A STUDY OF THE BEST PRACTICE ON THE PREVENTION AND REDUCING THE IMPACT OF DISASTER BY CIVIL ENGINEERING METHOD IN JAPAN FOR ADEPTATION TO THAILAND

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CHAPTER1: INTRODUCTION

1.1 BACKGROUND AND SIGNIFICANCE OF THE STUDY

Climate change, the expansion of the urban and changes in land use. As a result, the risk and impact of disasters is increasing and more intense. Disaster had happened in Thailand, causing loss of life and property of many people.

Flooding disaster is causing the most damage to the country. During the year 2002 – 2011 floods nine times per year. In the year 2003 flooding of up to 17 times. Flood occurred in the year 2003 caused the most damage impact. Bangkok and 65 provinces affected more than 13 million households killed 813 people losses worth 1.44 trillion baht.

Landslide occurs along or after a flash flood or a storm with heavy rains continued. Mudslides occur frequently and with more intensity. In Year 2001 caused mudslides in Phrae province. People have suffered 1,651 households have killed 36 people, injured 58 people, four people missing. Year 2006 caused mudslides five provinces (Uttaradit, Sukhothai, Phrae, Lampang and Nan) in the northern part of Thailand. The number of deaths to 87 people, 697 houses were damaged, 2,970 partially damaged, 108,762 households 352,016 people have suffered, 10,601 people were evacuated and 29 people missing. The main causes of human behaviour that loggers Deforestation and destruction of soil.

Windstorm during the 2002 – 2011 average 2,067 times a year, 326 people have died and 2,080 million baht worth of damage. Windstorm occurred in the year 2004 the number was 3,834. The current storm is likely to come up.

Earthquake - Thailand has a large earthquake. However, there is a fault near the Kanchanaburi province, which can cause earthquakes is SriSawat fault. Earthquake felt in about 5-6 times a year, usually on the west and north. Year 2007 earthquake that affected the country. From Chiang Rai to the northeast, about 120 kilometers with a depth of about 17.6 kilometers cause the pinnacle of Phra That Chom Kitti broken.

Tsunami - Thailand Tsunami Victims harsh on the year 2004, with six provinces affected. Has killed 5,395 people, injured 8,457 people and more than 2,187 people missing. The tourism industry along the Andaman Sea coast has been a loss of 30,000 million baht.

From the disaster that happened in the above you can see that. Thailand affected by the disaster many different public and take place in the country. The impact in terms of lives, property and the economy. DDPM as the central national government agency responsible for disaster management need to create and develop knowledge Innovation to prevent and reduce the impact on the risk of area.

The Civil Engineering method is a way for prevent and reduce the impact of disaster by structure. Japan is a best country to use in civil engineering for prevention and reducing the impact of disasters. Japan has the knowledge and Innovative solution for studying.

A study of the best practice on the prevention and reducing the impact of disasters by Civil Engineering method in Japan for adaptation to Thailand is a way for developing knowledge and Innovation of DDPM. The case of Japan Researchers will have the knowledge and experience to bring for the situation of the Thailand.

1.2 PROBLEM

The Researcher and many civil engineers at DDPM who have begun to work in the disaster division lack the specific expertise needed to develop innovative solutions for disaster prevention. Creating a fast experience is a study from the good practices of disaster and a source of disaster education but Thailand has little a source of disaster education and learning centre about this.

From such a problem, it is a great opportunity to learn and create experience because Japan is the most famous countries about that and suitable for beginners to create experiences.

1.3 QUESTION

How does japan use civil engineering methods to prevent and reduce the impact? In addition, what is the good practice in Japan appropriate in Thailand?

1.4 SPECIFIC AIMS

- To study the Disaster Management System in Japan.
- To gather the knowledge of Civil Engineering to prevent and reduce the impact of the disaster in Japan.
- To identify better ways of Civil Engineering method for prevention and reducing the impact of disasters that can be applied to Thailand.
- Prepare recommendations for improvement of DDPM in Thailand

1.5 SCOPE OF THE STUDY

This study in Civil Engineering method used for prevent and reduce the impact in Japan for guidance as a whole and can be visit during the period January 11 - April 8, 2017 only. Not go deeper into design details or specialized techniques.

CHAPTER2: LITERTURE REVIEW

2.1 DISASTER MANAGEMENT

2.1.1 The Disaster Management Cycle

(W. Nick Carter 2008) As stated in the introductory notes, the disaster management cycle can be, and often is, portrayed in various forms. Moreover, alternative terminology may be used. The important factor, however, is that the format should indicate that disaster and managing it is a continuum of interlinked activity. It is not a series of events which start and stop with each disaster occurrence.

The basic format of the disaster management cycle that is used in this report, and which is also shown in the introductory notes, is repeated here for ease of reference (figure 2.1).

An alternative format, which is sometimes used, shows the main components in the form of activity segments, as shown in figure 2.2.

It will be noted that the outer segments of preparedness, response, and recovery, superimposed on figure 2.2, relate to similar segments in figure 2.1.

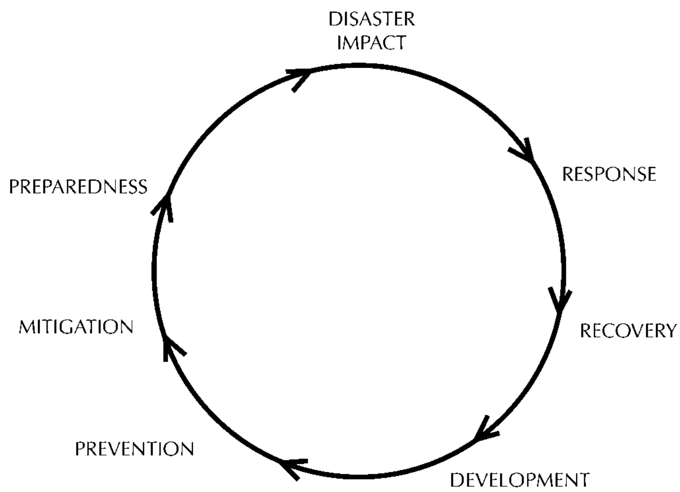

Figure 2.1: Basic Format of the Disaster Management Cycle

Source: (W. Nick Carter 2008).

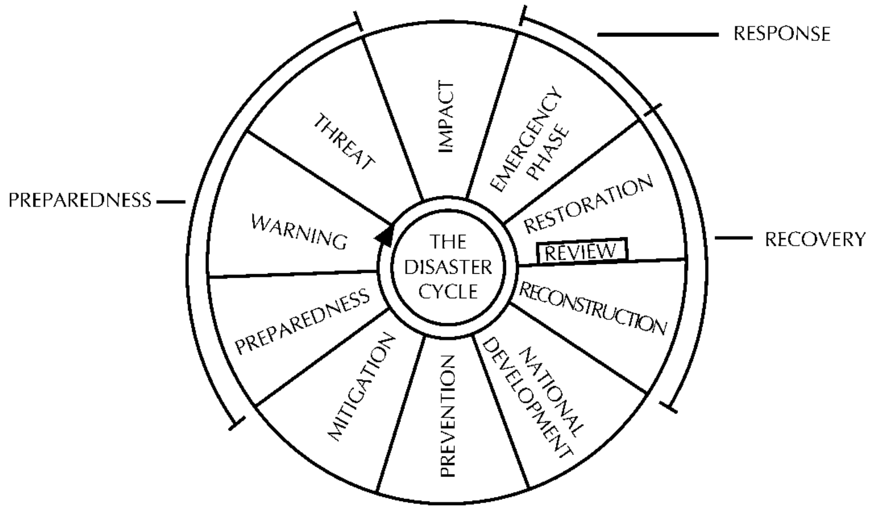

Figure 2.2: Alternative Format of the Disaster Management Cycle

Source: (W. Nick Carter 2008).

The format in figure 2.2 can be utilized to make two significant points:

- i. Such format is schematic only. It does not and cannot designate the length or relative importance of the component parts. For instance, the actual recovery period may vary considerably for different disasters. Or, in a particular set of circumstances, the amount of importance, priority, and effort allotted to prevention may be small when compared with that given to, say, preparedness.
- ii. Such format should not be allowed to give the impression that each activity segment is clearly and precisely divided from adjacent ones. On the contrary, it is important to understand that segments generally tend to overlap and/or merge. For instance, some response activities may be initiated prior to disaster impact—that is, during the preparedness segment. Such activities might include the precautionary movement of threatened persons or communities to safe havens prior to the impact of a cyclone. Similarly, recovery action often begins while the emergency response period is still operative. For example, a technical advisory team would probably begin collecting information immediately after impact and such information would be used for both response and recovery purposes.

The composition of the main in this connection, it is worth bearing in mind that two major factors are likely to trigger action in some or all of these segments. These factors may also affect the balance between activities and the priorities allotted to individual activities. The factors are:

- Post-disaster review Post-disaster review should be carried out as early as practicable in the recovery period. Such review will often reveal deficiencies in plans and will also indicate, for example, if certain activities such as preparedness measures and response arrangements need strengthening.

- Results of exercise or simulations Provided exercises and simulations are accurately evaluated and the lessons from them are correctly drawn, they can exert influences similar to those of post-disaster review. In some cases, exercises and simulations can be more effective because they can be directed toward testing a particular part within the disaster management cycle (e.g., coordination in the use of resources); and their lessons can be more accurately defined than is sometimes the case with post-disaster review (because the latter may lack vital information which was overlooked or lost under the pressures of disaster impact).

Furthermore, effective day-to-day disaster management should monitor all aspects of activity and initiate necessary action accordingly.

2.1.2 Prevention

Action within this segment is designed to impede the occurrence of a disaster and/or prevent such an occurrence having harmful effects on communities or key installations. The following are usually classified as preventive measures:

- constructing a dam or levee to control floodwaters so that the latter cannot adversely affect people, buildings and other installations, livestock, means of production and subsistence, and so on;
- controlled burning off in a bushfire-prone area prior to the high fire-risk season. This action can remove potential fuel and actually prevent the start of a fire or, if it does start, prevent it from reaching threatening proportions;
- some forms of legislation can also be regarded as prevention (e.g., land-use regulations which ensure that communities are not allowed to develop on vulnerable sites such as the disaster-prone areas of a flood plain).

It is noteworthy that some countries tend to use the term prevention/mitigation as a combined heading for action within these two segments.

2.1.3 Mitigation

Action within this segment usually takes the form of specific programs intended to reduce the effects of disaster on a nation or community. For instance, some countries regard the development and application of building codes that can reduce damage and loss in the event of earthquakes and cyclones, as being in the category of mitigation. Other countries may regard such building codes as being in the category of prevention; recent developments in earthquake proof buildings have undoubtedly influenced this outlook.

The term mitigation more generally implies that while it may be possible to prevent some disaster effects, other effects will persist but can be modified or reduced provided appropriate action is taken.

The foregoing points suggest that, under some circumstances, the term prevention/mitigation may be more suitable for some countries than using prevention and mitigation as two separate concepts and activities.

The following actions or programs are generally regarded as coming under the heading of mitigation:

- enforcement of building codes;
- land-use regulations;
- safety regulations relating to high-rise building, control of hazardous substances, etc;
- safety codes governing land, sea, and air transport systems;
- agricultural programs aimed at reducing the effects of hazards on crops;
- systems to protect key installations such as power supplies and vital communications; and
- developments in infrastructure, such as the routing of new highways away from disaster-prone areas

2.1.4 Preparedness

Preparedness is usually regarded as comprising measures which enable governments, organizations, communities, and individuals to respond rapidly and effectively to disaster situations. Examples of preparedness measures are

- formulating and maintaining valid and updated counter-disaster plans which can be brought into effect whenever required;
- special provisions for emergency action, such as evacuating populations or moving them temporarily to safe havens;
- providing warning systems;
- emergency communications;
- public education and awareness; and
- training programs, including exercise and tests.

