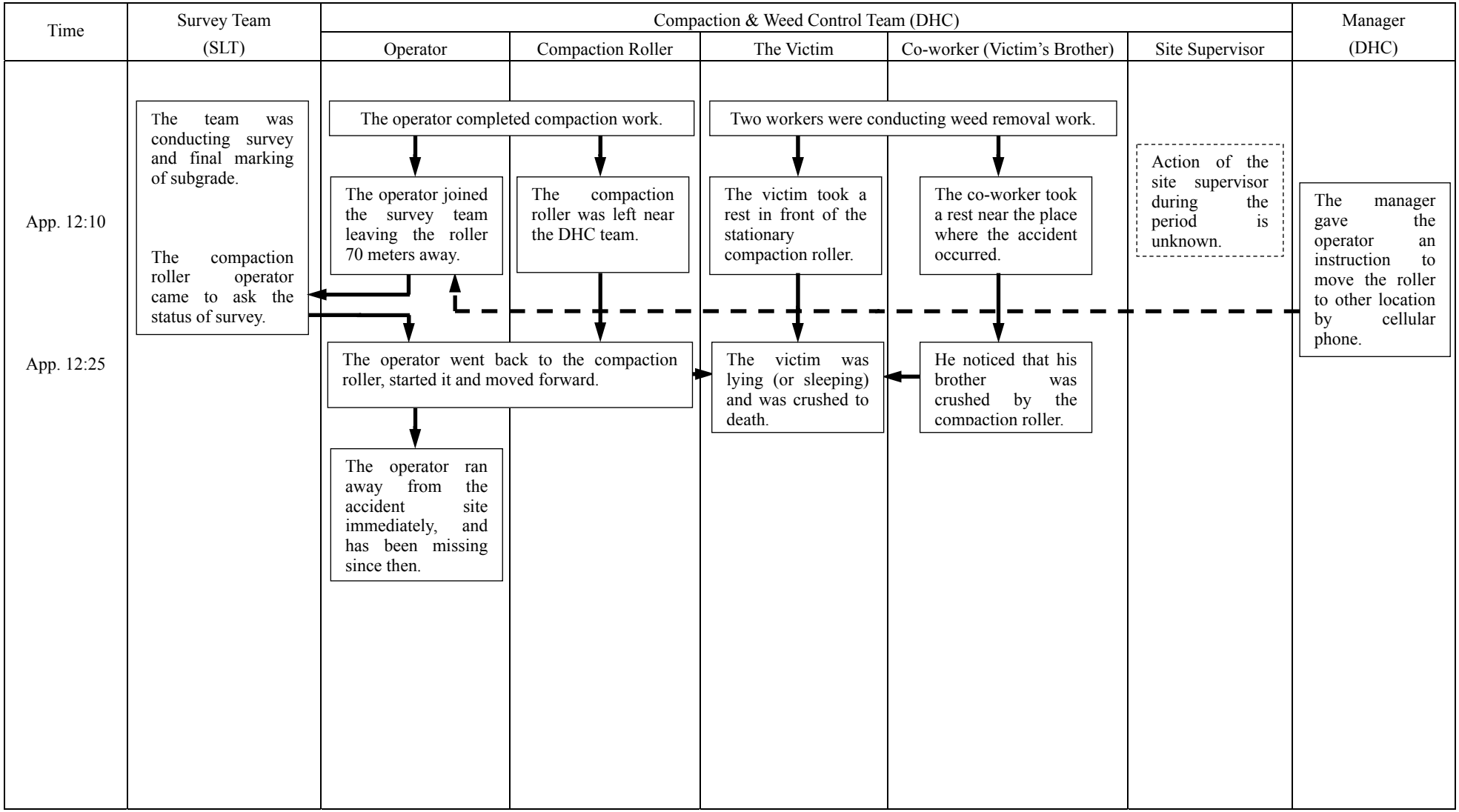


Figure 4.3.21 Progress Chart of the Objective Accident

b) Why-why Analysis

Pursuit of Root Causes by the Why-why Analysis Diagram

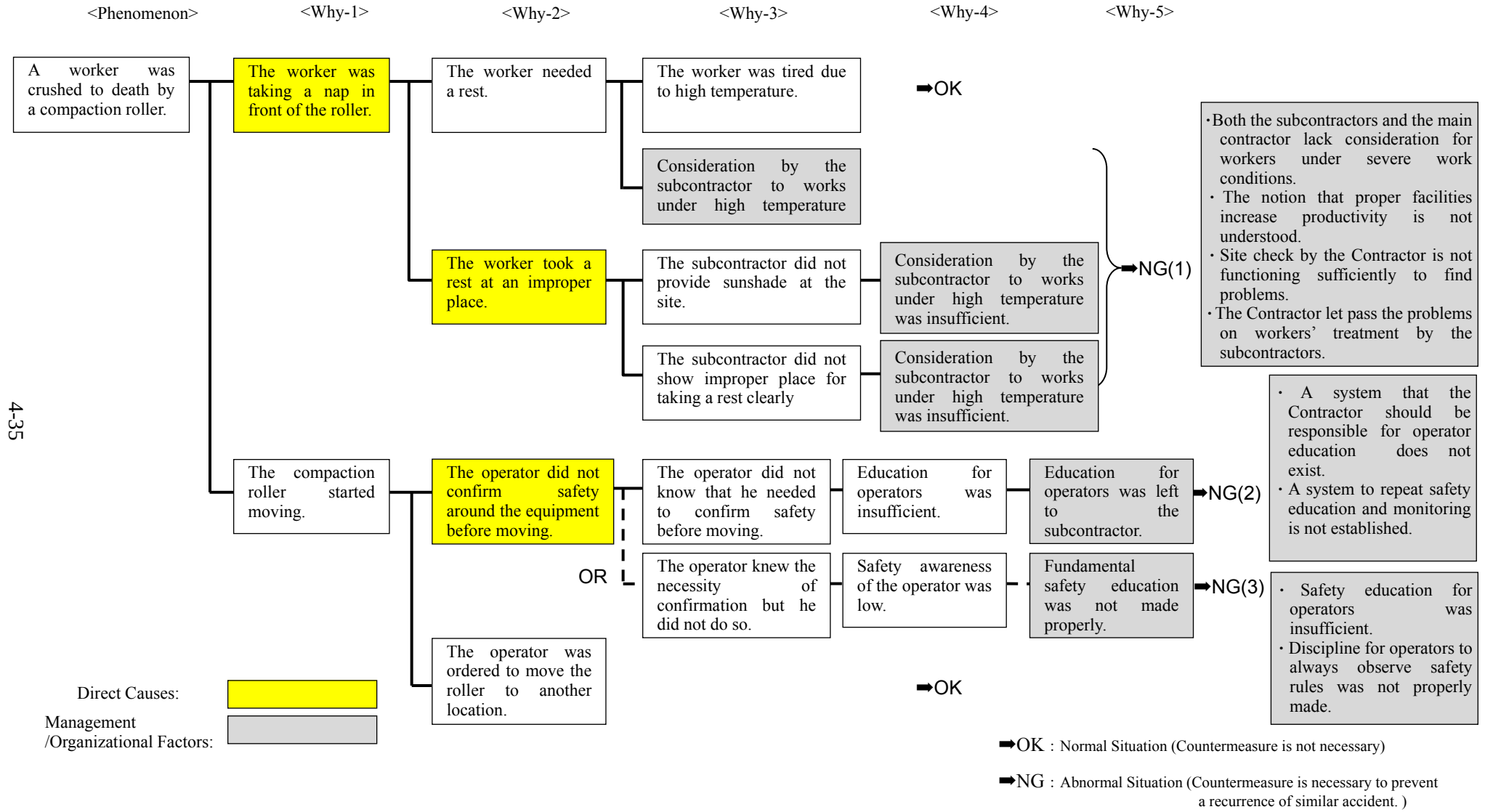


Figure 4.3.22 Why-why Analysis Diagram

c) Countermeasures against Direct Cause

Table 4.3.5 Provisional Countermeasures to Prevent Recurrences of Similar Accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. The worker took a rest in front of the compaction roller and slept.	Make sure that anyone should not take a rest near equipment. Utilize tool box meeting and other occasions to make it sure thoroughly.	-	-
2. The operator did not confirm safety around the equipment before moving.	Educate operators to confirm safety around whenever before operating equipment.	Use tool box meeting for operators to remind the confirmation activity.	-
3. The worker took a rest at an improper place.	Provide sun shade facilities for workers to take a rest.	In order to avoid excessive fatigue, give workers proper break and drinking water.	-

(Source: Accident Report)

d) Developing Management/ Organizational Factors

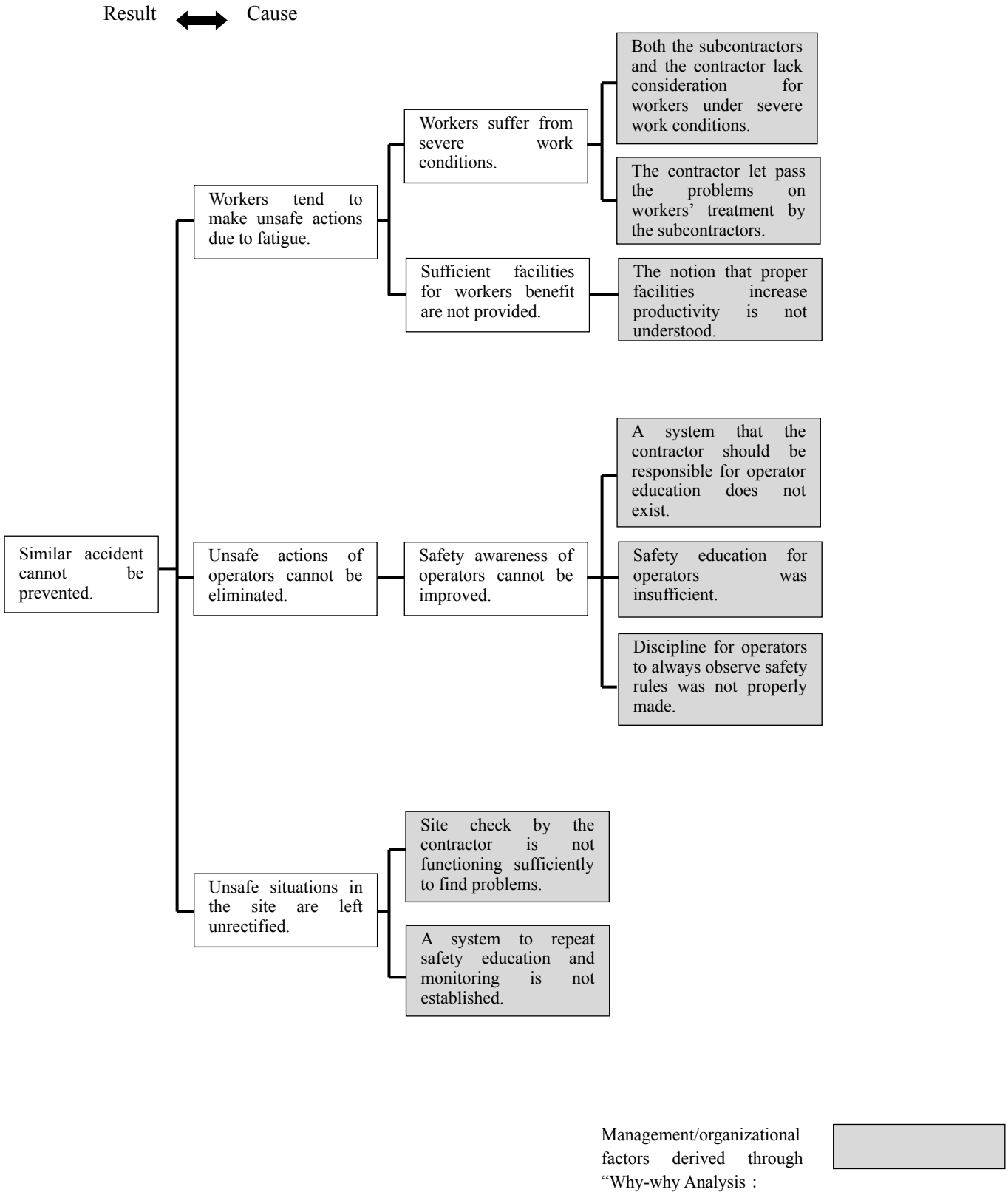


Figure 4.3.23 Problem Tree Leading to the Accident (Management/Organizational Factors)

e) Countermeasures for Management/Organizational Factors (1)

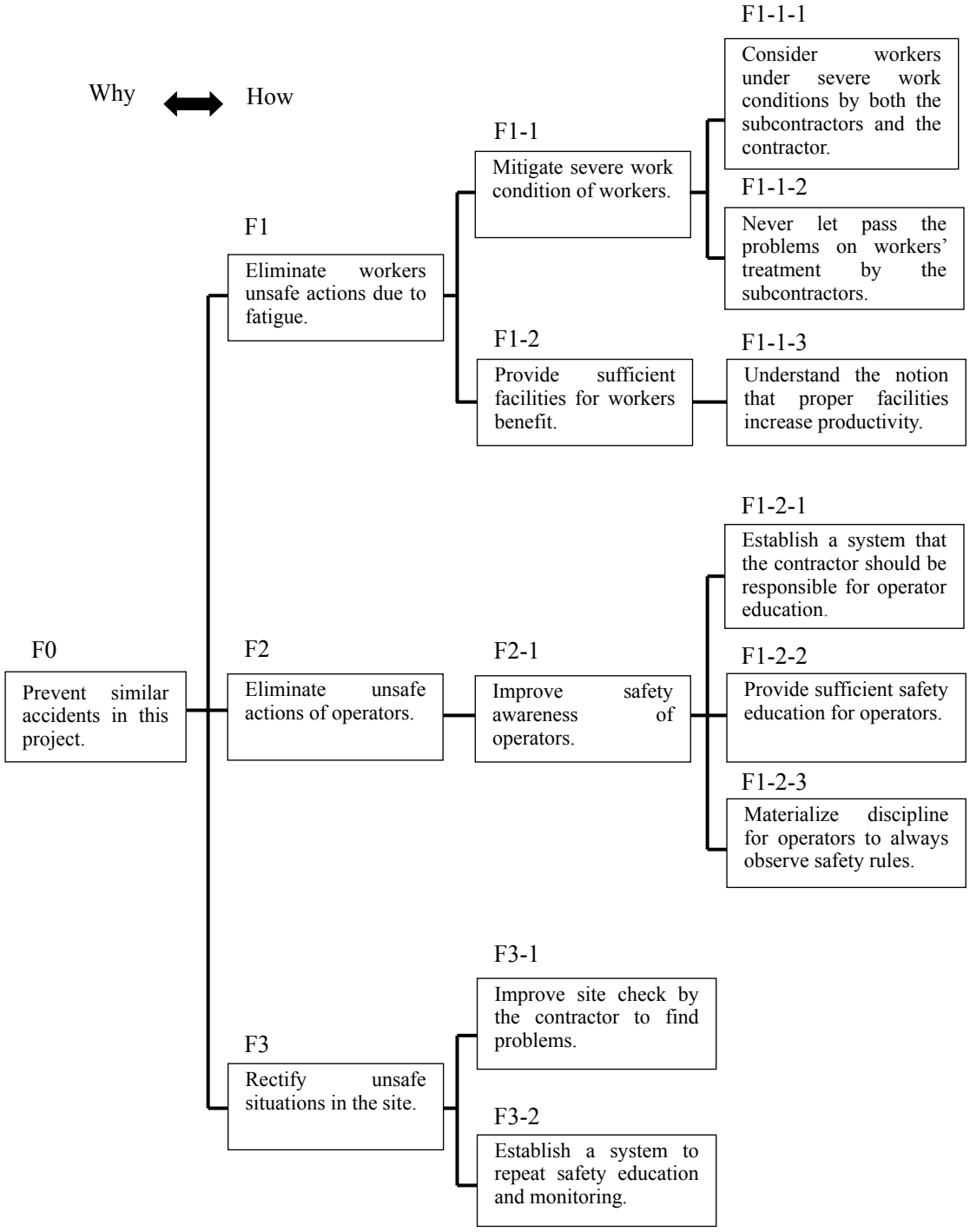


Figure 4.3.24 Function Tree to Prevent Grave Accident (Management/Organizational Factor)

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.3.2.3 Root Cause Analysis of Accident by Exploded Drum Occurred on 2015/10/23

1) The Accident

[Outline of the Accident] (Following information is based on the Incident Investigation Report submitted to the consultant, NK Consortium (NKC) by the contractor (SLT).)