One aspect of preparedness that is not always prioritized adequately is individual and/or family preparedness. In many circumstances where government resources and emergency services are limited, such individual and family preparedness may be vital for survival.

Some disaster management cycles may divide the preparedness segment into subsegments such as:

- Warning – The time or period when a hazard has been identified but is not yet threatening a particular area (e.g., notification that a cyclone exists but is far away).
- Threat – The time or period when a hazard has been identified and is assessed as threatening a particular area (e.g., a cyclone is tracking toward that area).
- Precaution – Action taken after receipt of warning to offset effects of disaster impact. Such action might include:
  - closing offices, schools, etc.;
  - bringing emergency power generators to readiness;
  - cutting crops to avoid total loss from high winds and heavy rain;
  - making safe boats and vehicles; and
  - taking household precautions, such as storing emergency water supplies.

An advantage in including these sub segments is that it provides some indication of the possible sequence of events/action leading up to disaster impact.

2.1.5 Disaster Impact

This segment is self-explanatory, being the point in the disaster cycle at which a disaster occurs; for instance, when a cyclone strikes a country or a particular area. However, including it serves as a reminder that—in disaster management terms—impact can vary between different types of disaster. For instance:

- An earthquake may give no warning and its impact time can be short. Yet the result can be very severe indeed.
- A cyclone may provide a long warning period and its impact time (i.e., the time when it has destructive and damaging effects) can be protracted. This may be particularly so if the cyclone passes directly over a given area, or backtracks as may sometimes occur.

2.1.6 Response

Response measures are usually those which are taken immediately prior to and following disaster impact. However, for ease of representation, the response segment is shown (figure 2.2) as following directly after disaster impact; and this is when most response measures are applied.

Such measures are mainly directed toward saving life and protecting property, and to dealing with the immediate disruption, damage, and other effects caused by the disaster. Typical measures include:

- implementing plans;
- activating the counter-disaster system;
- search and rescue;
- providing emergency food, shelter, medical assistance, etc.;
- surveying and assessing; and
- evacuating.

The segment is sometimes called emergency response to indicate that it applies to a fairly short period (i.e., the 2–3 weeks after impact) when emergency measures are necessary to deal with the immediate effects of a disaster and when, perhaps, a state of emergency or state of disaster may have been declared by government.

It may be noteworthy here that it is sometimes said that all disaster-related activities that follow impact (including measures of relief, rehabilitation, restoration, and reconstruction) constitutes response. However, for a user handbook, it is more convenient and practicable to divide response from recovery.

2.1.7 Recovery

Recovery is the process by which communities and the nation are assisted in returning to their proper level of functioning following a disaster. The recovery process can be very protracted, taking 5–10 years, or even more. Three main categories of activity are normally regarded as coming within the recovery segment. These are:

- restoration,
- rehabilitation, and
- reconstruction.

Typical activities include:

- restoring essential services;
- restoring of repairable homes and other buildings/installations;
- providing temporary housing;
- measures to assist the physical and psychological rehabilitation of persons who have suffered from the effects of disaster; and
- long-term measures of reconstruction, including the replacement of buildings and infrastructure that have been destroyed by the disaster.

Post-disaster review should also be included as part of the recovery process. It should take place as soon as practicable after the disaster.

2.1.8 Development

The development segment provides the link between disaster-related activities and national development. Its inclusion in the disaster cycle is intended to ensure that the results of disaster are effectively reflected in future policies in the interests of national progress. For instance, to produce the best possible benefits by:

- introducing improved and modernized building systems and programs;
- using international disaster assistance to optimum effect;
- applying disaster experience in future research and development programs; and
- using any other means appropriate to a particular situation.

At the same time, this linkage should be used to ensure that national development does not create further disaster problems, or exacerbate existing ones.

2.1.9 Application to Practical Disaster Management

It is suggested that individual countries should choose the form of disaster management cycle which is most appropriate to their needs.

Apart from its obvious value in providing a “visual aid” for those involved in the study of disaster and in disaster management, the disaster cycle can have various practical applications. For instance, in:

- **Training programs:** These programs tend to concentrate mainly on the various aspects of preparedness, response, and recovery. Use of the disaster management cycle helps facilitate understanding of not only the important relationship between these three vital aspects but also their connection with other disaster-related activities. The cycle can also have other training applications. For example, it can be used during exercise briefings to illustrate the precise point, within the total disaster management process, at which an exercise is set.
- **Programs of public education and awareness:** For these programs, the cycle can be used in much the same way as for training programs. It could be especially useful for:
    - disaster education in schools, and
    - heightening public awareness (through posters or television programs) prior to high-risk seasons, such as a cyclone or flood season.
- **Day-to-day disaster management activities**: The cycle could be an effective reference and calendar against which to check the progress of disaster management at various levels of government; for instance, developing plans, progress in preparedness measures, review by the NDC, and so on.

- **Maintaining government impetus behind disaster management**: The cycle could be an effective tool during periodic briefings for cabinet and/or those ministers with key responsibilities for disaster management, especially to show where deficiencies need to be remedied.

2.2 CIVIL ENGINEERING FOR DISASTER PREVENTION AND MITIGATION

2.2.1 Roles of Civil Engineers for Disaster Prevention and Mitigation

Masanori HAMADA said the first role of civil engineers for the natural disaster mitigation is the development of technologies for enhancement of infrastructures, such as technologies for the improvement of soft soil, high-performance structures, and warning and rescue systems. The second role is actual construction of infrastructures with high natural disaster resistance. The third role of civil engineers is the involvement in the rescue operation, and restoration and reconstruction works after natural disasters. A large number of infrastructures such as highways, railways, port-harbor facilities have been constructed on improved soft alluvial and man-made ground along the seaside of the Tokyo Bay. Various kinds of methods for improvement of soft alluvial and artificial ground have been developed. Technologies such as passive and active control systems have been developed to reduce the dynamic effects on buildings and bridges during earthquakes, and have been applied to a large number of structures. The 1995 Kobe earthquake destroyed a huge amount of infrastructures. Therefore, Reinforcement of existing infrastructures against future earthquakes has been one of most important roles of civil engineers after the Kobe earthquake. A numerous number of infrastructures such as railway and highway bridges, and subway stations have been reinforced. The real time earthquake warning system has been developed and applied to some practical uses as shown in Figure 2.3. In this system, the magnitude and the epicenter of earthquakes will be judged by the ground motion records in the vicinity of earthquake faults, and if the earthquake has such a large magnitude as to cause serious damage, the warning will be sent to various organizations before the arrival of the main ground motion of the earthquake. Based on the warning, the high-speed trains will be stopped, and the road and air traffic will be carefully controlled. The operation of the various kinds of plants will be shutdown, and the water gates will be closed against the tsunami. In the case of Tokai earthquake, the time allowance before arrival of the main shocks is estimated as about 50 seconds in Tokyo area. In low land areas in Tokyo, which has lower elevation than river water level, so-called “super levee” has been constructed against future earthquakes and for development of the areas with high natural disaster resistance, as shown in Figure 2.4. New banking behind the original riverbank elevated a wide area and the area was redeveloped to enhance the natural disaster resistance, by creating open spaces for the rescue operation and by constructing high earthquake resistant buildings. (HAMADA 2009)

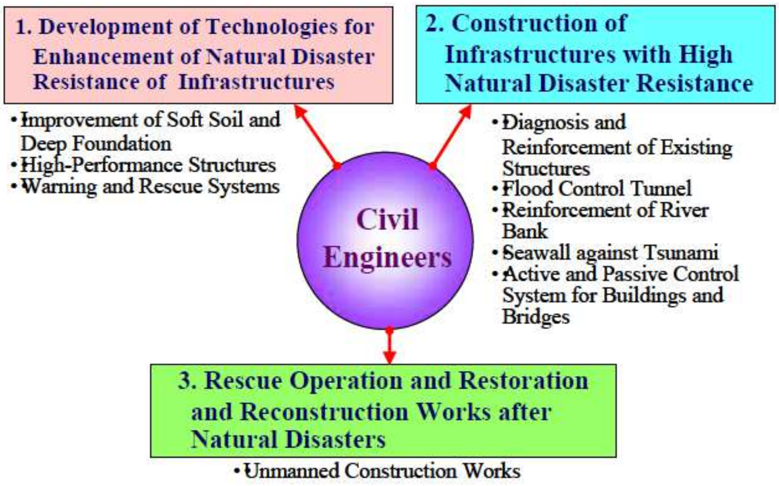

Figure 2.3: Roles of Civil Engineers for Natural Disaster Mitigation

Source: (HAMADA, 2009)

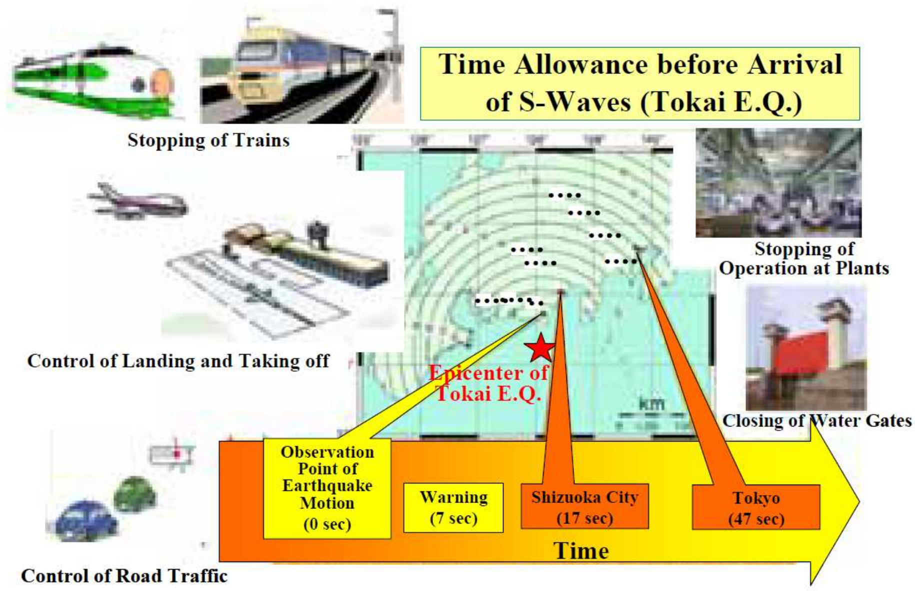

Figure 2.4: Real Time Earthquake Warning System

Source: (HAMADA, 2009)

Paresh V. Patel said Disasters are adverse or unfortunate events or great and sudden misfortunes which have a profound effect on society and the nation. They may occur due to natural causes such as earthquakes, tsunamis, floods or cyclones or due to man-made causes such as blasts, missile attacks or fire. Generally, during a large-scale disaster, civil engineering structures like buildings, bridges, dams, roads, water supply projects, coastal structures, infrastructure facilities etc are severely affected, causing immense inconvenience to people and disrupting routine life. Prevention of natural disasters is not possible but reduction in the undesirable effects of disasters can be the only way to cope with them. Natural disasters identify the mistakes made in the process of development of civil engineering structures in that particular locality, and teach important lessons for the future. If the learning from such undesirable events is utilized, hazardous effects can be reduced in the coming years. Civil engineers can play a major role in disaster mitigation by creating safe structures through the integrated efforts of all those involved in the construction process. (Patel 2010)