Works had been done to improve the housekeeping of the construction site for an important visit. During lunch, a group of workmen discussed the need of a waste bin for the site. The supervisor took the initiative to make a waste bin. He found an empty shuttering oil barrel on the site and decided to cut the lid of the drum which was sealed from both sides.

Before cutting, he tried to open the lid which was on the top of the drum, but he couldn't. Then he called a site helper who was standing nearby to help him to remove the lid. But after trying they both failed to open the lid, so the victim decided to cut the drum using an oxy acetylene gas cutter.

The victim was warned of the risk by another site helper who informed him that the drum will burst. Other workers present nearby, fearful of the consequence of his actions moved away. But the victim refused to stop and stated that nothing will happen.

The heat from the cutting torch combined with flammable material residue that was confined within the drum released, cutting open the drum and exploding. The explosion caused the victim's body to catch fire. The victim was also showered with metal fragments from the drum as well as chemical residue.

Immediately the people who were working nearby came to the rescue and extinguished the fire using soil. The impact of the explosion caused burns to him and he was treated on site. He was first taken to the hospital which is on the way to Jaipur. But his condition appeared to deteriorate and later he expired.

Figure 4.3.25 Exploded Drum

2) Causes of Accident (Incident Investigation Report)

[Direct Cause]

Shock as a result of burns sustained from an exploding drum and fire.

[Root Cause]

(1) Inadequate competence to perform gas cutting operation and victim was unaware of hazard
(2) Unplanned work
(3) Reckless behavior of the victim
(4) Inadequate supervision resulting in shortcuts
(5) Lack of recycling rules and guidance
(6) Waste bins not provided by stores
(7) Lack of process to return empty drums
(8) No permit or permission taken to use gas cutting equipment
(9) Lack of safety signage to inform of the golden rules of safety
(10) Inadequate PPE as a result of no risk assessment

[Countermeasures] (Incident Investigation Report)

(1) Pep talks to improve the awareness among the workmen about the hazard of accidental rollover while resting near to the vehicle or earthmoving equipment.
(2) Each construction site supervisor will maintain a site diary and produce a daily condition report which will detail any safety concerns and any compliance issues.
(3) SLT will conduct a review of all emergency plans from all construction sites to establish the facilities to administer first aid and effect timely evacuation to capable medical facilities.
(4) Gus cutting training conducted by Third Party Agency.
(5) Display of warning sign and posters to prevent from hazard.
(6) Systematic plan for site usage and storage of empty flammable oil barrels.
(7) The new drum to be issued only with return of old drum.
(8) Mock drills and training to be conducted on particular incident in all sites.

3) Root Cause Analysis and Study for Countermeasures

a) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the accident.

b) Why-why Analysis

Pursuit of Root Causes by the Why-why Analysis Diagram

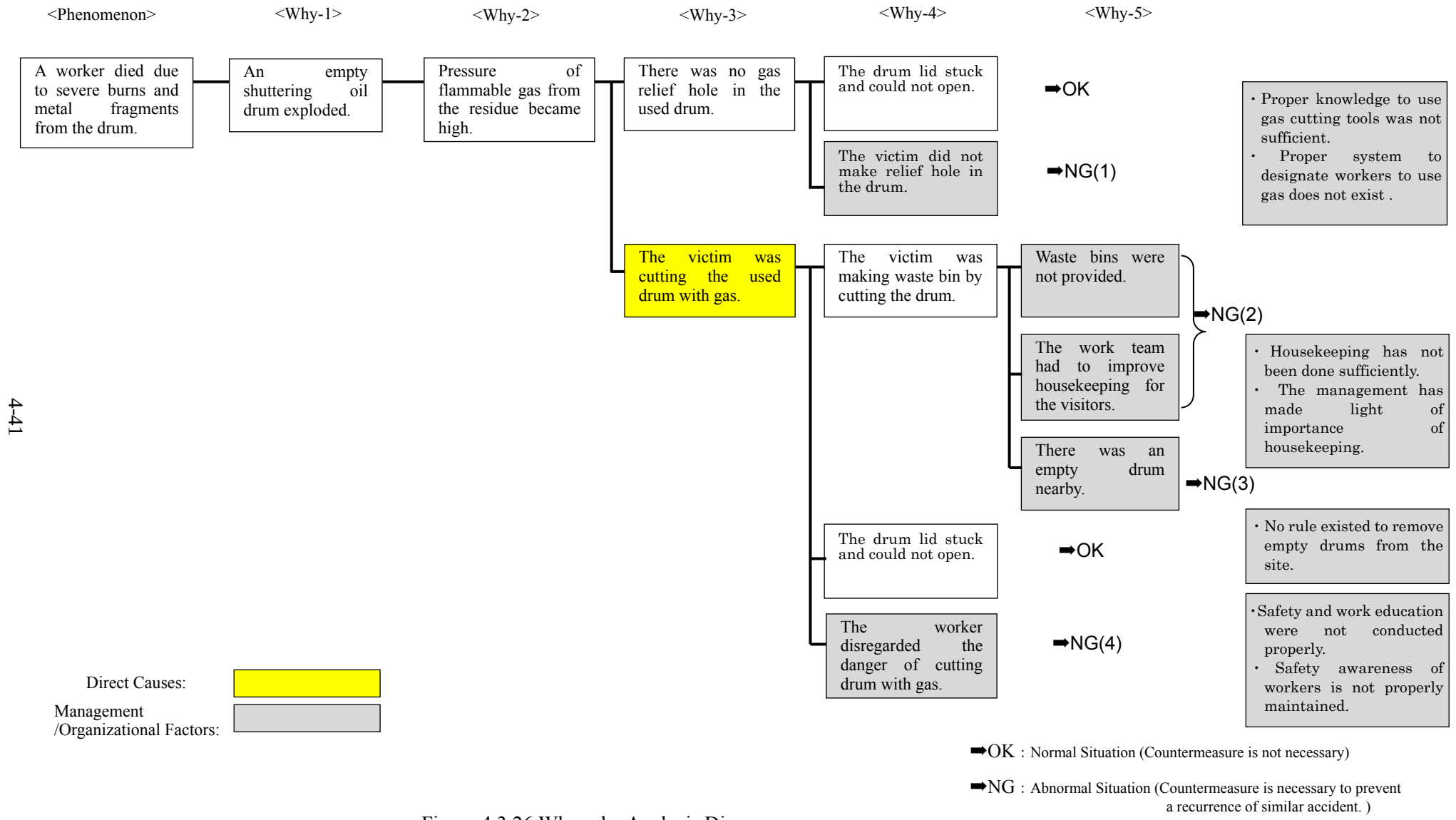


Figure 4.3.26 Why-why Analysis Diagram

c) Countermeasures against Direct Cause

Table 4.3.6 Provisional Countermeasures to Prevent Recurrences of Similar Accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. The victim was cutting the used drum with gas in order to make a waste bin. (There was residue of shuttering oil in the drum.)	Establish rules for reuse of empty drums and notify all sites of the rules thoroughly displaying signage and posters.	Notify all workers of danger of flammable material utilizing tool box meeting.	Designate specific personnel for using gas cutting devices and give necessary training and education.
	Provide all sites proper waste bins.	-	-

(Source: Accident Report)

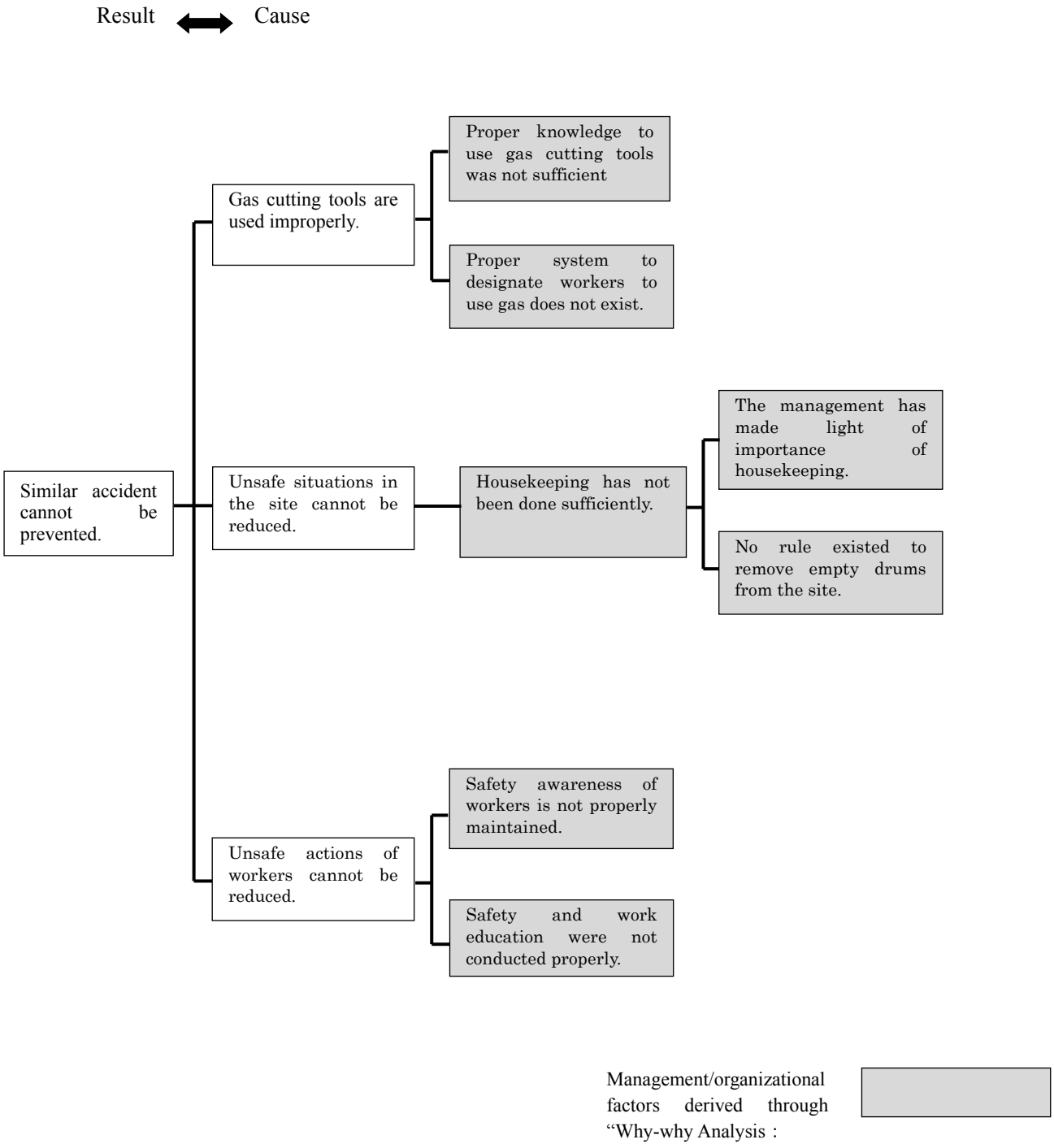


Figure 4.3.27 Problem Tree Leading to the Accident (Management/Organizational Factors)

e) Countermeasures for Management/Organizational Factors (1)

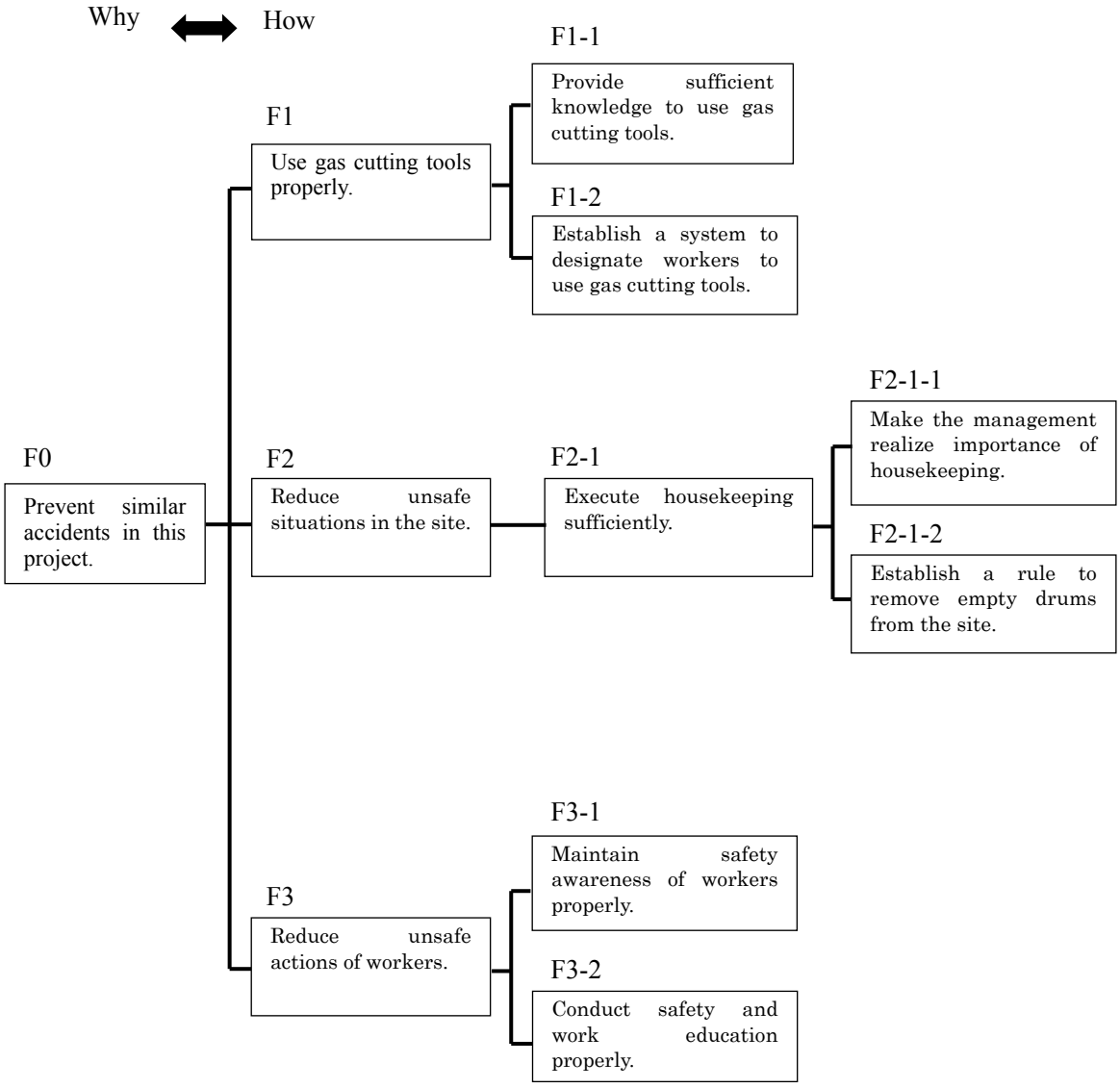


Figure 4.3.28 Function Tree to Prevent Grave Accident (Management/Organizational Factor)
Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.4 Root Cause Analysis - Integral Analysis

4.4.1 Accidents Concerning Safety of Works (3 Re-bar Collapsing Accidents)

[Concept and Procedure of Integral Analysis]
In the previous chapter, the individual re-bar collapsing accident was studied for its root causes.
Through the analysis flow of Why-why Analysis ~ Problem Tree ~ Function Tree, it has been clarified what kind of management and/or organizational factors must be solved in order to prevent recurrence of similar kind of the accident.

In the next step, Integral Analysis, the countermeasures for securing safety and preventing accidents in this project shall be discussed by seeing the management/organizational factors objectively.
Many countermeasures and recommendations obtained in this study are expected to be able to apply to other projects which may have similarities in construction conditions and local characteristics.

Procedure of the integral analysis is as follows;

(1) Integral Function Tree (It shows the activities necessary to prevent accidents in the project.)
The integral function tree can be made by superposing the function groups (a group of functions which have relations each other when these functions have a certain common purpose.) which are shown on some individual function trees. By doing so, functions to be achieved in order to solve the problem in the concerned project can be shown visually.

↓

(2) Sorting out the management and organizational factors derived from the individual accident.

↓

(3) Classification of the factors and evaluation of those by their significances.

↓

(4) Presenting measures to solve those factors, countermeasures to prevent recurrence of accidents and recommendations.

1) Integrated Function Tree

When looking at the problem trees for three re-bar collapsing accidents (Figure 4.3.4, Figure 4.3.9, Figure 4.3.14) and the function trees (Figure 4.3.5, Figure 4.3.10, Figure 4.3.15), they are almost same and there is no difference in the necessary functions to achieve for preventing recurrence of similar accidents.
Thus, Figure 4.3.15 shall be used as the integral function tree.
Figure 4.4.1 represents the integral function tree as the ideal state (the to-be function tree) for safety management in DFC project drawn based on the re-bar collapsing accidents.

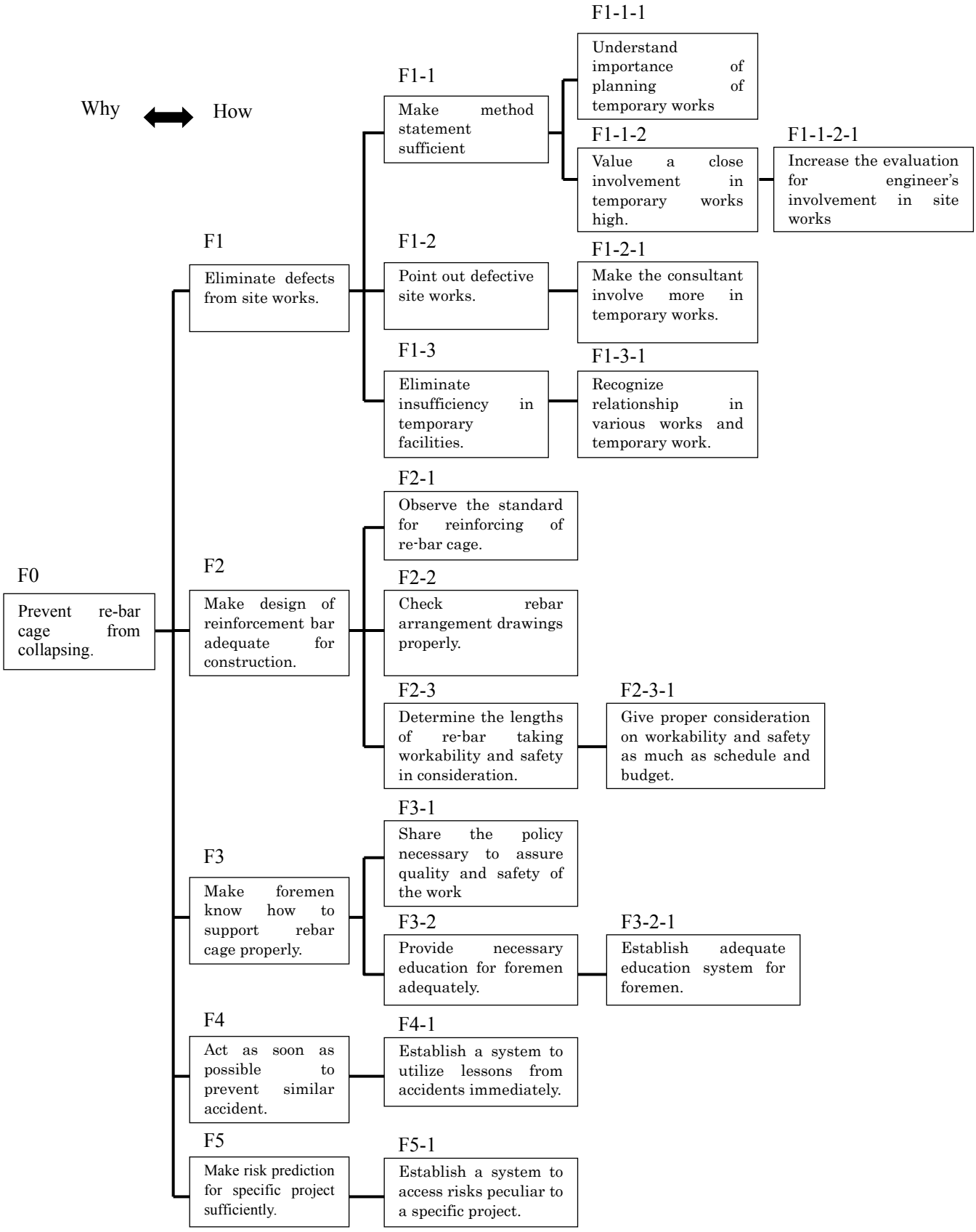


Figure 4.4.1 Integral Function Tree of Safety Management for Re-bar Collapsing Accidents in DFC Project (To-be Function Tree)

The unstable shape of the re-bar structures during assembling work must be given as one of the main causes of those accidents. The other phenomenal problem should be that the support for re-bar structures were not planned systematically and left to discretion of the site engineers and foremen at individual work site.
Only three days after the first accident occurred on 2015/07/17, the second accident occurred. And ten day after the first accident, the third accident occurred successively.
The problem is that the fact in which no immediate measures was not taken during these ten days to the other hazardous sites can be inferred insufficient sense of risks in DFC's management.

Figure 4.4.2 shows information/comments regarding the design and construction planning/process for the re-bar works obtained during the hearing and the site inspection.

Figure 4.4.3 is the flow showing the process from preliminary design stage to construction stage.
Looking generally, the Delhi design team of DFC is taking charge of preliminary and technical design, and Jaipur design team is taking charge of construction design. However, it can be understood that communication between the two design teams and the construction teams was not maintained sufficiently from the result of the hearing due to the extended project site, and the type of contact (design and build) and also due to the tight schedule of the project.