Ragini Gogoi talked about the role of the engineer in disaster management is a structural engineer's role cannot be exaggerated. They need to play an active role in preparing the development plan of an area. Specifications should be followed, structural analysis should be done using the latest techniques and advanced methods like performance based designs must be followed rather than simple code based approaches. Materials such as High Performance Concrete, Fiber Reinforced Concrete, Self-Compacting Concrete, Fiber Reinforced Polymers etc. should be preferred in the construction of new buildings; and floating columns, soft stories and other irregularities should be avoided. Civil engineering involves designing structures on the ground and thus the study of the ground behaviour is a must. Detailed examination of the subsoil by a Geotechnical engineer is very important criteria in construction works, ensuring the structure will not give in in the face of a calamity and to understand the site specific response. Landslides may occur due to modification of slopes for construction works, overloading of slopes or due to alteration of the natural drainage, all of which can be avoided if proper soil knowledge is available. Geological conditions leading to the failure of dams, channels are of common occurrence, making related studies essential. A hydraulic engineer can provide information about bridges and dam construction and also suggest flood control measures. A construction manager must ensure that the quality of the construction material doesn't compromise the safety and the stability of the structure; proper construction strategies should be worked upon and building and safety codes and regulations should be complied with. City planners must keep in mind the vulnerability of a specific area to disasters. Specifications and guidelines should be issued for construction activities in these areas. Third party checks and by the Local Authority for the compliance of the project with all the requirements must be conducted before issuing the Building Use permission and also regular investigations should be conducted after the completion. (Gogoi 2013)

2.2.2 Flood

Flood Management in Japan

The Ministry of Land, Infrastructure, Transport and Tourism(MLIT) implements a variety of flood control projects to protect life and property from floods. To drain floodwaters safely and efficiently, the MLIT improves river channels and constructs floodway and retarding basins. In urban areas, comprehensive MLIT flood protection measures improve the water-retaining and retarding functions of river basins. MLIT projects also improve and construct river channels, regulating basins, and underground rivers. MLIT projects also use dams for flood mitigation.

- **River Channel Improvement**: River channel improvement includes channel widening, levee construction and reinforcement, and riverbed dredging so that flooding of less than the design flood can be discharged without inundating lands along the river.
- **Floodway***:* A floodway is a canal constructed to lead flood waters from the middle and lower reaches of a river to another river or directly to the sea. A floodway is constructed when channel improvement is insufficient to carry the design flood.
- **Retarding Basin and Control Basin**: Retarding basins and control basins mitigate flooding in the lower reaches. In case of flood part or most of the floodwaters flow into the basins. The water stored in basins can also be used as a water resources.
- **City Inundation Countermeasures**: Inundation can cause great damage in cities. In addition to active improvement of city rivers in order to diminish inundation, construction of underground discharge channels, water reservoirs, and storm sewers are carried out.
- **Protection against Tsunami and Storm Surges**: To protect vulnerable coastal areas from storm surges caused by typhoons and tsunami caused by earthquakes, various structures, such as sea walls, tide gates, and drainage pump stations, are constructed along seashores and at the mouths of rivers that have suffered major damage in the past.
- **High-Standard Embankments (Super Levees)**: A "super levee" is a thick embankment created by applying a layer of fill material over a conventional embankment. Super Levee are designed to prevent catastrophic flood damage which could result from urban levee breaks caused by overflowing of banks, seepage, and earthquakes. They also enhance urban spaces with water and greenery.
- **Comprensive Flood Control Measures**: River basins that are being rapidly urbanized are losing their natural water-retaining and retarding functions. At the same time, concentration of population and property in these urban river basins contributes to increasing "damage potential" (maximum amount of damage that could potentially result from a disaster). These problems are being dealt with through MLIT "Comprehensive Flood Control Measures", which consolidate the combined use of facilities to maintain the water-retaining and retarding functions of river basins, the creation of incentives to use land safely and to build flood-

resistant buildings, and the establishment of flood warning and evacuation systems. Comprehensive flood control measures are implemented through the establishment of Council for Comprehensive Flood Control Measures for individual river basins and through the formulation of basin development plans that include improvement of the environment.

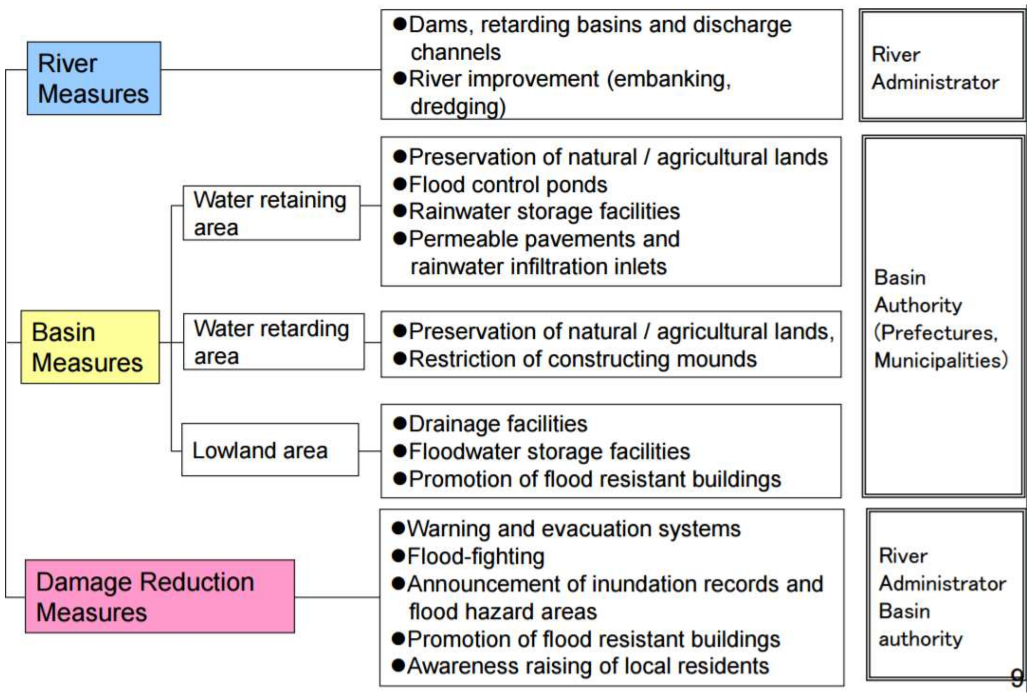

Figure 2.5: Structure of Planning System

Source: (IKEUCHI 2012)

Urban Flooding

Kingo Saeki, 2017 explained in Urban cities, Strom water is drained to rivers and seas by way of sewerage. However, the Intensity of rainfall exceed design intensity of sewer, floods occur. Also, when level of receiving water become higher than planned water level , the sewer cannot drain runoff leading to flooding.

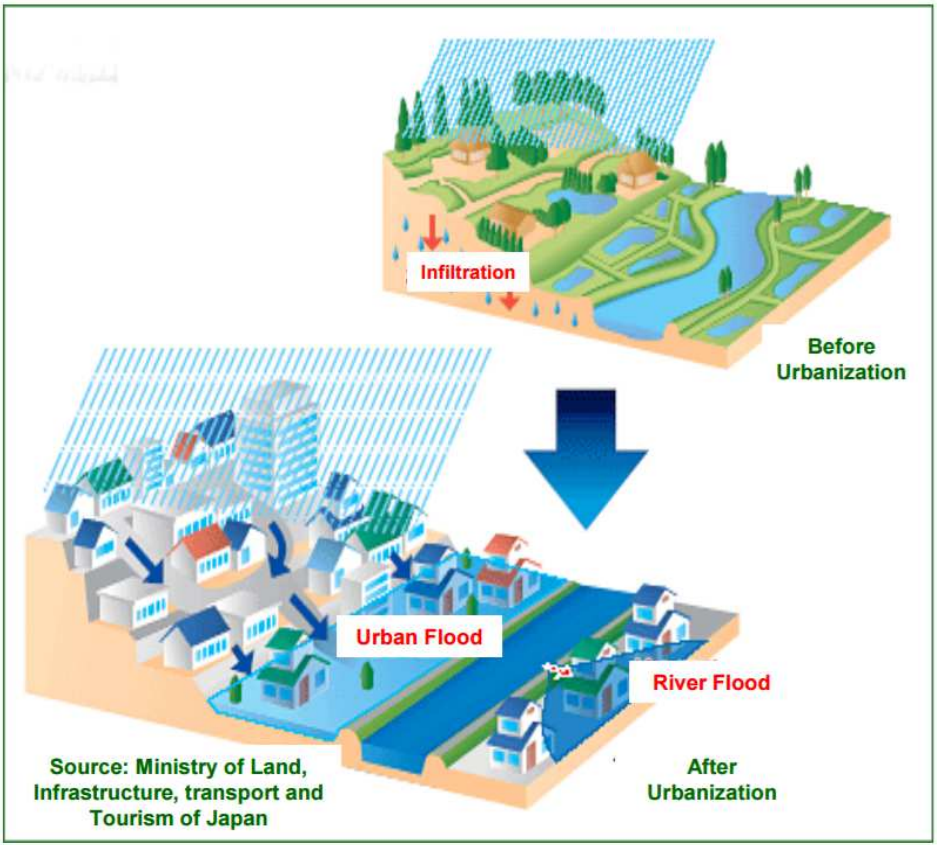

Figure 2.6: Concept of Urban Flooding

Source :(Saeki, 2017)

Causes of flood damage in Japan

- Since the 1960s, urban areas have expanded and land use has been advanced rapidly.
- As compared with urbanization, the construction of flood control facilities by river and sewerage system has been slower.
- Development in watershed has increased runoff resulting in shorter time of concentration.
- The capacity of old sewerage facilities is insufficient now.
- The frequency of intense rainfall has increased.

Current Status of Flood Control

Promotion of comprehensive flood control measures

- Flood control measures are promoted with a combination of structural measures and self-help efforts. The former includes the improvement of sewers and pumping stations. The latter includes the provision of rainfall information to help private companies, residents, and the community to take disaster precautions.

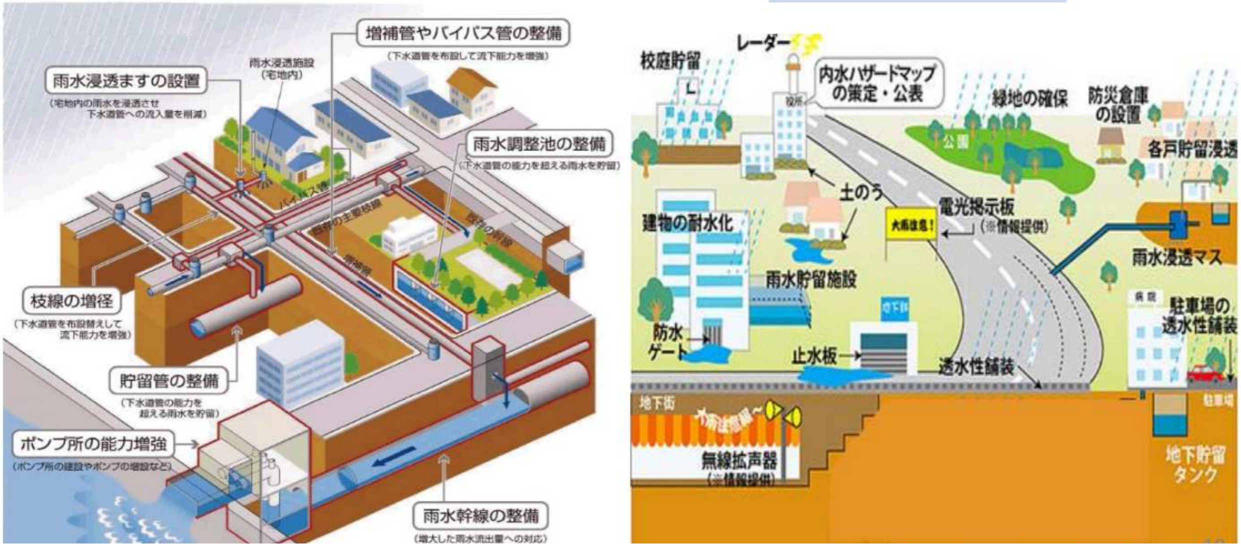

Figure 2.7: Structural measures (left) and Self-help efforts (right)

Source :(Saeki, 2017)

Measures through the improvement of flood control facilities, structural measures.

- Improvement of storm sewer and pumping station for draining storm water safely
- Improvement of storage facilities to compensate for limited sewer capacity in the downstream
- Improvement of stormwater infiltration facilities to reduce storm water runoff from the surface

Effective and Efficient Operation of Pumping Stations

- To rationalize operation, water levels of sewer and receiving rivers are monitored.
- Operational standby pumps are installed to deal with a rapid stormwater inflow.
- An operational standby pump can operate at full speed regardless of water level.
- The pump can be ready with the delivery valve full open prior to stormwater inflow and drain water promptly in response to surge.

Stormwater Storage / Infiltration Facilities

- •Improvement of stormwater storage facilities to compensate for the sewer capacity shortage in the downstream of network
- •Improvement of stormwater infiltration facilities to reduce stormwater runoff
- These facilities are sometimes constructed due to discharge limit to the river or for recharging ground water in case of infiltration facilities.

Measures to caution private companies, residents, and the community for self-help efforts

- Provision of rainfall information
- Development and public release of a flood risk map
- Information on the water level of trunk sewers

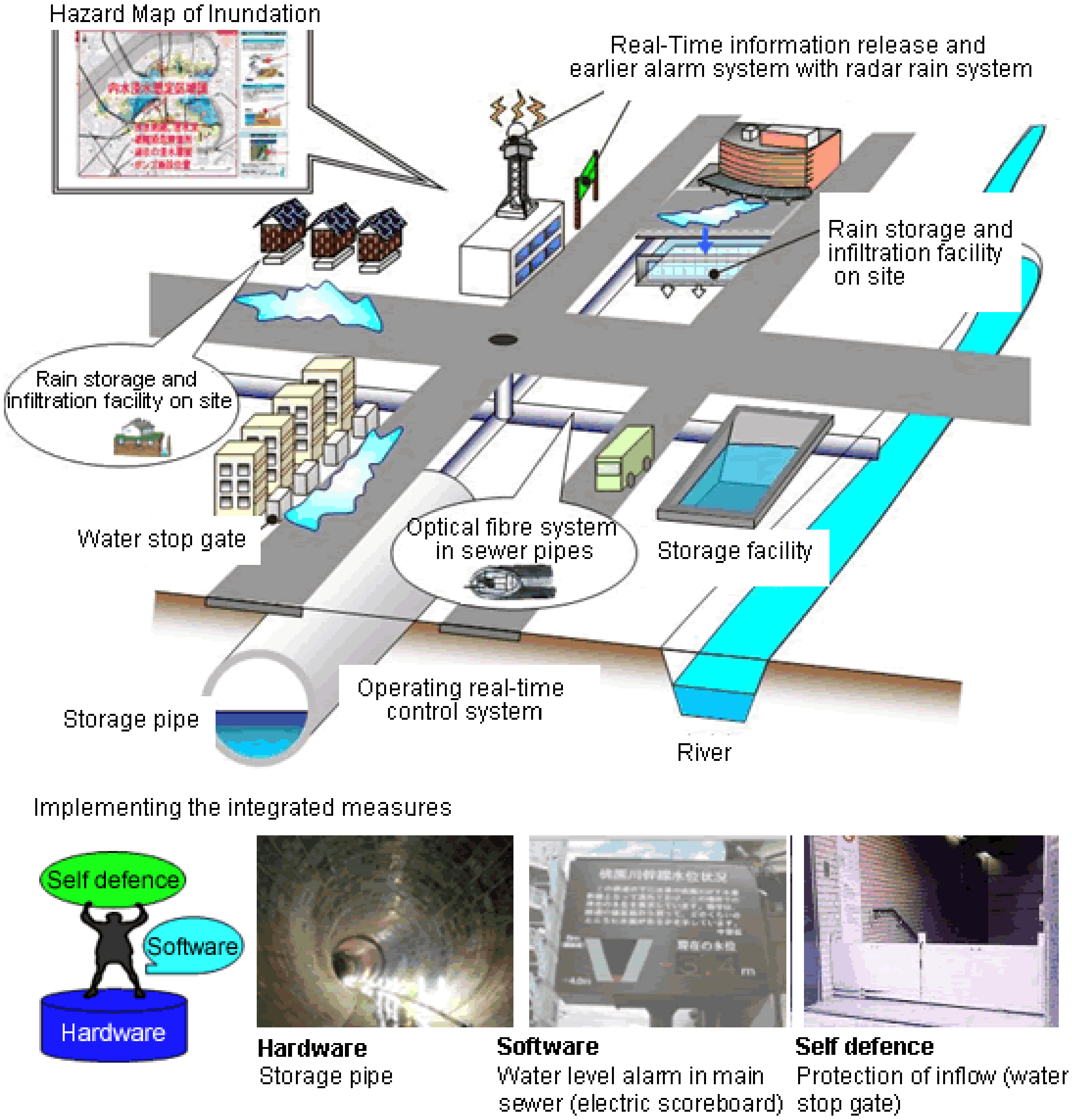

Figure 2.8: Implementation of the integrated measures

Source :(Ministry of Land, Infrastructure, Transport and Tourism)

2.2.3 Earthquake

After the Kobe earthquake (AKA Great Hanshin earthquake) in 1995, which killed about 6,000 people and injured 26,000, Japan also put enormous resources into new research on protecting structures, as well as retrofitting the country's older and more vulnerable structures. Japan has spent billions of dollars developing the most advanced technology against earthquakes and tsunamis. One of these technologies is known as "base isolation." This type of engineering is currently the most effective defense against seismic activity.

Base Isolation

The system that has been adopted most widely in recent years is typified by the use of elastomeric bearings, the elastomer made of either natural rubber or neoprene. In this approach, the building or structure is decoupled from the horizontal components of the earthquake ground motion by interposing a layer with low horizontal stiffness between the structure and the foundation. This layer gives the structure a fundamental frequency that is much lower than its fixed-base frequency and also much lower than the predominant frequencies of the ground motion. The first dynamic mode of the isolated structure involves deformation only in the isolation system, the structure above being to all intents and purposes rigid. The higher modes that will produce deformation in the structure are orthogonal to the first mode and consequently also to the ground motion. These higher modes do not participate in the motion, so that if there is high energy in the ground motion at these higher frequencies, this energy cannot be transmitted into the structure. The isolation system does not absorb the earthquake energy, but rather deflects it through the dynamics of the system. This type of isolation works when the system is linear and even when undamped; however, some damping is beneficial to suppress any possible resonance at the isolation frequency.

The second basic type of isolation system is typified by the sliding system. This works by limiting the transfer of shear across the isolation interface. Many sliding systems have been proposed and some have been used. In China there are at least three buildings on sliding systems that use a specially selected sand at the sliding interface. A type of isolation containing a lead-bronze plate sliding on stainless steel with an elastomeric bearing has been used for a nuclear power plant in South Africa. The friction-pendulum system is a sliding system using a special interfacial material sliding on stainless steel and has been used for several projects in the United States, both new and retrofit construction.

Basically: The foundation of the building is made of alternating layers of steel and rubber, just like in the diagram on the left. This allows for horizontal shifting because the base is not fixed.

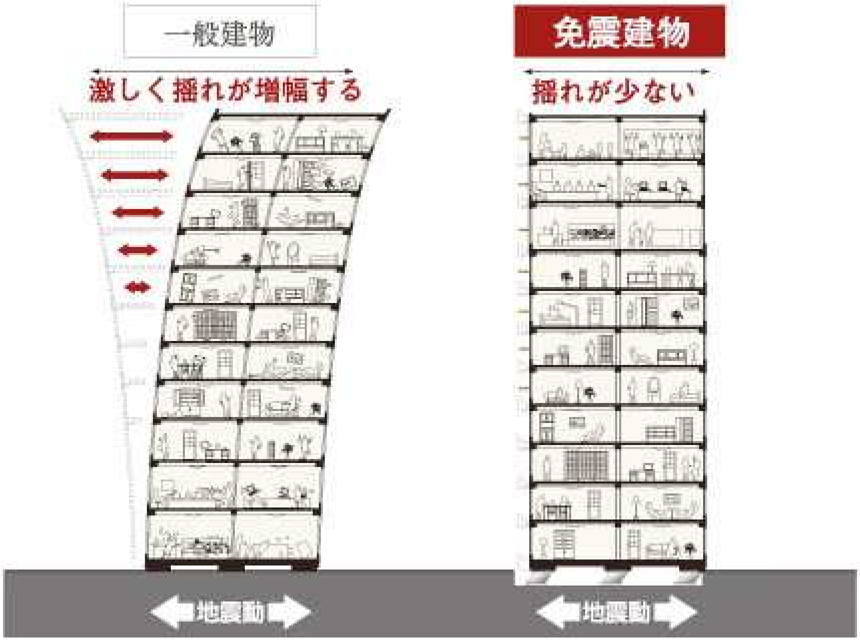

Figure 2.9: Base isolation system (right) versus an ordinary building (left)

Source : http://japanpropertycentral.com/2012/01/30-of-apartments-with-base-isolation-systems-suffered-damage-in-earthquake/

Vibration Control

This method is self explanatory, but involves the use of damper systems such as steel and rubber in the walls, foundation, pillars, and roof.

Quake-Proof

This method focuses on strengthening the structure of a building so that it can withstand the vibration energy of an earthquake. One company, Yahagi Construction Co., developed a method known as a "pita column." In plain terms, they attach steel plates or reinforcement rods on the outer walls and cover them with concrete.

The key to a building surviving seismic activity is not only durability, but flexibility. Tall buildings in Japan are actually safer during earthquakes because they are able to bend or sway back and forth in tune with the earth like a tree, while short buildings are more rigid and therefore more likely to collapse. Most earthquake resistant buildings in Japan will use a variety of the above methods. Materials also play an important role. Common earthquake resistant materials include steel, wood, and high intensity concrete because of their ductility.

Seismic Retrofit Methods

Seismic retrofit technology consists of three methods:

1.The Seismic strengthening method which raises the intensity and modification performance of a building. This is the most popular method.

2.The seismic-isolating method which reduces the effect on a building of the shake produced by an earthquake.

3.The vibration control method which controls the shake of the building itself.

From the result of the seismic diagnosis, the most suitable technology method is proposed.

Seismic strengthening method

Seismic strengthening is the standard technology of seismic retrofitting. It is the technique of generally raising the intensity and modification performance of a structure. There are various methods as shown below.