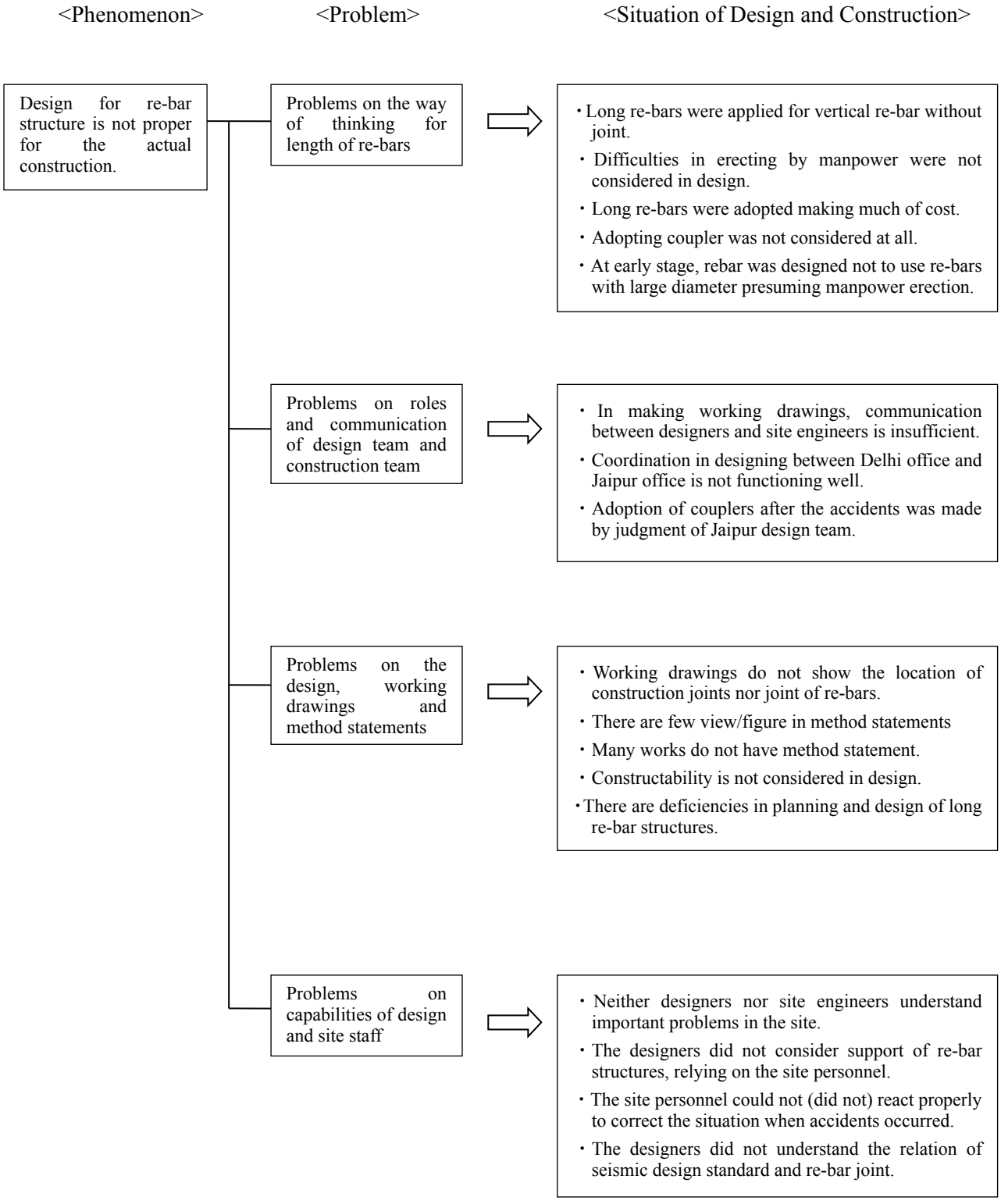


Figure 4.4.2 Problems and Situation in Designing and Construction Planning

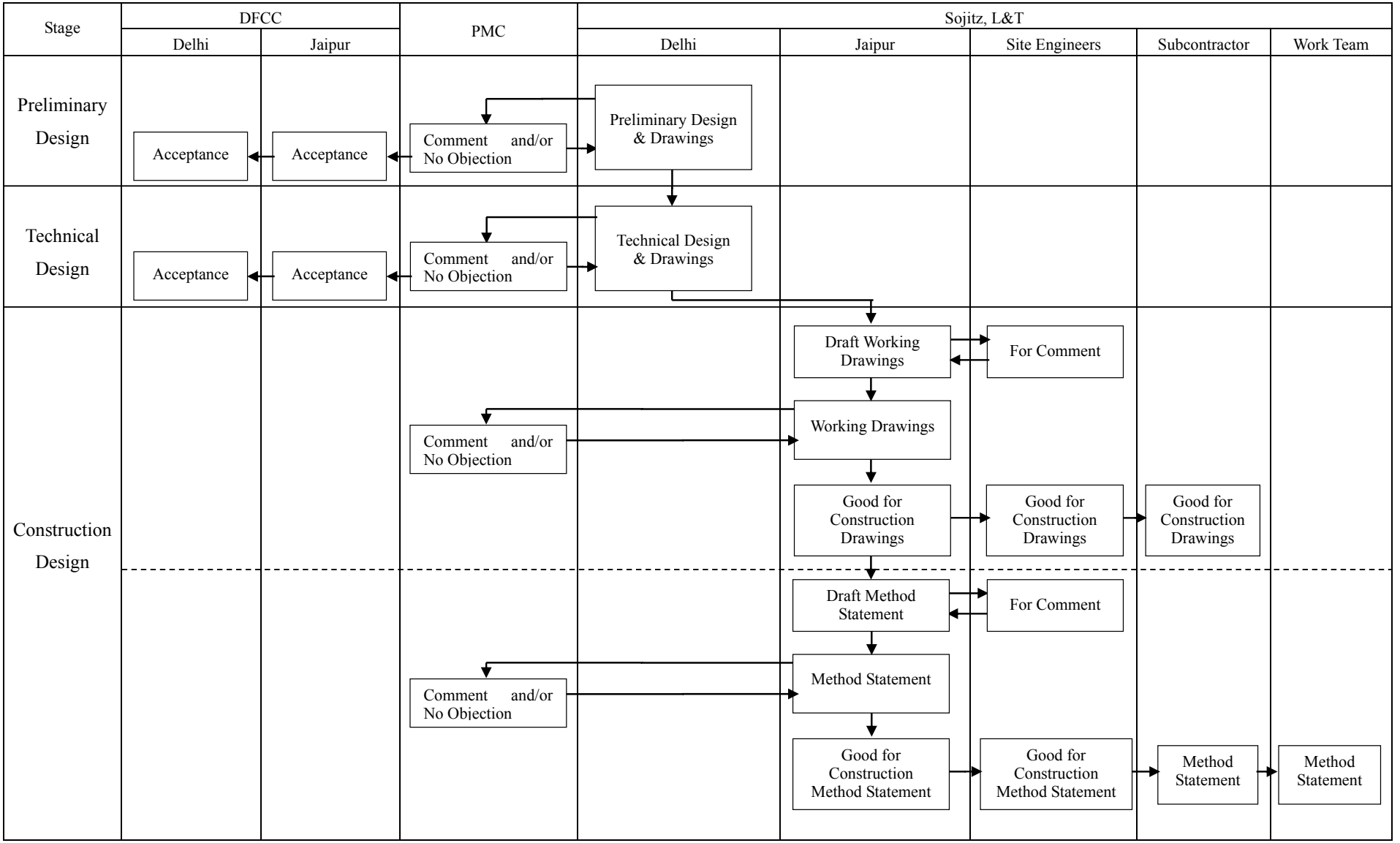


Figure 4.4.3 Design and Construction Flow in DFC

2) Sorting out the Management and Organizational Factors

Three accidents occurred under almost same situation, and the results of the root cause analysis also support the fact.

As the representative and comprehensive result, the why-why analysis diagram, the problem tree and the function tree for the accident on 2015/07/27 can be summarized to the management/organizational factors as shown in Table 4.4.1.

Table 4.4.1 Management/Organizational Factors for the Re-bar Accidents

Problem	Management Factors	Organizational Factors
1. Defects in construction works are overlooked and/or uncorrected.	1) Defects in works were overlooked due to lack of awareness to find out insufficiencies in re-bar supports. 2) Method statements were insufficient and there was no system to check their appropriateness. 3) Involvement of the consultant was not enough especially in the site works, as a result they could not find defects of works.	1) Site engineers did not recognize importance of planning of temporary facilities, thus necessary temporary facilities were not provided properly. 2) Top management does not recognize well the importance of site engineers' involvement in site works.
2. Re-bar design does not match to actual construction	1) There was no system to check the properness of re-bar drawings (the working drawings). 2) Erection of re-bar was left discretion of work teams, and there was no involvement of the design team for working drawings.	1) Application of long re-bar was determined making much of the economic merits. 2) There was little notion to consider constructability in design. 3) Communication was insufficient between design team and construction teams for sharing peculiarities and problems of construction sites.
3. Site engineers do not know proper re-bar support.	1) Education for foremen was insufficient, thus their knowledge stayed low. 2) Site engineers did not understand well the method of re-bar supporting.	1) The head office leaves all safety/ work education to the site without establishing education system. 2) Awareness for making quality/safety policy effective was low in the site.
4. Actions against accident tend to delay.	1) Awareness for utilizing the analysis results to prevent similar accident form reoccur was low. 2) Prompt action was not taken to prevent similar accident form reoccur.	1) Action to be taken for preventing recurrence of accidents was not understood well in the site.
5. Hazzard prediction of the site is insufficient.	1) Awareness that re-bar structures are most dangerous during erection was low. 2) There has been little preparation for unanticipated weather.	1) A system to conduct risk assessment thoroughly at the site did not exist.

3) Classification and Evaluation of Management/Organizational Factors for Safety

Table 4.4.2 Classification and Evaluation of Management/Organizational Factors for Re-bar Collapsing Accidents

Management Factors	Signifi-cance	Organizational Factors	Signifi-cance
(1) Management Factor concerning Design Works and Management		(1) Organizational Factor concerning Design Works and Management	
1) There was little notion to consider constructability in design.	◎	1) Communication was insufficient between design team and construction teams for sharing peculiarities and problems of construction sites.	◎
2) There was no system to check the properness of re-bar drawings (the working drawings).	◎	2) There was little notion to consider constructability in design.	◎
3) Erection of re-bar was left discretion of work teams, and there was no involvement of the design team for working drawings.	◎	3) Application of long re-bar was determined making much of the economic merits.	◎
(2) Management Factor concerning Construction Works and Management		(2) Organizational Factor concerning Construction Works and Management	
1) Defects in works were overlooked due to lack of awareness to find out insufficiencies in re-bar supports.	○	1) Communication was insufficient between design team and construction teams for sharing peculiarities and problems of construction sites.	◎
2) Site engineers did not recognize importance of planning of temporary facilities, thus necessary temporary facilities were not provided properly.	◎	2) Top management does not recognize well the importance of site engineers' involvement in site works.	○
3) Method statements were insufficient and there was no system to check their appropriateness.	◎	3) Erection of re-bar was left discretion of work teams, and there was no involvement of the design team for working drawings.	◎
4) Involvement of the consultant was not enough especially in the site works, as a result they could not find defects of works.	○		
5) There was no system to check the properness of re-bar drawings (the working drawings).	◎		
6) Erection of re-bar was left discretion of work teams, and there was no involvement of the design team for working drawings.	◎		
(3) Management Factor concerning Other Situations		(3) Organizational Factor concerning Other Situations	
1) Prompt action was not taken to prevent similar accident form reoccur.	◎	1) Action to be taken for preventing recurrence of accidents was not understood well in the site.	◎
2) Education for foremen was insufficient, thus their knowledge stayed low.	○	2) Awareness for utilizing the analysis results to prevent similar accident form reoccur was low.	◎
3) Site engineers did not understand well the method of re-bar supporting.	◎	3) A system to conduct risk assessment thoroughly at the site did not exist.	◎
4) Awareness that re-bar structures are most dangerous during erection was low.	◎	4) The head office leaves all safety/ work education to the site without establishing education system.	○
5) There has been little preparation for unanticipated weather.	○	5) Awareness for making quality/safety policy effective was low in the site.	○

◎ : Very Important, ○ : Important

4.4.2 Accidents Concerning Occupational Safety and Health

1) Integral Function Tree

Figure 4.4.4 shows the integral function tree derived from three accidents relating to occupational safety and health. The integral function tree is representing the “To-be” functions for safety management in DFC project.

The integral function tree tells the followings;

a) Same as the general occupational accidents, those accidents were also occurred when unsafe actions of workers meets unsafe situation of the work site. Determined actions for both side is required for preventing recurrence.

b) For unsafe actions, understandings of accident factors and countermeasures based on characteristics of DFC project. The followings should be noted as characteristics of the project.
   - The project is on a large scale and numbers of workers is also large.
   - The work condition is very harsh for workers, especially in summer with severe heat.
   - Education tends to be ineffective because many workers are coming in and leaving in short time.
   - Safety awareness of workers is not satisfactorily high.
   - Safety monitoring by the contractor is difficult especially for suppliers’ drivers.
   - Conditions and maintenance of vehicles and equipment owned by supplier and some of the subcontractors are in improper state.

c) For unsafe situations relating to objective accidents, the following characteristics are recognized.
   - There are cases that staff in charge cannot see the unsafe situation due to the broadness of the site.
   - Due to change of works and location of the site, safety facilities tend to become insufficient.
   - Insufficient housekeeping, cleanliness and tidiness often become one of the causes of an accident.
   - There are unsafe situations induced by changes of works and conditions of site location etc.

d) Accidents due to aging or poorly maintained vehicles are problems which are often found commonly in developing countries.

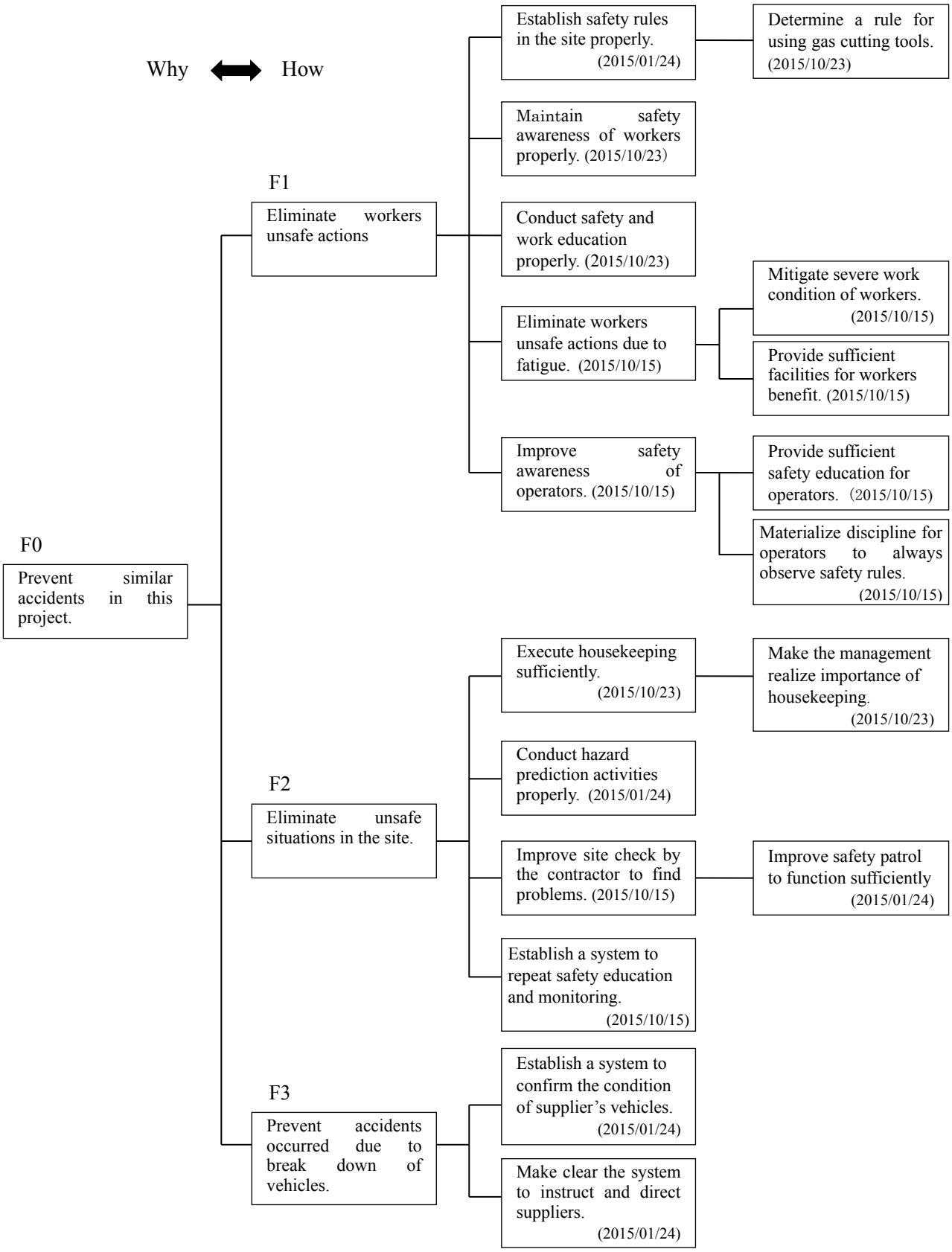


Figure 4.4.4 Integral Function Tree of Safety Management for Occupational Safety and Health in DFC Project (To-be Function Tree)

2) Sorting out the Management and Organizational Factors

Table 4.4.3 Management and Organizational Factors for Occupational Safety and Health

Accident	Management Factors	Organizational Factors
Crushed to Death by Turning Over of a Truck (2015/01/25)	1) There is no system to confirm the conditions of vehicles owned by suppliers. 2) Safety patrol has not functioned well judging from the fact it could not point out the hazardous road due to lack off safety facilities. 3) The driver who tried to jump off the truck and was crushed was most probably not using the seat belt. Safety rules were not observed sufficiently.	1) The system to instruct and direct suppliers is not clearly established. 2) Safety education for drivers and workers who are employed by suppliers (including some subcontractors) are left to them.
Crushed to Death by Compaction Roller (2015/10/15)	1) Site check/patrol by the contractor is not functioning sufficiently to find problems. 2) Safety education for operators was insufficient and discipline for operators to always observe safety rules was not also properly made.	1) Both the subcontractors and the contractor lack consideration for workers under severe work conditions. 2) Sense of improving treatment of workers is lacking in the contractor. 3) A system to repeat safety education and monitoring is not established. 4) Safety awareness of workers stays at low level.
Burned to Death by Exploded Drum (2015/10/23)	1) Proper system to designate workers to use gas does not exist. 2) Safety education and enlightenment for hazard in the construction site was not sufficient. 3) Safety and work education for safe work were not conducted properly.	1) Notion of necessity for housekeeping, cleanliness and tidiness of construction site was not commonly recognized in the whole site. 2) The management has made light of importance of housekeeping. 3) Safety awareness of workers stays at low level.