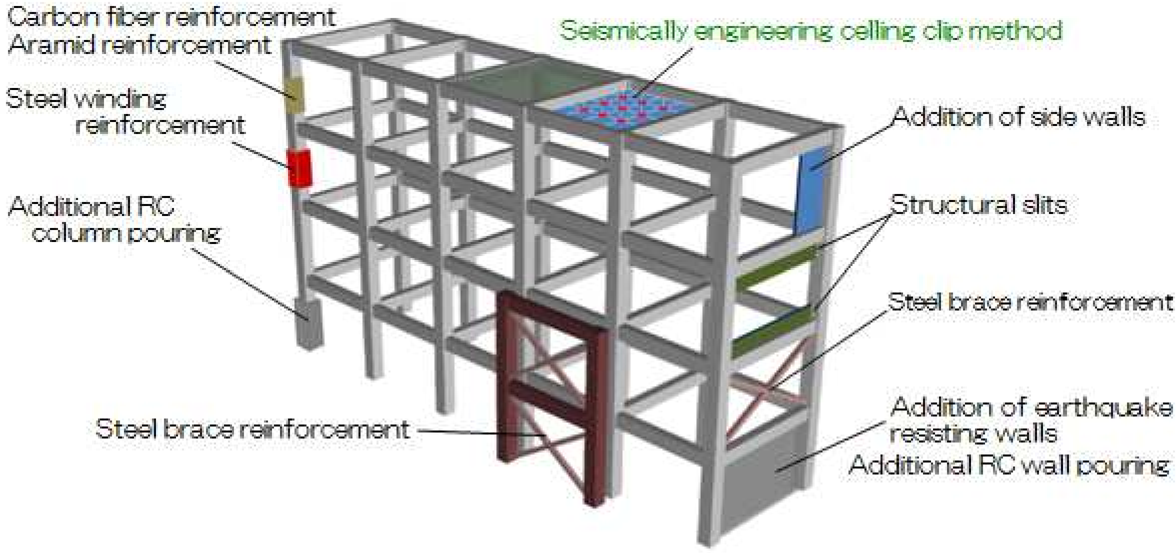

Figure 2.10: Seismic strengthening method

Source :(NISHIMATSU CONSTRUCTION Co.,Ltd., 2017)

Seismic-isolating method

This is the technology of reducing the effect of shake produced by an earthquake on a building by installing seismic-isolating devices, such as rubber, between the ground and the building as shown below. In addition, this technology may include the seismic isolation of the floors of only specific rooms in a building.

Shake Control Method

This technology method provides various vibration suppression dampers fixed to the surface of a wall, or installs a huge water tank or a suspended mass in the roof etc to control the shake of the building as shown below. In addition, there is a method which controls the shake of a ceiling by installing a ceiling damping system.

Also, the BiD Frame Construction Method, as shown below, uses an outer steel frame of columns and beams to reinforce the building and may include damping systems in the columns. *BiD is the abbreviated name for Built-in Damper.

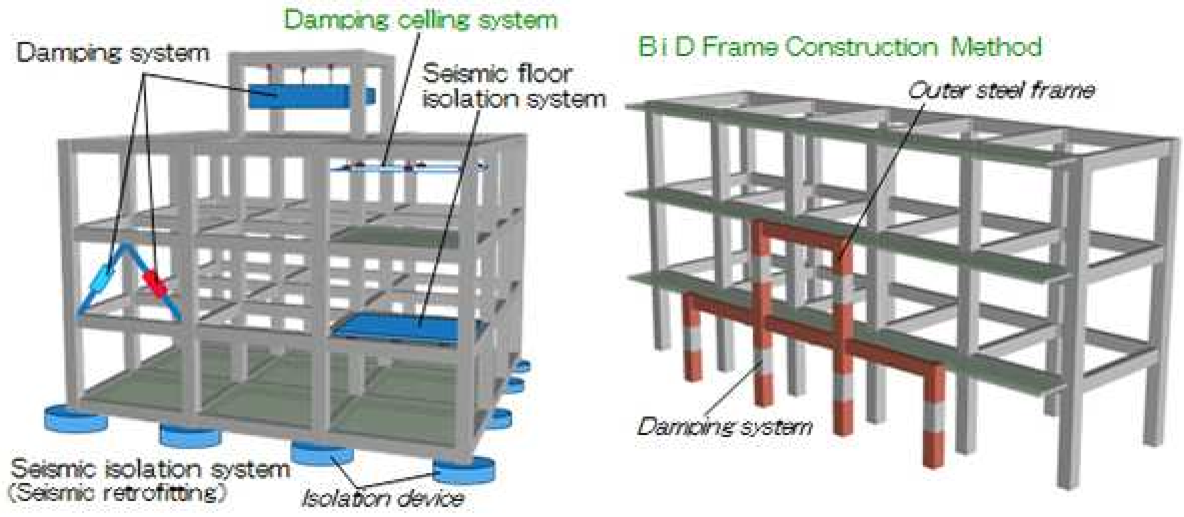

Figure 2.11: Shake Control Method

Source :(NISHIMATSU CONSTRUCTION Co.,Ltd., 2017)

2.2.4 Tsunami

The term tsunami is derived from two Japanese words: ‘tsu’, meaning harbor, and ‘nami’, meaning wave. That is because these waves may create large surges or oscillations in bays or harbours, which are not responsive to the action of normal sea waves. In deep water, a tsunami is hardly noticeable, but near the coast various mechanisms cause the wave to grow with sometimes devastating effects. The term ‘tsunami’ was created by fishermen who returned to their ports to find the surrounding area devastated, although they had not been aware of any wave in the open water.

Tsunamis are caused by rapid perturbations of the seabed or of the water column above it, which either lift the sea surface up above its normal level (the usual case) or depress it. This perturbation produces a series of waves, or wave train, which then propagates outwards from the source area until it either dissipates or collides with a coastline. The physics of this propagation process are considered later. The used terminology is presented in Figure 2.12.

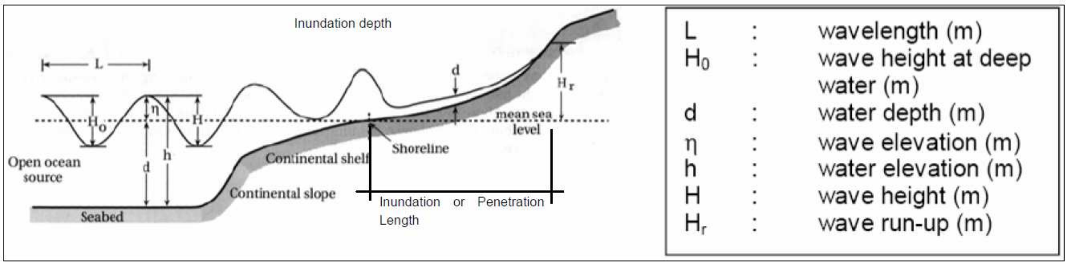

Figure 2.12: Terminology for tsunami waves

Source :(Ton van der Plas, 2007)

Tsunami Barriers

Seawalls

(Wikipedia, 2017) has given meaning A seawall (or sea wall) is a form of coastal defense constructed where the sea, and associated coastal processes, impact directly upon the landforms of the coast. The purpose of a sea wall is to protect areas of human habitation, conservation and leisure activities from the action of tides, waves, or tsunamis. As a seawall is a static feature it will conflict with the dynamic nature of the coast and impede the exchange of sediment between land and sea.

The coast is generally a high-energy, dynamic environment with spatial variations over a wide range of timescales. The coast is exposed to erosion by rivers and winds as well as the sea, so that a combination of denudation processes will work against a sea wall. Because of these persistent natural forces, sea walls need to be maintained (and eventually replaced) to maintain their effectiveness.

The many types of sea wall in use today reflect both the varying physical forces they are designed to withstand, and location specific aspects, such as local climate, coastal position, wave regime, and value of landform. Sea walls are hard engineering shore-based structures which protect the coast from erosion. But various environmental problems and issues may arise from the construction of a sea wall, including disrupting sediment movement and transport patterns. Combined with a high construction cost, this has led to an increasing use of other soft engineering coastal management options such as beach replenishment.

Sea walls may be constructed from various materials, most commonly reinforced concrete, boulders, steel, or gabions. Other possible construction materials are: vinyl, wood, aluminium, fibreglass composite, and large biodegrable sandbags made of jute and coir.[6] In the UK, sea wall also refers to an earthen bank used to create a polder, or a dike construction.

Figure 2.13: Terminology for tsunami waves

Source : (http://ameblo.jp/wada-masamune/entry-11980826821.html)

Tsunami Protection Breakwater

The deepest breakwater in Japan is constructed at the mouth of Kamaishi Bay, to protect the port area from tsunamis. The Kamaishi Tsunami Protection Breakwater reduces the bay-mouth opening to lessen tsunami run-up height as well as wind waves and swell. The deepest point in the bay-mouth is 63m. The retaining height is approximately 5,0m +MSL

Figure 2.14: Plan view and impression of Kamaishi Breakwater in Japan

Source :(Ton van der Plas, 2007)

At the mouth of Kamaishi Bay there were two breakwaters stretching from north to south. Though the northern breakwater was 990 m and southern was 670 m long both were destroyed by tsunami. However, their destruction was not in vain as they succeeded in delaying and suppressing the tsunami's run-up height. From the GPS wave gauge data from offshore of Port of Kamaishi it was calculated that without the interference of breakwaters the tsunami at Kamaishi Bay would have been 13.7 m tall. However, since the actually observed height was only 8.1 m it was reasoned that breakwaters succeeded in reducing the tsunami by about 40%

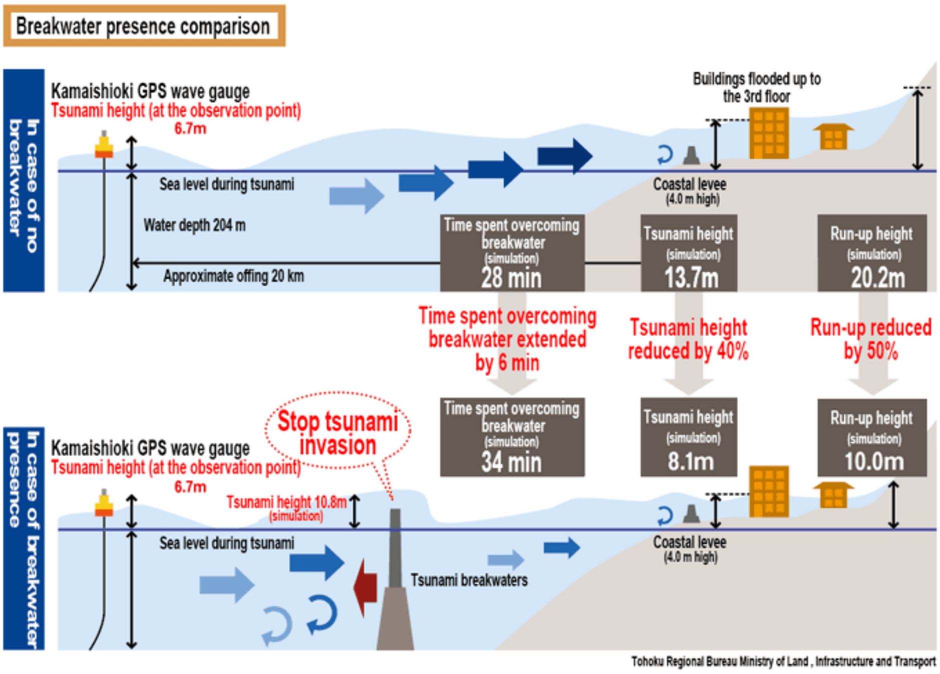

Figure 2.15: Breakwater presence comparison

Source : (Tohoku Regional Bureau, MLITT)

Twin-Wing Tsunami Barrier

Van den Noort Innovations BV, 2012: The Twin-Wing Tsunami Barrier has been developed in order to disrupt and neutralise a tsunami flood wave, in both its negative and positive occurrence.

In its resting position, the barrier wings are positioned horizontally on the sea bed, ready to swing up like a wall from their piled foundations as soon as the coastal waters retreat (negative tsunami) or, from the occurrence of a direct positive tsunami wave hit.

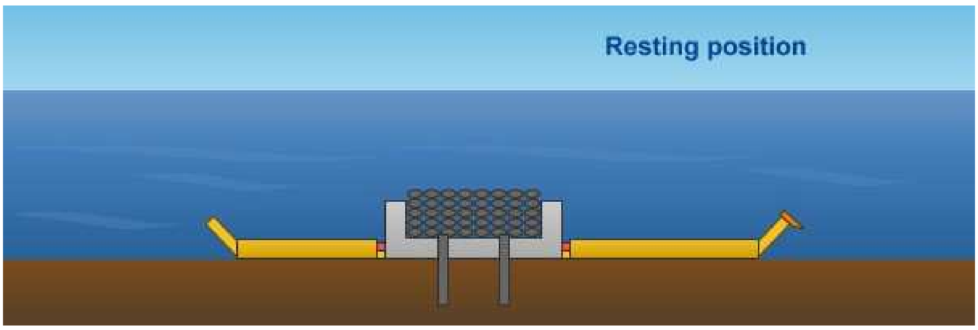

Figure 2.15: resting position

Source : (Van den Noort Innovations BV, 2012)

On either side of the foundation, the barrier wing through its spoiler is instantly pushed up into a vertical position once a strong upcoming onshore or offshore ground stream starts to emerge. During normal flood and even high tides, the wings always remain in their horizontal positions. Should a negative tsunami wave strike, the barrier wing on the shore side is swung into its vertical position and it closes off the shore water effectively barring the flood wave.

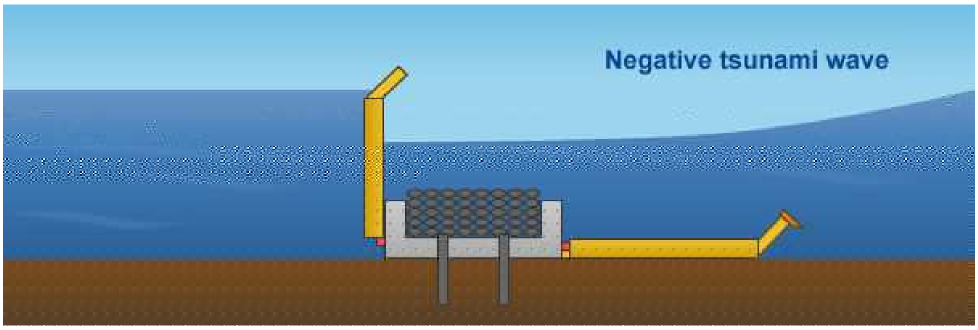

Figure 2.16: Negative tsunami wave

Source : (Van den Noort Innovations BV, 2012)

In a positive tsunami run, the wave will be reflected back to the ocean by the diffuser on top of the barrier wing. However, when there will be an overflow of flood water surging towards the shore, the speed of its movement will be greatly impaired by the unmoved coastal water mass which has been blocked by the barrier. The wave impact is thereby neutralised by the stalled coastal water body. Through their hinges, the barrier wings can swing back and forth from their horizontal positions into a vertical position, staying in place like a sluice gate and picking up the impact of secondary waves.

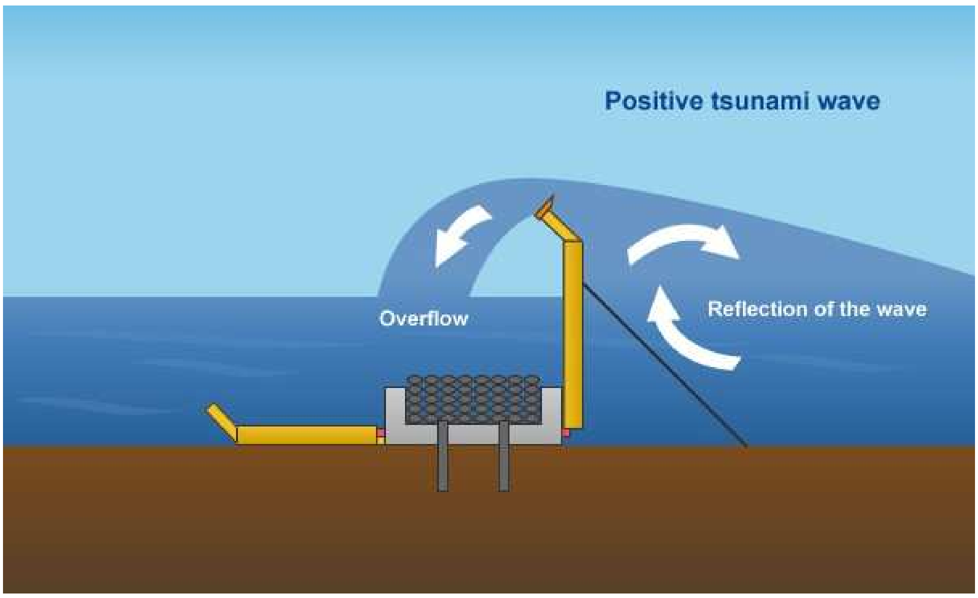

Figure 2.17: Positive tsunami wave

Source : (Van den Noort Innovations BV, 2012)

2.2.5 Slope Land slide

(Erosion and Sediment Control Research Group, 2007): In Guidelines for Landslide Prevention Technologies have explained the Landslide phenomena present varying behaviors depending on the features of the environment, such as the topography, geology, and geological structure, making it difficult to predict their development. Therefore, when implementing landslide prevention measures, it is required to take flexible and effective measures by adequately grasping the characteristics of individual landslides.

In order to prevent landslide disasters, it is necessary to implement emergency surveys and inspections/monitoring after construction, in addition to carrying out general surveys, planning, design, and construction. This PWRI technical note provides standard methodologies and key points to be used for the preparation of landslide prevention plans Include:

Surface water drains

Surface water drains are constructed to prevent seepage of rainfall and re-seepage of water from spring water positions, bogs, channels, etc. in order to control an increase in groundwater. Surface water drains include channels and seepage water prevention. Works that can be constructed quickly should be chosen in consideration of landslide conditions. Channels should be planned to suit the topography of the landslide site and should be of a scale that needs no large-scale earthworks. Channels to prevent surface water from flowing into the landslide site should be constructed at a stable peripheral area away from cracks and scarps.

The effectiveness of surface water drains cannot presently be quantified, but it is desirable that they form part of landslide prevention. They are particularly effective when rainfall and landslide movement are closely interrelated 1) Surface water drains

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The effectiveness of surface water drains cannot presently be quantified, but it is desirable that they form part of landslide prevention. They are particularly effective when rainfall and landslide movement are closely interrelated.

(1) Channels

Channels are constructed to collect rainwater within the landslide site quickly and to drain it away from the site, or to prevent water from flowing into the landslide site.

Channels are classified into collection channels and drainage channels.

(i) Collection channels

Collection channels are usually constructed in the traverse direction of the slope to collect rainfall and surface water quickly. Channels are constructed to relatively wide and shallow and connected to drainage channels.

(ii) Drainage channels

The cross section of drainage channels should be determined by a runoff calculation because they are used to discharge collected water away from the site quickly. Channels are constructed in locations that have a valley topography. Girdles are placed at intervals of 20 to 30 meters along the channel in principle, and a groundsill and a catch basin are installed at the end of the drainage channel or at the junction of the channels.

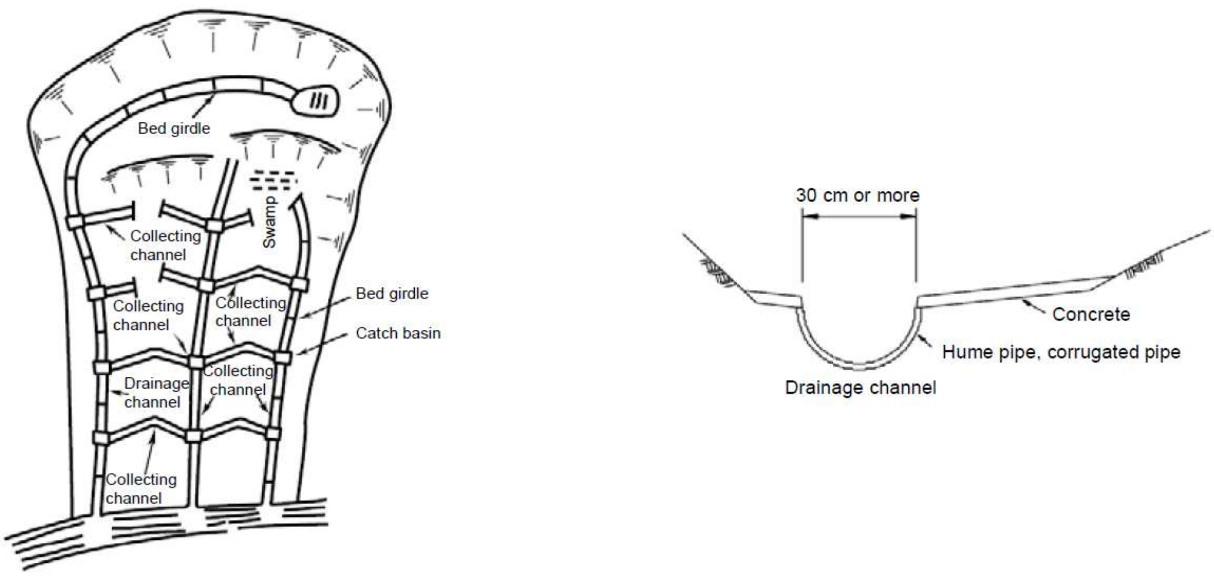


Figure 2.18: surface drainage channels

Source :(Erosion and Sediment Control Research Group, 2007)

(2) Seepage prevention works

Seepage prevention works involve covering cracks with clay, cement, plastic sheeting, etc. To prevent water leaking from bogs, channels, etc., an impermeable cover can be applied, the bog can be cut, or the channels can be rerouted or improved.

Groundwater drains

The purpose of groundwater drains is to remove groundwater that flows into, seeps into, or is distributed in the landslide site in order to reduce the pore water pressure (groundwater level) in the landslide mass. Groundwater drains are classified into shallow groundwater drains to handle the groundwater flowing in the layer near the surface, and deep groundwater drains to handle deep groundwater near the slip surface.

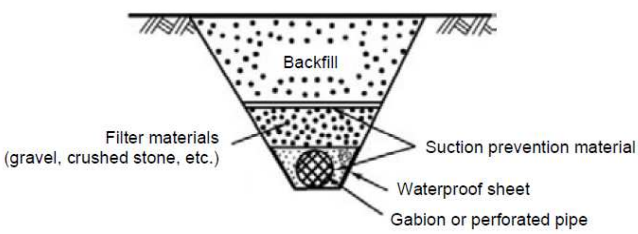
The design groundwater level varies by the type of prevention works and topography, geology, and groundwater conditions at the landslide site. The groundwater level must therefore be examined and determined by referring to the groundwater level analysis results, past groundwater reduction results at similar locations, etc. When these reference materials cannot be obtained, the following values may be used as a reference. However, it must be noted that the values presented here are empirical values when groundwater drainage facilities are adequately placed at the landslide site, and they should be assumed as the maximum groundwater level reduction that can be expected. Hence, continuous monitoring must be made after the construction and if the expected groundwater level reduction is not achieved, the works must be reexamined and additional works applied if necessary.