3) Classification and Evaluation of Management/Organizational Factors for Safety

Table 4.4.4 Classification and Evaluation of Management/Organizational Factors for Occupational Safety and Health

Management Factors	Significance	Organizational Factors	Significance
(1) Management Factor concerning Safety Management		(1) Organizational Factor concerning Safety Management	
1) Safety patrol has not functioned well judging from the fact it could not point out the hazardous road due to lack off safety facilities.	○	1) Notion of necessity for housekeeping, cleanliness and tidiness of construction site was not commonly recognized in the whole site.	◎
2) Site check/patrol by the contractor is not functioning sufficiently to find problems.	◎	2) The management has made light of importance of housekeeping.	◎
(2) Management Factor concerning Safety Education and Enlightenment		(2) Organizational Factor concerning Safety Education and Enlightenment	
1) Safety rules such as using seat belt were not observed sufficiently.	◎	1) Safety education for drivers and workers who are employed by suppliers (including some subcontractors) are left to them.	◎
2) Safety education for operators was insufficient and discipline for operators to always observe safety rules was not also properly made.	◎	2) A system to repeat safety education and monitoring is not established.	○
3) Safety education and enlightenment for hazard in the construction site was not sufficient.	◎	3) Safety awareness of workers stays at low level.	◎
4) Safety and work education for safe work were not conducted properly.	◎		
(3) Management Factor concerning Labour Management		(3) Organizational Factor concerning Labour Management	
1) Proper system to designate workers to use gas does not exist.	○	1) Both the subcontractors and the contractor lack consideration for workers under severe work conditions.	◎
		2) Sense of improving workers treatment is lacking in the contractor.	◎
(4) Management Factor concerning Supplier/Subcontractor Management			
1) There is no system to confirm the conditions of vehicles owned by suppliers.	○		
2) The system to instruct and direct suppliers is not clearly established.	○		

◎ : Very Important, ○ : Important

4.5 Permanent Countermeasures for Preventing Recurrence of Accidents

Table 4.5.1 Permanent Countermeasures for Preventing Recurrence of Accidents from Management/Organizational Factors (Safety of Works)

Classification	Item	Recommendations
Recommendations concerning Safety of Works	For Factors Relating to Design Works and Management	1) In every step of designing works, re-bar arrangement shall be determined by not only economic standpoint but taking constructability and stability/safety during construction into account. 2) When making working drawings, close cooperation between design and construction teams shall be maintained so that the working drawings match with the actual site conditions etc. 3) In each step through design to construction, communication among preliminary/technical design team, working design team and construction teams shall be maintained and improved. 4) Joint of re-bar and reinforcement of cage and its support etc. shall be shown in working drawings taking characteristics and conditions of the site into account. 5) A practical system shall be established in order to transmit information concerning such as re-bar assembling works to design teams to feedback them to the future design. 6) Allocate staff from working design team to each package to collect and transmit information of construction effectively.
	For Factors Relating to Construction Works and Management	1) A system to select re-bar support method suitable to each site conditions shall be made by studying and developing various support methods. 2) Site inspection tour shall include checking of re-bar support as one of the most important items 3) Systematic education concerning temporary works including re-bar support shall be given to site engineers and foremen. 4) In order to make effective method statements, prepare prototype method statements stating also re-bar support in detail with figures which are easy to understand. 5) A system to check the method statements in cooperation of construction team, working design teams and other related staff.
	For Factors Relating to Other Situations	1) In order that immediately after an accident occurred, urgent countermeasures to prevent recurrence of similar accident can be taken, a chain of direction shall be clear and established. 2) Arrangement for each department and staff in charge can act immediately for an accident shall be clearly made. 3) Effort for site engineers to find hidden risks in the construction site shall be clearly defined as an important task.

Table 4.5.2 Permanent Countermeasures for Preventing Recurrence of Accidents from Management/Organizational Factors (Occupational Safety and Health)

Classification	Item	Recommendations
Recommendations concerning Occupational Safety and Health	For Factors Relating to Safety Management	1) Top management takes initiative to infiltrate the importance of housekeeping, cleanliness and tidiness in the construction site thoroughly. 2) Safety patrol and site inspection tour shall be improved so that they function to find unsafe situations and actions which may cause similar accidents as the objectives.
	For Factors Relating to Safety Education and Enlightenment	1) A system of conducting safety education repeatedly and monitoring its effectiveness shall be established. 2) Safety education for workers shall include education of discipline to observe the site safety rules surely. 3) Actions for site engineers to take shall be clearly defined addition to improvement of workers' safety awareness. 4) Establish a system of work education and technical education for safe works. 5) The contractor shall make proper safety education program and instruct subcontractors and suppliers to conduct safety education to their workers and to report its result regularly.
	For Factors Relating to Labour Management	1) The contractor in cooperation with subcontractors shall make an effort for improving work environment and work conditions. 2) A system shall be made in order to check workers' capabilities and experience when making them use sort of special devices and tools.
	For Factors Relating to Supplier/Subcontractor Management	1) The contractor shall conduct surprise check for the status of vehicles owned by suppliers and make a rule to prohibit from using them when he judges that they do not fulfil the standard. 2) A system for the contractor to instruct/direct suppliers regarding status of load and transporting in the site and other aspects shall be made.

Chapter 5 Safety Seminar

The major purposes of this study were to collect the latest information on the legal framework, standards, regulations, etc. for occupational safety and health management in the host country, verify how the safety management was conducted as the construction works were actually done, analyze the causes of accidents, if any, in the construction work, and study how to prevent accidents in the future, and so on. Another purpose of this study was to feed back the results of the study thus conducted to all stakeholders in the construction project in the form of a seminar to help them make further efforts for the prevention of occupational accidents and public disasters in the future.

5.1 Seminar Outline

(1) Configuration of the presentations

In planning the seminar aimed to help the Project's construction sites better prevent accidents in the future, we found it most effective for the local parties involved in the construction works if we present specific examples of particular efforts and attention made in Japan to ensure safety on construction sites. Further, we thought that, to make our proposals for the prevention of future accidents really effective, we should look not only at technical aspects (direct causes) of accidents, but also at how the safety management system, or even the project itself, is being run (indirect causes). Thus, in addition to proposals on how to prevent specific types of accidents, we made proposals on how to enhance the project management system itself, if we found rooms for improvements.

Based on the above philosophy, we designed the presentations to be given in the field seminar to focus on five subjects:

(i) Presentation of the legal framework for occupational safety and health management in Japan
(ii) Presentation of examples of efforts made to prevent accidents on construction sites in Japan.
(iii) Presentation of the contents and purposes of the Guidance for the Management of Safety for Construction Works in Japanese ODA Projects
(iv) Results of the survey conducted by the study team on the safety management in the Project's construction sites; proposals for measures to be taken
(v) Root cause analysis method; examples of application

(2) Audience, language, venue, etc. of the seminar

We planned the seminar on the initial assumption that the audience would be 30 to 40 people from the parties concerned in the construction work (the employer, consultant, contractor, subcontractors, etc.). The venue of the seminar was chosen from cities that seemed easily accessible to these participants.

In India, the study concerned the Dedicated Freight Corridor Project (Phase I), so we found it appropriate to organize the seminar somewhere near the segment where track construction would be presumably most active at the time of the field survey (mid- to late-October, 2015). In consultation with JICA, we decided to hold the lecture in the city of Jaipur, Rajasthan. As the venue, we reserved a hotel that offers the space best fit to the size of the event. English was chosen as the language of the seminar and handouts materials.

Outline of the seminar
Date : October 29, 2015, 14:00-15:30
Venue: Seminar Hall, Hotel Radisson Blu Jaipur
Attendees: 46 (5 from DFCCIL, 24 from SLT, 9 from PMC, and 2 from the survey team (Some

forgot to sign the guest register).

(3) Seminar program

Table 5.1.1 shows the program of the safety seminar held in Jaipur.

Table 5.1.1 Program of the seminar (Jaipur)

Session /Time	Description
Opening Address 14:00-14:15	Nigel WIRTZ, Head of Environment, Health & Safety, L&T Toshio TAKEBAYASHI, JICA study team leader
Session 1 14:15-14:35	**Framework of safety management in Japan, India, and Japan's ODA projects** - Framework of Occupational Safety and Health Management in India and Japan - Framework of Occupational Safety and Health Management in Japan's ODA Projects Fujio ITO, JICA study team member <Brief Q&A session>
Session 2 14:35-14:55	**JICA team's findings on the safety management in the WDFC Project** Toshio TAKEBAYASHI < Brief Q&A session>
14:55-15:10	Coffee Break
Session 3 15:10-15:25	**Recommendations for the safety management in the WDFC Project** Toshio TAKEBAYASHI <Q&A session>
Session 4 15:25-15:40	**Root Cause Analysis for the Issues of WDFC Project** by Mr. Toshio TAKEBAYASHI <Q&A >
Closing Address 15:40-15:45	Nigel WIRTZ

5.2 Presentation by the Study Team

Shown below are the description of the presentations given by the study team, summarizing the purpose and gist of each one. The presentation materials used in the seminar are attached at the end of this report in Appendix.

(1) Section 1 Safety Management Framework - at the National Level and in ODA Projects

(i) Occupational Safety and Health Framework in Japan

Gave a general presentation on the occupational safety and health management services provided in Japan, focusing on the administrative framework, management systems, and how they are operated on construction sites, and so on. The presentation specifically covered the following subjects:

- How the administrative systems for occupational safety and health management are operated by the Ministry of Health, Labor and Welfare, other national and/or local governments and agencies; what kind of roles the labor standard bureaus and the Labor Standards Act play in it;
- How laws and regulations on occupational safety and health management are organized, what the provisions of the Occupational Safety and Health Act say;
- How the number of deaths and injuries on construction sites in Japan has evolved since the 1950s;
- In Japan, construction contracts are often closed, two-party relationships between the owner and the contractor, giving the owner strong authorities in the supervision and audit of the construction work;

- Relationship between the Industrial Safety and Health Act and the Detailed Regulations for Enforcement of the Act;
- Roles of the Occupational Safety and Health Management Systems (OSHMS) and the Construction Occupational Safety and Health Management Systems (COHSMS);
- How the COHSMS are operated;
- How construction works are carried out in Japan;
- Three major features of the Japanese systems of safety management on construction sites: the presence of the Industrial Safety and Health Act; site visits by labor standard inspectors; and penalty imposed upon accidents;
- Examples of safety manuals; safety instructions by work type correspond to provision numbers in the Detailed Regulations for Enforcement of the Occupational Safety and Health Act;

(ii) Framework of occupational safety and health management in India

Presented the framework of occupational safety and health management in India based on the results of preliminary information collection in Japan and the field survey in India as follows:

- The result of classification of the central government's ministries and agencies, public corporations, etc. into those who have authority to carry out/order a construction work and those who have not;
- A summary of the national administrative system for OSHM under the Ministry of Labour and Employment and other ministries and agencies; the role of the Directorate General, Factory Advice Service and Labour Institutes (DGFASLI), part of the MoLE;
- A summary of the legal system on OSHM in India;

(iii) Comparison of OSH frameworks in India and Japan

- Comparison of legal system on OSHM in India (this study), Kenya, and Japan;
- Comparison between the Indian policy on safety, health, and environment (SHE) and the Japanese Occupational Safety and Health Act;
- Comparison of the provisions on the enforcement, supervision, and penalty in the OSHM-related laws and regulations in India and Japan;
- Three major features of the framework for OSHM on construction sites in Japan: the presence of the Industrial Safety and Health Act; site visits by labor standard inspectors; and penalty imposed upon accidents;

(iv) Framework of occupational safety and health management in Japan's ODA projects

Gave a presentation on the framework for OSHM in construction works carried out as part of Japanese overseas yen-loan projects. In individual construction works, the top priority is given to compliance with the laws and regulations of the host country. If the host government or owner of the construction work has its own guidelines on OSHM, the construction work is carried out in compliance with those guidelines.

(v) Guidance for the management of safety for construction works in Japanese ODA projects

Gage a presentation on *the Guidance for the management of safety for construction works in Japanese ODA projects* developed and published by JICA for construction works carried out by Japan as part of its overseas ODA projects. Also gave clarifications to questions that the readers might have regarding how to apply the guidance.

(2) Session 2: JICA team's observations on safety management in the WDFC Project

(i) Challenges facing this project

(a) An unprecedentedly large, single contract and stretched logistic routes

- Breakdown of the mega-scale, single contract
- With a 626-km total length of the construction work site, more than 5,000 workers engaged, the project is divided into CTP-1, which is subdivided into Packages A and B and CTP-2, which is subdivided into Packages C and D.

b) Schedule to handle large quantities
- The initially planned four-year construction period; the actual progress of the work as of the time of the study (late October, 2015).
- The construction work soon enters its most intensive phase.

c) Resources and hierarchy to handle the project
- Organization to carry out the construction work (Employer: DFCCIL, Contractor: SL&T)

d) Contractual requirements on quality and safety
- Configuration of contractual documents on construction works; In design and build projects, the Employer's requirements and specifications include requirements on quality and safety;
- General configuration of the Employer's requirements;
- Safety-related provisions in the contractual documents for the Dedicated Freight Corridor Project (Phase I);
- Provisions in contractual documents on Indian SHE policy;

(ii) Works adjacent to railways

The result of our site visits revealed that some of the DFC construction work sites adjacent to the existing Indian Railway (IR) tracks involve high construction work risks (i.e., influence on IR's tracks and embankment; the DFC construction work itself). We expressed opinions and made proposals as follows:

- Points to note on construction sites adjacent to IR's tracks as defined in construction work contracts (specifications, employer's requirements)
- (Three) specific technical work risks found in the field;

(iii) Major Accidents in the project

A summary of accidents (six in total) that occurred in the project by the end of October 2015, specifically focusing on three successive collapse of reinforcing steel structures in July 2015 (for piers and culverts under rail flyovers).

(iv) What are behind the anomalies and accidents?

As factors that contributed to the occurrence of the accidents, the study team pointed out such problems as problems in the Contractor's system in meeting the demands of mega-scale project and exchanging information (including design information), insufficient sharing of experience between the packages, etc., specifically from the following viewpoints:

(a) Progress and accidents
- August and September monthly reports (from the Consultant and the Contractor) indicated that the site works were entering their most intensive phases.
- Generally speaking, experience shows that, when a construction work enters its busiest phase, there tend to occur accidents and disasters.
- Showed an example from the team's last year's survey on an expressway construction site in Sri Lanka: As the construction work entered its peak phase, the frequency of accidents increased, as

shown in an S-shape curve graph (of work progress).