Horizontal bore 3 m, Drainage well 5 m, Drainage tunnel 8 m.

(1) Shallow groundwater drains

(i) Closed conduits

Closed conduits are installed to remove groundwater distributed in shallows areas of ground and rainwater that seeps into the ground from the ground surface. These works are particularly recommended when the objective is to remove abundant groundwater in the layer of soil that has a small permeability coefficient. Groundwater to a depth of two meters can be removed.



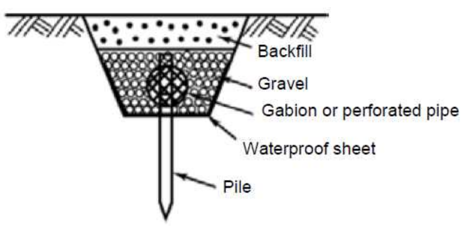


Figure 2.19: Closed conduits

Source :(Erosion and Sediment Control Research Group, 2007)

(ii) Open drains and closed conduits

Open drains and closed conduits are installed to prevent inflow and the seepage of surface water and to remove groundwater that has seeped from the surface into shallow ground. Shallow groundwater is water that has seeped from the surface, so a combined structure of closed conduits and surface water channels should be constructed at valleys and depressions on the slope.

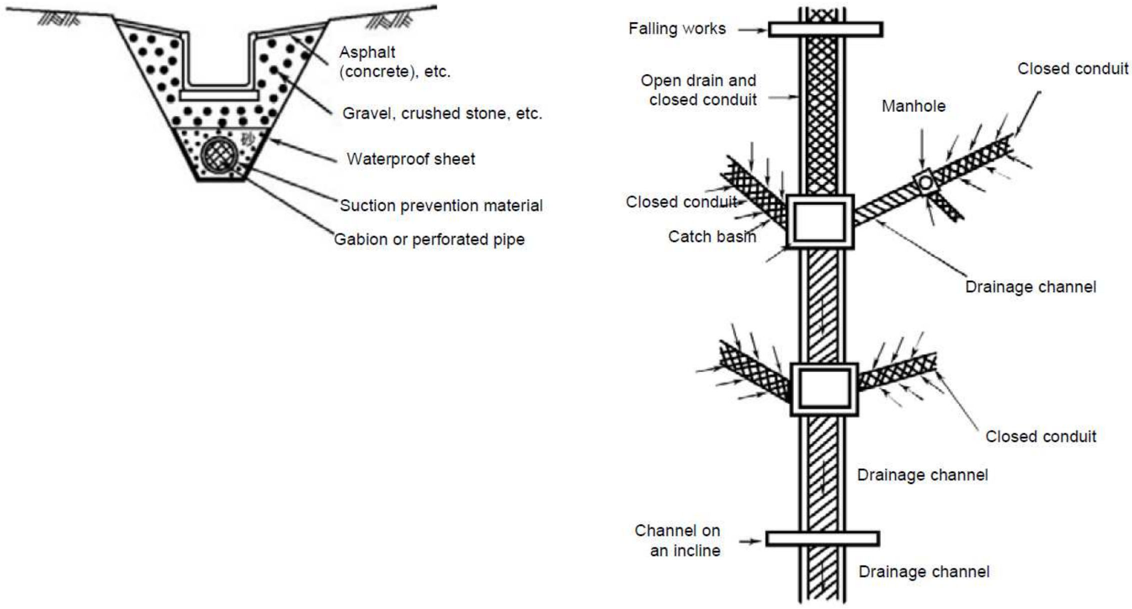


Figure 2.20: Open drains and closed conduits

Source :(Erosion and Sediment Control Research Group, 2007)

(iii) Horizontal bores

Horizontal bores are the structures for removing shallow groundwater that cannot be removed by open drains or closed conduits, etc. The bores are constructed when topographically feasible. It is desirable to determine the diameter, length, angle, etc. of the horizontal bores based on the results of groundwater analysis, but their tip intervals are generally 5 to 10 meters. They are constructed intensively in areas that have abundant groundwater.

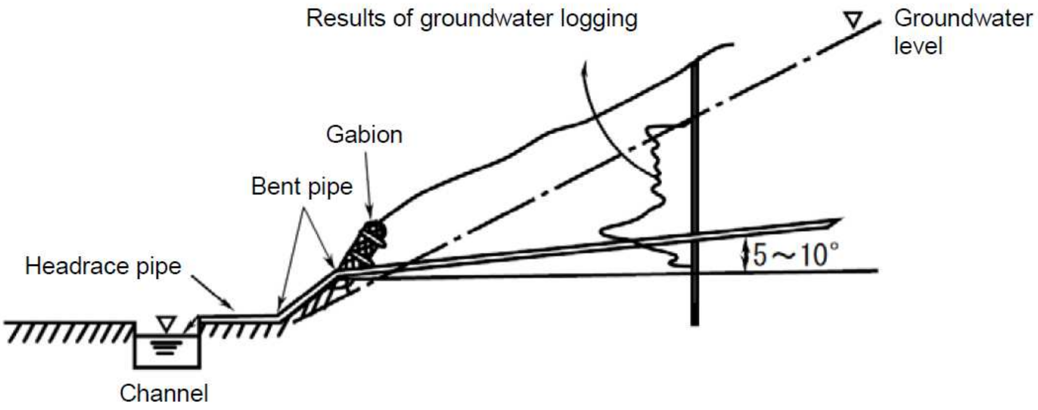


Figure 2.21: Horizontal bores

Source :(Erosion and Sediment Control Research Group, 2007)

(2) Deep groundwater drains

(i) Horizontal bores

Horizontal bores that are constructed to remove deep groundwater remove the groundwater distributed around the slip surface and groundwater along the faults and crush zones. These bores should be planned toward the aquifer after confirming the presence of deep groundwater in the landslide block, the groundwater level, etc. The tip intervals of bores are generally 5 to 10 meters. They are often planned to create a 5- to 10-meter overbreak penetrating through the potential slip surface.

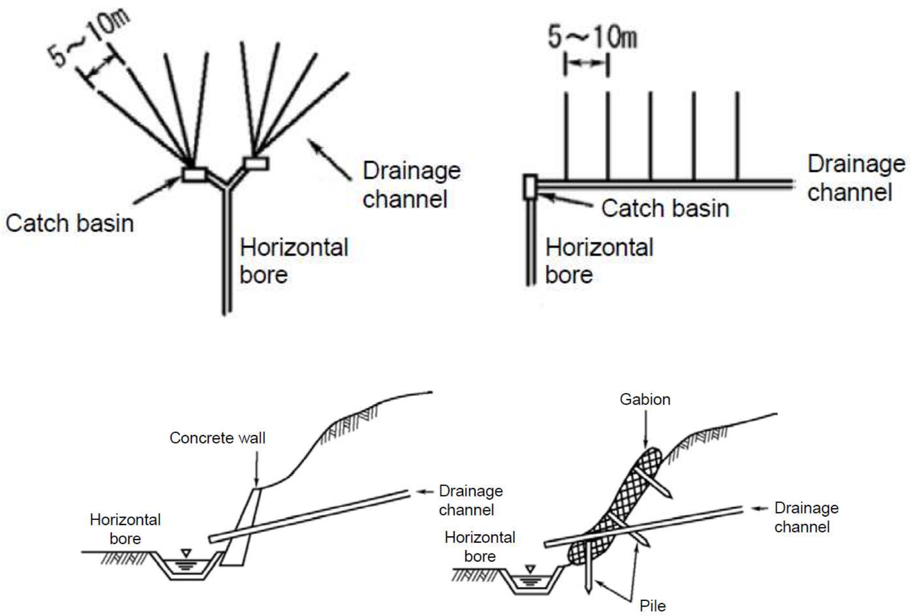


Figure 2.22: Layout of horizontal bore

Source :(Erosion and Sediment Control Research Group, 2007)

(ii) Drainage wells

Drainage wells are constructed to remove deep groundwater. They are planned particularly when the intention is to collect deep groundwater intensively or when the length of the horizontal bores exceed 50 meters.

Drainage wells are constructed when no spring water is expected from the well walls but when a large volume of water is expected from the groundwater artery by drainage bore.

The position of the drainage well should be at least two meters shallower than the slip surface to ensure the stability of an open caisson and drainage bore in the case of an active landslide site. If the landslide site is not active, the caisson foundation of the drainage well can be constructed in the stable ground penetrating through the slip surface.

The position and scale of the drainage well should be determined by considering the water collection effect, construction safety and maintenance, etc. In particular, the position and construction method of the drainage well should be determined in a way that allows natural drainage of water from the well to the ground surface. If direct drainage of the water from the well to the ground surface is impossible, construction of a relay well should be planned. In either case, drainage bores should be constructed at positions that do not cross landslide blocks in principle so that they will not be cut by a landslide.

Drainage wells are constructed when intensive groundwater drainage is necessitated at the landslide site where groundwater is distributed in a layered or folded form. If the groundwater distribution is multi-layered, more than two layered bores in the vertical direction are required.

If the geology is poor and spring water is abundant, construction of the drainage well is difficult and other construction methods should be adopted. Also, at positions where there is active deformation, the caisson may sustain strain due to increased side pressure, which may result in a failure. It is advisable to avoid such a position in consideration of maintenance after the construction as well as the prevention of disasters during construction. Therefore, determine the position of the drainage well in principle by examining the geological conditions and the bedrock through survey bores.

When multiple drainage wells are constructed, determine their number and positions by considering the length of the drainage bores, the scope of possible impact of groundwater reduction due to those wells, and the groundwater conditions at the site.

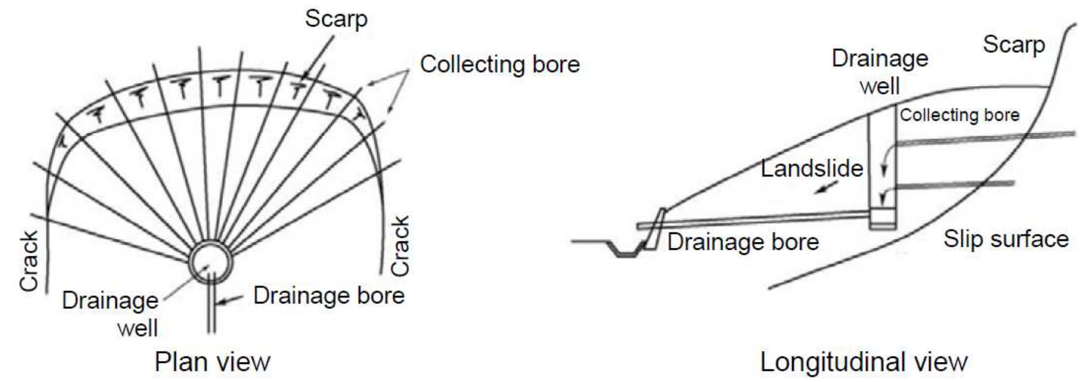


Figure 2.23: Drainage well

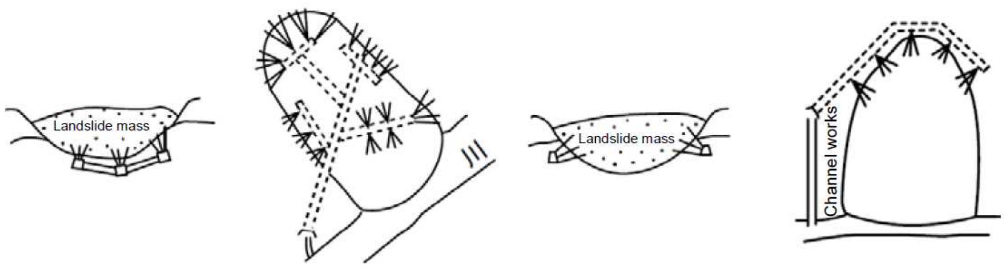
Source :(Erosion and Sediment Control Research Group, 2007)