(b) Weakness in the project management

Suggested some viewpoints focusing on the weakness in the project management, here exacerbated with a mega-scale project;

(c) (Overall) communication/coordination

- What often happens in a mega-scale project is the lack of communication and information exchange between different levels of participants in the project, including the management, engineers, officers, and workers, which may constitute a factor contributing to the occurrence of accidents and disasters (See Figure 5.2.1);
- Indicated the need to review more in detail and concretely how communication and information exchange are ensured between the different levels of participants in the project;

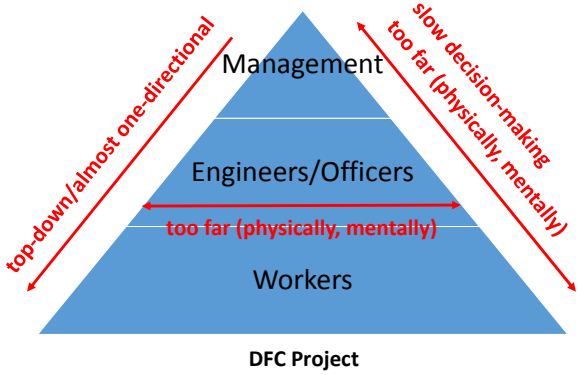


Figure 5.2.1 Lack of communication and information exchange in a mega-scale project

(d) Communication/coordination between the design team, the construction team, and the safety team

Presented the results of an interview survey we conducted about how the Contractor (L&T)'s design office in Delhi and the site office in Jaipur exchanged design-related communication and information between them, specifically about the type of design drawings exchanged and responsibilities shared between them;

- Taking for instance the collapse of reinforcing steel structures that happened in July, suggested the need to review such questions as: What happened between the design office and the site office at the time of the accident? Were temporary works designed according to the Employer's requirements?, and so on;
- Suggested the need to review what happened in the stage of construction design that the Jaipur office was responsible for;
- Presented the provisions in the Employer's requirements on temporary works; submission, after designing temporary works, of design drawings to the consultant; and verification and approval of the drawings by the consultant;
- Presented similar provisions in the specifications;
- Expressed the study team's opinion that there was a lack of communication and information exchange between the design office in Jaipur and the site office;

(3) Session 3: Recommendations on WDFC Project

Based on the results of the study shown and opinions held above, we made eight proposals:

- Need to review if the current project management system sufficiently responds to the scale of the mega-project;
- Inside the Contractor, the need for the design team and the construction work team to keep good communication between them before, during, and after the development of the execution scheme;
- When designing structures, it is important to always take into care of onsite workability and potential execution risks;

- When running a mega-scale project, it is indispensable to systemize and standardize methods for managing various operations and procedures;
- When drafting an execution scheme, it is important to make the best use of drawings and sketches;
- On construction sites adjacent to IR's tracks, the need to regularly conduct monitoring and set values of permissible displacement to prevent influence on the IR's tracks (displacement and deformation);
- On construction sites adjacent to IR's routes, the need to study measures to prevent the construction work from affecting them by drafting a list of high work-risk points (Risk Register) from an earliest stage;
- The need to continuously carry out educational and training activities to increase workers' awareness for safety

(4) Root cause analysis for the issues of WDFC Project

- Outline of root cause analysis; flow of analysis;
- Explanation of external environmental factors contributing to the occurrence of accidents and disasters; individual factors that may constitute such external environmental factors in the WDFC Project;

5.3 Summary of Questions and Answers

Shown below is the outline of the questions and answers exchanged between the lecturers and the audience at the seminar.

Question 1

Question	You said that, in Japan, the number of accidents drastically decreased after the implementation of OSHM Act in 1972. What I'd like to know is how the law is actually enforced: Is it an exact routine that the construction company that caused the accident is punished or imprisoned?
Answer	That's right. It's a very routine procedure. If a company caused a fatal accident, someone representing the company is summoned in any case.

Question 2

Question	What will be the trend of the enforcement regime of OSHM-related legislation in India in the decade to come?
Answer	According to the Ministry of Labor, the enforcement regime is going to change gradually. Currently a legislation reform is under way to simplify and combine seven OSHM-related acts into four ones, they said.
Comments by participant	Let me say a word about punishment: In India, it's the rumor that a company caused an accident that damages it more than monetary penalty. If the case is brought into court, the rumors spread and significantly influence the sales activities of the company.

Question 3

Question	In Japan, are most the site workers those who have worked in other construction works? Are there cases where there are many novices like in this project? Workers constantly change in the DFC projects. Whether you can effectively enforce laws and rules depends, to certain degree, upon workers' experience.
Answer	Many of construction workers in Japan today are experienced workers, but, in the 1960s and 70s, there were many holes in the education and training of workers and we had some difficulty dealing with problems. What we see now in Japan is the result of repeated and continuous efforts to educate workers over time. The labor management system in Japan is a

	complex, well-developed one, but we supplement it with double and triple contingency, for example by adding punishment rules and so on.

Shown below are some of the comments given by attendees to the seminar.

Participant No.1	Resources will be provided to the design team for having a better interaction between the design team and field team.
Participant No.2	The team has realised that there is lack of communication between the site and design team. They will also modify method statements accordingly.
Participant No.3	Package A is the leader. All things first happen in Package A and the other package follows. The managers of package A will be merged in other packages so that they can share their experience in other packages.
Participant No.4	Design team is divided into packages.
Participant No.5	Working drawings will be introduced which were not there earlier. There would be more clear drawings easy to be understood by site people.
Participant No.6	Observers for faults in designs and on-going constructions are required apart from site engineers.
Participant No.7	SLT will be doing why-why analysis on their problems too.
Participant No.8	The gap between designers and site will be reduced. The designers will be asked to go to site and inspect site conditions.
Participant No.9	The three fatal accidents will be analysed using why-why analysis by SLT.
Participant No.10	Safety is to be inculcated at grass-root level to senior level management.
Participant No.11	SLT was in great trauma after accident and lots of brain storming was done to analyse the accident.

5.4 Seminar in Delhi

In response to DFCCIL's request, another seminar for DFCCIL's management was conducted in Delhi in the following manner.

Date : October 30, 2015, 12:30-13:30
Venue : DFCCIL Delhi Office, Meeting Room
Attendees : 15 (2 from JICA, 4 from DFCCIL, 1 from SLT, 6 from PMC, 2 from the study team).
Program : Sections 2 & 3 of Table 5.1.1

5.5 Seminar Scene (in Jaipur)






Photo 5.5.1 Seminar Scene

Chapter 6 Follow-up

6.1 Accident Recurrence Preventive Measures taken by the Project Staff's Initiative

Six accidents occurred until the completion of field study as indicated in Table 4.1.1. Out of which four accidents had occurred before commencement of field study on 17 October 2016, and adequate countermeasures had been taken immediately after each accident. Similarly, adequate countermeasures were taken immediately after the two accidents occurred during the field study period. Those countermeasures are summarized in the following table.

Attention should be drawn to Item Nos. 5 & 6 in the table, where the project safety team tried to apply "Root Cause Analysis" together with "Why-Why Analysis" which the Study Team introduced in the seminars on site conducted on 29 & 30 October 2015.

Table 6.1.1 Accident Recurrence Preventive Measures taken by the Project Staff's Initiative

No.	Causes of Accident (inferred by project staff)	Accident Recurrence Preventive Measures (taken by project staff)
1	1) The new driver did not have a good grip of site conditions. 2) Due to a mechanical trouble, the truck became out of control. 3) The loaded steel members which were not fixed tightly shifted during transportation and the truck lost the balance.	1) Review/update transport management plan. 2) Review/update the management of vehicles without entrance certificate 3) Review/update safety plans of all sites 4) Notification of safety requirements to all transporters and suppliers 5) Safety training to supervisors, staff and drivers
2 3 4	1) Heavy windy condition. 2) Heavy rain caused earth erosion at the supports. Rebars were supported by a single support at either end, which could not stop collapse of rebar cage. 3) Insufficient tying of all nods of horizontal and vertical rebars with wires during assembling bars. 4) Insufficient experience of site engineers, foreman, and rebar fitters. 5) Risk assessment did not considered accident risk during assembling of rebars. 6) Method statement did not describe on temporary bars for assembling works or foundations/quality of support pipes.	1) Rigid supporting system 2) Use of couplers of rebars to make short vertical rebars or use of L-shape rebars for bottom of long vertical bars 3) Training to site engineers, foreman, and rebar fitters. 4) Frequent check of rebar safety by site engineers 5) Dissemination of accident recurrence preventive measures at workshops by Project Director, Project managers, Structure engineers, Jr. Structure engineer; safety training to foremen & workers; Pep talk at morning assembly

5	1) The plant operator started the machine without first checking around it to ensure that no one was in front or underneath. 2) It is assumed that the victim might have felt tired and wanted to take rest in the shadow in front of the compaction roller. 3) There is shade in other locations around the site but this is more than 100m away. Portable shade or a fixed resting facility was not available on this site. 4) The Victim may not have been aware of the hazard of accidentally being crushed by roller while either sitting or lying in front of the machine. It is assumed that even if the victim may have been aware of the danger he might have assessed that the operator would not be starting or moving the machine without first checking around or giving some kind of warning. 5) No alarm warning system was fitted to the compaction roller to warn or delay start of the machine. 6) The level of education and training was underestimated by the contractor for the workers.	<Immediate Action> 1) Pep talks to improve the awareness among the workmen about of the hazard of accidental rollover while resting or sleeping near to the vehicle or earthmoving equipment. 2) Each construction site supervisor to maintain a site diary and produce a daily condition report which will detail any safety concerns. 3) Mock drill to be conducted on workmen hit by Earth mover. 4) Training conducted on Safe Operation Plant & Machinery and Incident Case Study 5) Inspection and Audit 6) All earth levelling graders and compaction rollers will be fixed with delay starters. 7) Issue of pamphlets printed with safety instructions in HINDI to the operators of earth moving equipment. 8) Display of warning sign board (Resting under Vehicle / Equipment is prohibited) on all earth moving equipment <Action required for preventing recurrence of similar incidents in future> 1) SLT introduce 4 Site Safety Surveillance Squads 2) Stopping Work on the Grounds of Safety 3) Emergency Preparedness 4) Safety Information and Training 5) Inspection and Audit 6) Monitoring and necessary maintenance to be ensued by P&M department. 7) Subcontractor and Partner Management 8) Bulletin boards to be displayed at various places to educate workmen about the safety working practices to prevent such accidents.
6	1) Inadequate competence to perform Gas cutting operation and Victim was unaware of hazard 2) Unplanned work 3) Reckless behaviour of the victim 4) Inadequate supervision resulting in shortcuts 5) Lack of recycling rules and guidance 6) Waste bins not provided by stores 7) Lack of process to return empty drums 8) No permit or permission taken to use gas cutting equipment 9) Lack of safety signage to inform of the golden rules of safety 10) Inadequate PPE as a result of no risk assessment	<Immediate Action> 1) Maintain a site diary and produce a daily condition report detailing any safety concerns. 2) Review of all emergency plan including first aid and capable medical facilities. 3) Gas cutting training by third party agency 4) Display of warning sign & posters to prevent from hazard. 5) Systematic plan for site usage and storage of empty flammable oil barrels. 6) The new drum to be issued only with return of old drum. 7) Mock drills and training to be conducted on particular incident in all sites. <Action required for preventing recurrence of similar

		incidents in future> 1) SLT introduce 4 Site Safety Surveillance Squads 2) Stopping Work on the Grounds of Safety 3) Safety Information and Training 4) Bulletin boards to be displayed at various places to educate workmen about the safety working practices to prevent such accidents. 5) Staff in charge of structure/store will make sure that the drums are returned back to store from site once it is utilized. 6) Store will control empty drums.

Note) Item Nos. 1-6 correspond to those in Table 4.1.1.

6.2 Recommendations on Additional Countermeasures

The issues/problems observed and the countermeasures recommended by the Study Team in the seminars conducted on 29/30 October 2015 in Jaipur/Delhi are summarized in the following table.

The Study Team judged that sufficient countermeasures had already been taken on site to the direct causes of accidents, and made recommendations on additional countermeasures to management/organizational factors.

In the table below, Item 1 is on "the overall project management" matter including safety, Items 2-7 on "Safety of Works", and Item 8 on "Occupational Safety and Health".

Table 6.2.1 Issues/problems observed and countermeasures recommended in the seminars (Re. Chapter 5)

No.	Issues/Problems Observed	Additional Countermeasures Recommended
1	This project is unprecedentedly large and long as a single contract, with stretched logistic routes. The required unit production rate is high due to the contract period of only 4 years despite a design & construction contract. To manage the project under such conditions, the contractor's organization is quite large with a single gigantic hierarchy structure. This has been causing communication problems such as one-directional instruction from the management, slow decision-making, psychologically too far distance between project members, etc. After July 2015, the frequency of accidents/ incidents increased as the construction speed increased. This may be attributable to gaps between various factors, such as the management and the site, engineers and workers, engineering and safety, etc.	The overall management structure/system presently applied shall be carefully reviewed. Enhancement of two-directional/cross-sectional communication and/or breaking one large hierarchy into one management + four medium-sized cells would be alternatives.
2	Communication between the Design Team and the Construction Team is poor. Documents required for construction works (such as permanent structure design, temporary structure design, method statements) are not necessarily prepared considering constructability or safety.	The Design Team shall communicate/coordinate with the Construction Team and Safety Team before/ during/after preparation of working drawings and method statements. It should be noted that people on site know the site better, while the Design Team knows design better. They should discuss the actual site conditions, design, construction methodology and safety regularly. Similar care shall be taken to the overall communication/coordination.
3	Temporary works design is not being implemented in accordance with the Employer's Requirements.	At design of any structure, the construction method/sequence, constructability and risks shall always be thought about. In addition to the design only the completion stage of structures, the structures in a

		temporary state and temporary structures, as/if necessary, shall be planned/designed together. Major/crucial temporary structures shall be registered to include in the design schedule. It is recommended to prepare a booklet on temporary works to share the knowledge/experience in the project organization, similarly to what the Safety Team is implementing.
4	Description of method statements is only general and does not consider peculiarities of each structure and its surrounding environment.	Since WDFC project is gigantic, it is impossible to manage the project without systemization/ standardization of various works, procedures, forms, etc. including design. However, each site has its own uniqueness. In preparation of working drawings and method statements, attention shall be paid to the peculiarities (including the surroundings) of each structure. Standardization is not necessarily optimum
5	Description of method statements is neat, but only with English essay without visual information.	In method statements, it is encouraged to use visual information rather than English writings. Site engineers' English literacy as well as their working conditions make it difficult for them to have a good grip of English-written information.
6	With regard to works done adjacent to the existing IR tracks, safety of workers is adequately considered. However, adequate measures are not taken the effects which construction of DFC structures may affect the IR structures and/or operation.	There two requirements to be achieved at any rate in sections adjacent to the existing IR tracks. a. The tracks shall not be damaged nor excessively displaced. There should be the threshold of allowable displacement. b. Periodical monitoring of the displacement of existing tracks shall be carried out throughout the period of the affecting construction. An emergency procedure shall be prepared in advance for excessive displacement/deformation.
7	Though almost the whole project is to be constructed in the vicinity of the existing IR tracks, a list of technically critical sections has not been prepared, and a proper design & construction management system based on such list has not been set up.	Sections where the DFC structures are constructed adjacent to IR tracks shall be registered in an adequate format. The register list shall describe characteristics of each section together with things to be noted from a truck/train safety point of view. The list shall be updated weekly incorporating site engineers'/safety officers' observations as well as the Design Team's follow-up comments, and reported to the management.
8	Both SLT and PMC are claiming that: Many workers are migrants and they tend to go home as soon as earning some amount of money. Consequently, the site should always keep hiring unexperienced workers newly and training them, which is preventing promotion of safety management capability and safety awareness.	It is not enough to conduct induction trainings/ seminars. For not only labors but also engineers, it is virtually impossible to memorize everything at once and their memory will fade out as time passes by. Therefore, it is imperative to keep reminding/training them as well as yourselves of the necessity of safety and how to achieve it with patience until the completion of the project.

6.3 Follow-up to Additional Safety Measures

The Employer (DFCCIL), the Consultant (PMC) and the Contractor (SLC) have jointly taken immediate action to the Study Team's recommendations on additional safety measure made in the seminars on site conducted at the end of October 2015. The status of such follow-up on site as of the end of November 2015 (one month after the seminars) is as follows, which indicates all project stakeholders' strong sense of crisis and strong will toward improvements on construction safety:

Table 6.3.1 Status of Follow-up to Additional Safety Measures

No.	Status of Follow-up to Additional Safety Measures (as of the end of November 2015)
-	The project management system has finally taken shape. It is planned to make PMC/SLT managers & engineers on site to guide them to effectively utilize the system. We, PMC and SLT, intend to cooperate to achieve the safety goal. (Comment by PMC Safety Manager)
1 2 3	Recently a meeting was held to discuss the safe construction method of a major bridge the work of which has been suspended for some time. In the meeting SLT Design Team made presentation on the proposed construction sequence in front of SLT Management, SLT site engineers and PMC (management & engineers), which was followed by discussion by the participants. SLT Design Team revised the relevant method statement incorporating the discussion results to resubmit to PMC. After obtaining PMC's approval, the work resumed. A method statement on works adjacent to the existing IR tracks was submitted and under review by PMC. This will be the routine procedure required prior to the commencement of works with high risks.
4 5	PMC/SLT engineers are being reminded to prepare structure by structure a practical method statement/construction sequence which properly considers the site conditions. Method statements are now being prepared including temporary works plan. The situation is observed improved.
6 7	A list of critical sections adjacent to the existing IR tracks has been submitted to PMC. PMC and SLT have confirmed the procedure that SLT submits a method statement section by section for SLT's review prior to the commencement of works and the work can start only after PMC approval.
8	With a view to showing SLT/PMC top management commitment to the safety and to confirming the adequacy of accident preventive measures, DFCC (CTP1 CPM, section managers), PMC (PM, section managers, safety manager) and SLT (PD, DPD, section managers, safety manager) inspected all sites in CTP1 on 17-21 November 2015. <Aim and Purpose> - Safe Working Condition of every plants and machines on sites to be checked; and confirmation that Operator Safety Trainings has been delivered at all locations of project. - To deliver Safety Pep Talks to as many site engineers/supervisors/workers at as many locations of project sites as possible. - Safety Inspections were conducted covering earth works, structure works, temporary works and so on at various locations - Audit of the site Safety Management System during the inspection and evaluate for improvement <Summary of Findings from the Safety Inspection & Action Required> - Green Sticker for earth working machines were given to majority of machines, all the machines must be checked daily by each operator and periodically by responsible department; - List of Do's and Don'ts to be provided for each machine respectively and operator must follow the

	rules; - Safety posters in Hindi language should be provided to each machine and work site; - Competency Certificate were not issued to majority of operators. Operators must go through induction training and operator training and get competency certificate before start operating machines; - Delay starters and wheel chocks are provided for majority of machines. Operators must check around and below the machine before staring the engine; - Repetitious trainings to supervisors and machine operators for safety machine operation to be delivered; - Majority of engineers, workers and operators hold ID Cards. ID Card should be issued only after induction training. Work specific induction training should be given to respective worker and his/her understanding must be checked before issuing ID Card. - ID Card should be renewed every 6 months and refresher trainings should be given to each personnel; - Vertical excavation around structures must be avoided, and layout plan for each work area must be prepared before starting excavation work; - Method statement, Work procedure, Temporary work design and Design calculation, and Risk Assessment to be provided for each structure work; - Work Permit system should be properly implemented, any high risk activities should not be undertaken without the permit - Primary responsibilities for site Safety must rest on PMC and SLT Site Engineers executing and supervising actual works on site. - PMC and SLT SHE Team must ensure site engineers' proper implementation of required safety system on sites and safety rules are followed by all the personnel on site. - PMC and SLT Top Managements' utmost commitment to the safety must be demonstrated all the time till completion of the Project.

Note) Item Nos. 1-8 correspond to those in Table 6.2.1.

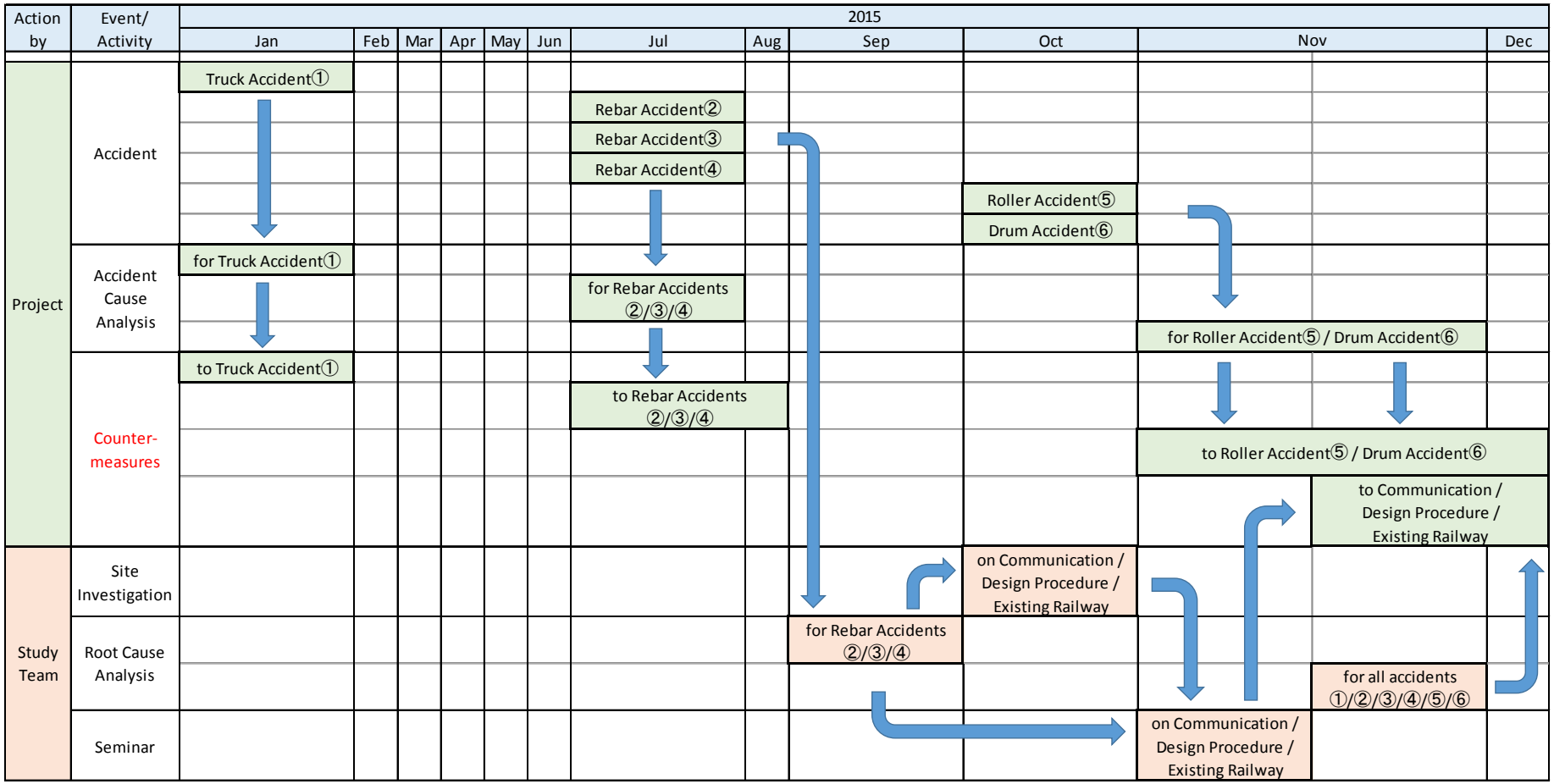


Figure 6.3.1　Accidents-Accident Cause Analysis-Countermeasures

Chapter 7 Recommendations

7.1 Characteristics of Construction Works in Overseas Projects

It is virtually impossible to prepare a universal and systematic manual for construction management which can be used repetitively due to the basic features of construction works in ODA projects (i.e. overseas projects). Hence, in many cases it is necessary to prepare a set of construction management plans for individual projects taking account of various external factors and finally to take such measures as the occasion demands on site.

Table 7.1.1 Characteristics of Construction Works in Overseas Projects

Characteristics of Construction Works in ODA Projects	
Basic Features	# Single Production: Even if the donor, recipient country, employer and project scale are the same, due to the variety of site conditions, the structure and dimensions of the works turn to be unique. # On-Site Production: Since the works are carried out on site, works are often implemented under severe environmental conditions and temporary conditions. Since the project sites are abroad, it is often more difficult than in Japan for the contractor to grasp the site conditions in advance. # Production By-Order: Unlike manufacturers, the construction works start only after getting an order from the employer in a recipient county. Prior to making the contract, the contractor should agree with the employer on the construction method and cost worked out based on the terms of reference prepared by the employer. Further details of construction method including the organization are determined after the award of the contract.
Influential External Factors	The primary objective of the work is to properly execute the contract between the employer and the contractor, where the contractor tries to maximize the profit under the constraints imposed by various external factors. ① Natural Conditions (topography, geology, weather, hydrology, etc.) ② Social Conditions (local laws & regulations, rights, living environment, markets, transaction, transportation, communication, social facilities, construction resources, labor employment, insurance system, etc.) ③ Technical Conditions (local materials quality/function/standards, construction standards, measurement standards, scientific knowledge on pollution/environment/safety, construction equipment, etc.) ④ Employer Conditions (contract documents, specifications/construction period/cost of works, construction method, equipment/materials, etc.) ⑤ In-house Conditions (organization, rules & regulations, construction experience, preceding work results, approved policies/plans, etc.)

(Source: prepared by the Consultant with reference to "System & Procedure of Civil Construction Works")

7.2 Lessons and Recommendations

Considering the characteristics of construction works in ODA projects mentioned above, lessons obtained in the project are summarized in five categories、such as Local Situation, Planning/Design, Tender/Contract, Construction, Accident Report.

(1) Local Situation

a. It appears that in India the binding effect of the act on occupational safety and health is weak, and consequently safety in construction works should rely on the site management framework of each project. With regard to the safety management in construction works, it is necessary to have not only a contractual framework project by project, but also a national legislative framework like the occupational safety & health law in Japan. Moreover, it is recommended to make the occupational safety & health law consistent with the construction and the tender laws compatible to enhance the effectiveness of the laws.
   There are a number of occupational safety and health management system, such as an internationally well recognized OHSAS18001, COHSMS (Construction Occupational Health and Safety management System) tailor-made for contractors in Japan, and "the Guidance for the Management of Safety for Construction Works in Japanese ODA Projects" prepared by JICA. It is recommended that the relevant agencies make use of these systems to supplement the national legislative framework and contractual framework, as/if necessary, getting assistance from ODA donors.
b. It is learnt that many workers are migrants and they tend to go home as soon as earning some amount of money. Consequently, the site should always keep hiring unexperienced workers newly and training them, which is preventing promotion of safety management capability and safety awareness.
   Taking account of the large land area, large population, great variety of culture, low level of average income of people, etc., the excess liquidity of workers will remain unchanged, and the countermeasures on site are to be taken on that basis.
   It is not enough to conduct induction trainings/ seminars. For not only labors but also engineers, it is virtually impossible to memorize everything at once and their memory will fade out as time passes by. Therefore, it is imperative to keep reminding/training them as well as yourselves of the necessity of safety and how to achieve it with patience until the completion of the project.

(2) Planning/Design

a. In this project, construction staffs are required to face, on a daily basis, unprecedented difficulties in management, procurement, communication, etc. caused by the project's gigantic scale (and stretched logistic routes). The accidents occurred in the project are perceived to be an egress of flaws which came up to the surface under such circumstances.

More Inter-city railway projects are being newly formed, and those projects tend to be long-distant/large-scaled due to their inherent nature of connection of remote cities.

Hence, from a viewpoint of risk (including safety) management in those railway projects, it is recommended to collect information on the problems/issues which the stakeholders of the ongoing DFC project are facing, and to analyze such information to work out the adequate countermeasures, and to incorporate such measures in advance into the project framework to be formed by the employers and donors.

The point is not to focus only on safety management, but to have a view point of "management of safety as a part of overall management of large-scaled project"

For instance, an approach could be to analyze the above problems/issues being encountered in DFC project to arrange the results in order with a keyword of "Management of Large-Scaled projects", to spell out those in the contract documents such as Employer's Requirements and/or Specifications for future similar projects, and to prepare budgets accordingly. By so doing, bidders' awareness of those problems/issues would be promoted, based on which they could prepare adequate construction planning.

As an example, the following table summarizes the problems/issues pointed out in the seminar conducted by the study team on site.

Table 7.2.1 Problems/Issues in DFC Project

Project Environment	Main Countermeasures	Problems/Issues	Recommendations
# Unprecedentedly large contract # Stretched logistic routes # Compressed construction period # Design & construction contract # Works within/adjacent to the existing railway	# Large consultant organization # Large Contractor organization # Systemization/ standardization of documentation/procedures # Strict contract requirements for quality & safety # Large number of labours to be employed	# Schedule slippage # Crash programme # Problems in decision-making/ communication # Poor coordination/ communication between design and construction # Design/ method statements not matching with site conditions # Improper temporary works design # Improper risk management of works adjacent to the existing railways # Very high labour turnover	# Overall management structure/system to enhance # Improve communication/ coordination between Design, # Consider constructability/ risks in the design # Prepare working drawings and method statements considering # Visualize information in method statements # Monitoring during works within/adjacent to the existing # Risk management plan for the existing railway # Repetitive safety trainings of labours

b. The natural conditions (climate) of the region where the project is located is severe. High temperature in summer and much precipitation during the monsoon season are obstacles to safety and health management of construction projects most which are labor-intensive works in India. (In fact, rebar accidents occurred in the typhoon time and a roller run-over accident occurred under the blazing sun in summer)

In future projects, it is recommended to draw bidders' attention to the severity of natural conditions requiring adequate care in implementation of occupational safety and health management in the bidding documents.

c. Most of the DFC project runs in parallel with/adjacent to the existing railways in operation. During the site visit, it was observed that sufficient care was taken on site to occupational safety matters (workers' safety), operation of the existing railway and signal cables buried along the railway track, however, it was not the case to the influence to the existing railway structures which DFC works may induce.

Table 7.2.2 Classification of Railway Accidents

Cause	Effect	Consequences	WDFC Contract Documents	Safety Category	Awareness in WDFC Project
Workers	Hit by train	Lives	Specifications: SHE Requirements	Occupational Safety & Health	YES
	Affect railway operation	Financial loss			YES
Works	Damage cables	Financial loss	Employer's Requirements: Construction		YES
	Damage/ Displace structures	Financial loss Lives		Safety of Works	?

The above problem may be attributable to insufficient communication between the Design and Construction teams. Furthermore, the Consultant and Contractor engineers, for lack of experience, could have disregarded the relevant provision in Employer's Requirements. In future projects, it is recommended to provide more concrete description on the matter to draw site staffs' attention to promote proper action.

d. Usually safety and quality management is perceived to be a matter for which the contractor is primarily responsible. In ODA construction projects, in addition, actions taken by the employer, the donor and the consultant supporting them at the upstream side are equally important.

At the stage of project planning/design, the employer, the donor and the consultant shall foresee/overlook the situation where the project will be placed during construction together with the risks accompanied to prepare a suitable framework and contract documents to deal with those risks, after which they shall entrust the construction works to the contractor. This approach could make the external environment of the construction in order, and lead to smooth implementation of works as well as promotion of safety.

At the planning/design stage of Yen loan projects, the Employers/JICA/consultants are encouraged to refer to "Guidance for the Management of Safety for Construction Works in Japanese ODA Projects" which provides standard safety management conditions. The Guidance could be useful reference for the Employers/JICA/consultants who are not very familiar to the site practice rather than for contractors who has sufficient experience on overseas construction projects.

It is recommended that the consultant at the project formation stage develop "a list of points to be included at the design stage concerning safety management requirements", and thereafter the design consultant, in consultation with the Employer, to build such points in the design documents.

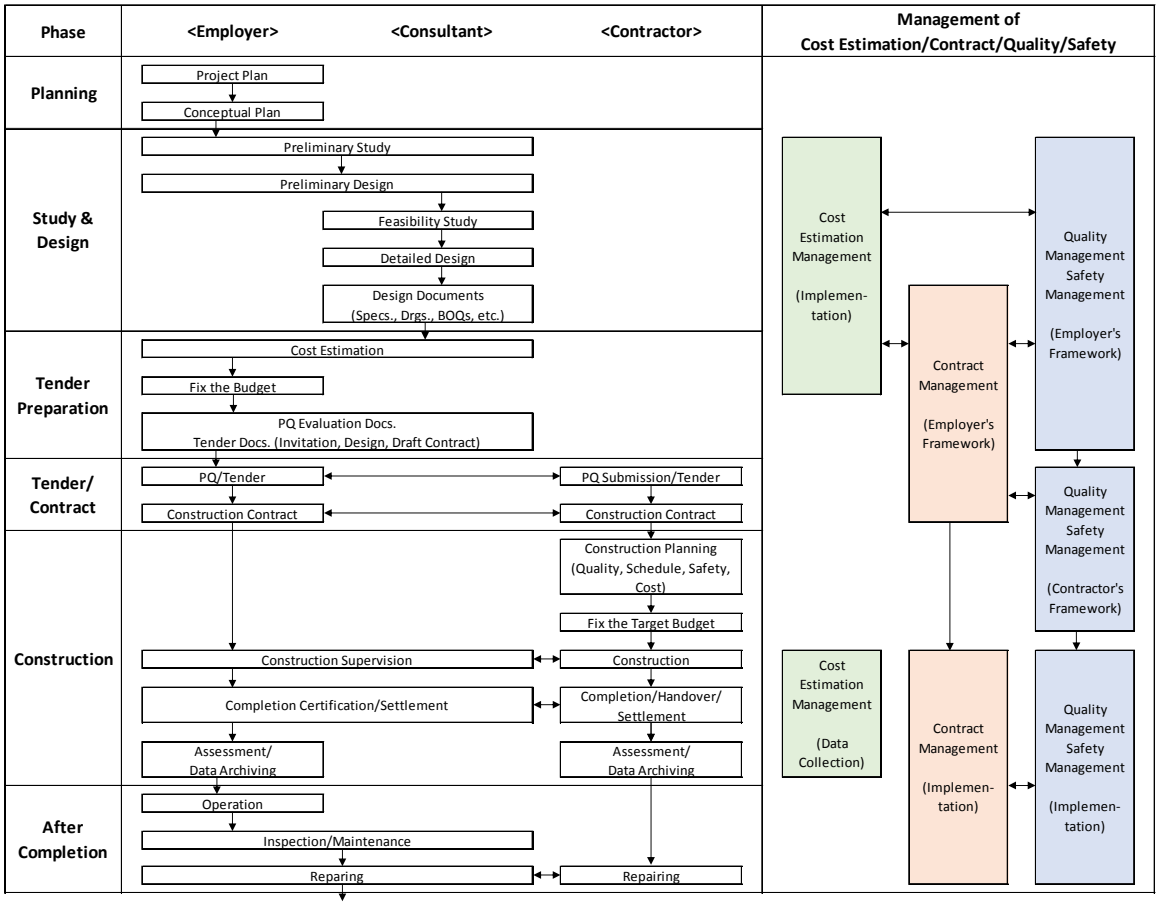


Figure 7.2.1 ODA Construction Project Flow and Management of Cost Estimation/Contract/Quality/Safety

(3) Tender/Contract

a. The contract value of this project is as big as JPY 110 billion. Since the total construction period is 4 years including the design period, the net construction period comes down to 3 years, and the monthly average production rate is as much as JPY 3 billion. In other words, almost all activities, such as design, design review/approval, land acquisition, utilities removal/relocation, procurement, construction, inspection/ approval, are on the critical paths of crash program.

For the hard portion of project (i.e. construction works on site), standard production rates are known to experienced construction engineers, while for the soft portions (i.e. design, review/inspection/approval) in the Contractor's as well as the Consultant's works, necessary time could have been underestimated. It is observed delays in the soft portions are inducing the delay of the overall project.

The Employer's Requirements provides comprehensive description on design and approval, by which process management of quality is implemented, however, time factor in the management could have been underestimated. In future projects, it is recommended to properly incorporate such time factor information into the contract conditions and construction period in reference to the data obtained in the DFC project.

b. The contract documents consist of General Conditions of Contract（FIDIC Yellow Book (Plant and Design-Build 1999)）、Particular Conditions of Contract、Employer's Requirements、Specifications、Data Book、Reference Drawings, etc., wherein Employer's Requirements and Specifications set out quite comprehensive requirements for safety/quality. This documentation is presumed to pattern that of a series of Delhi Metro projects which commenced late 1990s, and the completeness of documentation is high.
There will be more new railway/subway projects coming up in India with the Japanese ODA scheme. It is recommended that DFCCIL who is the Owner of DFC projects, DMRC who is the Owner of Delhi Metro Projects and JICA who is the donors to both projects proactively exchange information to feedback it to the consultants in charge of new projects to prepare a set of documentation with higher quality.

(4) Construction

The following situation was observed commonly for the Contractor and the Consultant concerning the safety management for this project.
As far as the "occupational safety and health" management is concerned, a well-designed system has been set up and the awareness of managers in charge was observed high. It may be attributable to the detailed provisions in the contract documents materializing the strong demand by DFCCIL and JICA on safety, the SHE plan of L&T, and most notably project staffs' daily efforts.
On the other hand, however, as far as the "safety of works" management, neither the project staffs' awareness nor implementation on site was observed sufficient at the time of the Study Team's site visit in October 2015. It could be partially due to the communication problem between stakeholders, but also due to their insufficiency of practical knowledge/experience on technical causes & effects relationship, which may be barring them from foreseeing consequences on site. Furthermore, it seems that either the Contractor or the Consultant did not fully realize as an organization that "safety of works" is also a safety factor in construction works.

Table 7.2.3 Safety in Construction Projects

Targets of Construction Project		Players in the office/on site	
		Engineers	Safety Officers
Safety	Occupational Safety & Health → Persons	✔	✔✔
	Safety of Works → Structures	✔✔	✔✔
Quality		✔✔	✔
Schedule		✔✔	✔
Cost		✔✔	✔

<Re. Consultant>

a. In proportion to the project size, the Consultant's organization is big as well. However, in interviews with the Consultant and the Contractor it was heard that the number of personnel for design review/approval and inspection/approval on site was not enough and hindering the progress of works. Review of the balance between the scope/volume of works and the organization may be required.

b. It was observed that the number of safety management staffs in the Consultant was a little too few compared with the overall scale of the project. Having such handicap, the safety management team was working effectively overseeing and also ell coordinating with the Contractor's SHE team. A good teamwork was observed.

   The Consultant's works include activities physically requiring a certain number of staffs such as site inspections, report-writings, etc. Review of the balance between the scope/volume of works and the organization may be required.

<Re. Contractor>

a. To manage this large-scaled project, the contractor's organization is quite large with a single gigantic hierarchy structure. This has been causing communication problems such as one-directional instruction from the management, slow decision-making, psychologically too far distance between project members, etc. which could be a background factor of safety problems.

   The overall management structure/system presently applied shall be carefully reviewed. Enhancement of two-directional/cross-sectional communication and/or breaking one large hierarchy into one management + four medium-sized cells would be alternatives.

b. It was observed that the information (permanent/temporary works design, method statements) required for construction works was not necessarily prepared considering the site conditions, constructability or safety, and that the Safety Team was not necessarily concerned about the safety of works.

   It is recommended that before/during/after preparation of construction drawings and method statements, the Design Team closely communicate/coordinate with the Construction Team and the Safety Team to discuss the site conditions, design, construction method and safety regularly.

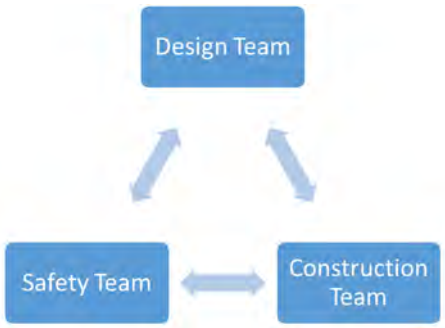


Table 7.2.2 Coordination between Design/Construction/Safety Teams

c. It was observed that design of temporary works was not necessarily conducted systematically.
In design of any structures, construction method/procedure, constructability and safety should be considered for the completion state as well as the temporary state, and plan/design the temporary works, if/as necessary. It is recommended to register large and/or important structures in the same manner as for permanent structures for management.
It is recommended that the Design Team prepares a series of booklets on temporary works to share the knowledge/experience in the project organization, similarly to what the Safety Team is doing.

d. It was observed that method statements prepared in the project have only general descriptions without consideration on the peculiarities of each structure and each site. Visual information was also missing.
Since the DFC project is gigantic, it is imperative to systemize/standardize as many activities/things as possible including design, operations, procedures, forms, etc. for good management of the project. However, standardization is not necessarily the optimum solution. In preparation of construction drawings and/or method statements, attention shall be paid to the peculiarities of structures and their surroundings.
It may not be easy for site engineers to instantly/correctly understand the English information contained in method statements due to their low English literacy, severe climate outside the office. Hence, it is encouraged to best utilize visual information rather than English essay.

e. Though almost the whole project is to be constructed in the vicinity of the existing railway tracks, a list of technically critical sections has not been prepared, and a proper design & construction management system based on such list has not been set up.
It is recommended that sections where the DFC structures are constructed adjacent to the railway tracks be registered in an adequate format (the register list shall describe characteristics of each section together with things to be noted from a truck/train safety point of view), and that the list be updated weekly incorporating site engineers'/safety officers' observations as well as the Design Team's follow-up comments, and reported to the management.

(5) Accident Report

a. The Study Team confirmed that the Contractor's safety team conducted root cause analyses (L&T version) for at least 5 accidents out of 6 accidents reported up to the time of site visit. Furthermore, for the 2 accidents occurred in October 2015, they tried application of root cause analysis (the Study Team's version) which was introduced by the Study Team in the seminar at the end of October 2015.
However, the Study Team sees that it is necessary to further improve the approach. For the purpose, it is considered necessary to promote the Contractor's (& the Consultant's) whole organization's understanding of the following points:
   - Differences between direct causes and root causes, and management/organizational factors therein
   - Necessity of technical/contractual knowledge for management of safety of works

b. <Accident Cause Analysis and Laws/Regulations>

In ordinary ODA projects,

- capability of the main players of the project is confirmed in the process of project development; the Employer's capability through the project formation process and the Consultant's /the Contractor's through the PQ/tender process.
- FIDIC standard conditions of contract has a provision that local laws/regulations are to be abided by.

Consequently, the daily safety management system of ordinary ODA projects is supposed to be a system where local laws/regulations are built in the conditions of contract and/or the contractor's various plans.

In the system, in other words, any insufficiencies/inadequacies in the local laws/regulations concerning construction safety management are to be supplemented/corrected in the construction contract prepared by the Employer/Consultant, further improved in various plans prepared by the Contractor and thereafter adjusted during the implementation by the Contract finally to ensure the final/overall satisfaction.

This safety management system could be working within the framework of ODA project contract/ construction management without involvement of government officers of relevant agencies.

Under such circumstances, Why-Why analyses of construction accidents could not pick up administrative problems at the national level alone, but does pick up those problems in the combined system including the site factors such as the conditions of contract and the contractor's plans, while a Why-Why analysis conducted to "insufficiencies/inadequacies of safety management provisions in the contract documents", could derive administrative problems at the national level.