(iii) Drainage tunnels

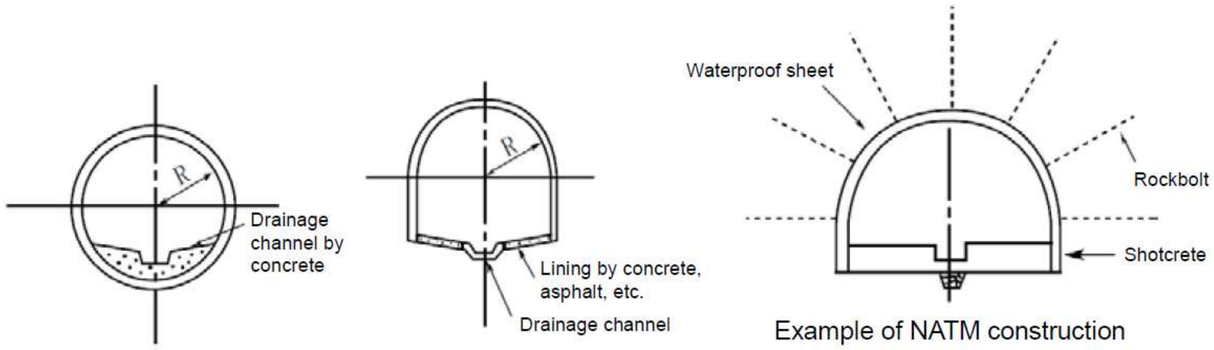
Drainage tunnels are planned when it is difficult to remove deep groundwater by drainage wells or horizontal bores.

Drainage tunnels are constructed with the aim of removing deep groundwater around the slip surface by water collection bores from inside the tunnel. Drainage tunnels are roughly classified into bottom drainage tunnels, which are constructed below the slip surface, and peripheral drainage tunnels which are constructed in the peripheral area of the landslide. Tunnels should not be constructed within the landslide mass in principle, and they should be located more than twice the diameter of the drainage tunnel from the slip surface.

Water collection bores should be bored toward the upper or horizontal direction from the bore space in the tunnel.



(a) Drainage tunnel below the mass (b) Drainage tunnel in the peripheral area



(c) Examples of the cross section of a drainage tunnel

Figure 2.24: Drainage tunnel

Source :(Erosion and Sediment Control Research Group, 2007)

Earth removal

Earth removal is conducted to reduce the sliding force of the landslide by removing a soil mass from the head area. Before planning earth removal, it is necessary to conduct sufficient surveys and examinations so as not to create a potential landslide at the upper slope. If a potential landslide is found to exit at the upper slope, earth removal should not be adopted.

The volume of earth removal should be determined by stability calculation by correctly estimating the landslide scale and the slip surface position. After earth removal is competed, restoration of the natural environment should be facilitated by introducing vegetation to the slope and the excavated earth.

Where earth removal is to be carried out on a steep slope or in an area where there is a large displacement and it is dangerous for workers to enter the site, the introduction of unmanned construction technologies should be studied.

The disadvantage of earth removal is that a considerable time may be required for the purchase of land, in addition to the cost necessary for the removing and treating sediment and maintenance of the cut slope. On the other hand, its advantage is that it is free from the problems of functional deterioration, unlike horizontal bores, drainage wells and groundwater drains, which tend to suffer from slime adhering to the water collection and drainage boreholes. Therefore, earth removal should be adopted actively if it is found favorable in terms of ease of construction, sediment treatment, necessary land, functional deterioration risks, and total cost, including maintenance.

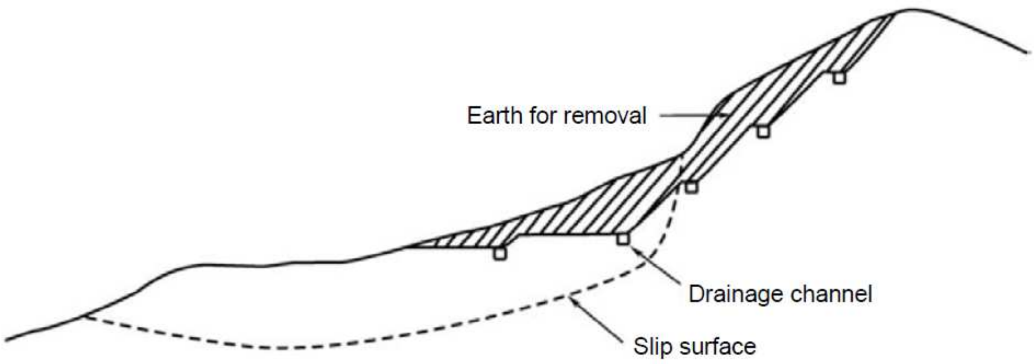


Figure 2.25: Earth removal and the cut slope
Source :(Erosion and Sediment Control Research Group, 2007)

Embankment loading

Embankment loading is performed to increase the resistive force against the sliding force by banking a soil mass having good permeability at the foot of the landslide. This work should be planned for the landslide foot after confirming that a new landslide would not be triggered at the embankment area or on the slope around it. The embankment position is often the bed of a river or a stream, so relocation of a river channel or revetment may be required in some cases.

Embankment loading is often planned as a combination with earth removal since this combination is effective. It is also desirable to combine it with groundwater drains as preparation for a possible increase in groundwater level at the back of the embankment.

The volume of embankment should be determined by stability calculation. After the work is completed, greening should be introduced to facilitate recovery of the natural environment and aesthetics. Also, a construction method that can secure the safety of workers should be adopted, as mentioned earlier for earth removal.

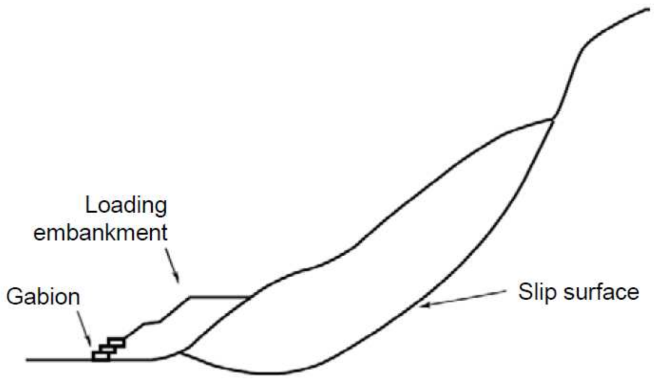


Figure 2.26: Embankment loading
Source :(Erosion and Sediment Control Research Group, 2007)

Restraining Structures

(1) Piles

Piles for the prevention of landslides can be classified as follows in terms of function:

- Flexural piles

Flexural piles are designed against the assumption that when sliding occurs, the landslide mass will be deformed and shear force and bending stress will be applied on the piles. There are two types of flexural piles: wedge piles and restraint piles.

(i) Wedge piles

These piles are designed by assuming that the sliding force of the landslide acts on the slip surface as a concentrated load, and that a shear force and a bending stress are generated when the piles move with the landslide mass and bend at above or below the slip surface.

(ii) Restraint piles

These piles are designed by assuming that the piles act like a cantilever beam when ground reaction on the side of the valley cannot be expected, and that the sliding force of the landslide acts on the piles in the moving layer as a distributed load or a concentrated load. Restraint piles are used for the foot or head area of the landslide.

- Shear piles

Shear piles are designed by considering only the shear force, assuming that the landslide mass will not be deformed during sliding (meaning that the bending stress will not occur in the piles) and hence the sliding force of the landslide acts on the slip surface as a concentrated load.

Piles should be designed to provide the required preventive force by considering the topography, geology, etc. of the landslide site.

When designing piles, investigation should be made of the stability of the piles against internal stress when force is applied, as well as on the prevention of passive failure in the moving layer above the piles, the failure of the foundation ground, and the extraction of soil mass between the piles.

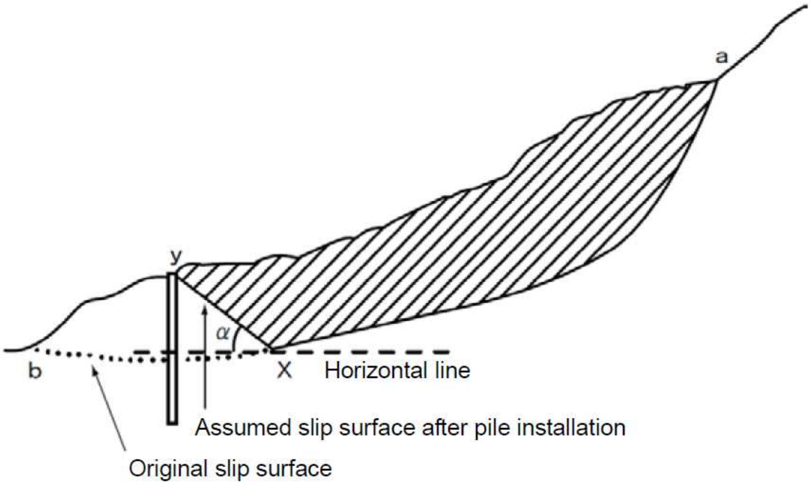


Figure 2.27: Passive failure at the upper part of a pile
Source :(Erosion and Sediment Control Research Group, 2007)

(2) Shafts

Shafts should be designed to provide the required preventive force by considering the topography and geology, etc., of the landslide site.

When designing shafts, investigation should be made concerning the stability of the shafts against internal stress when the force is applied, as well as on the prevention of passive failure in the moving layer above the shaft, the failure of the foundation ground, and the extraction of soil mass between the shafts.

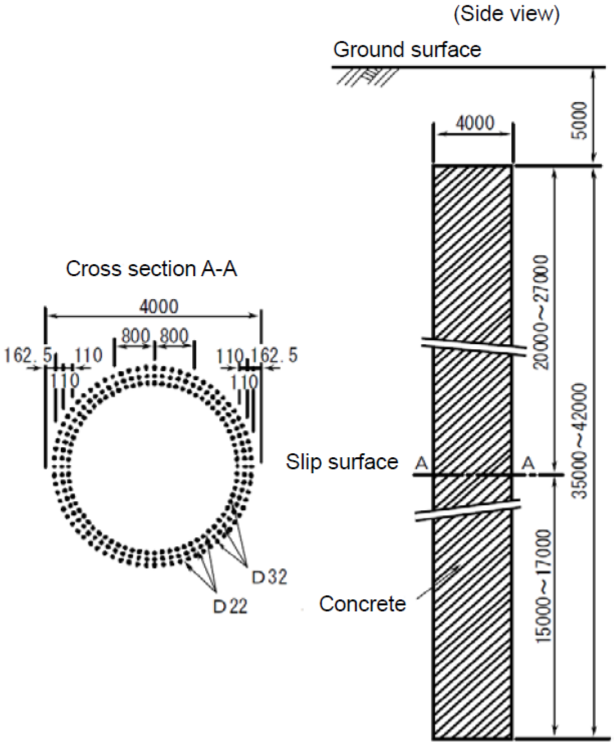


Figure 2.28: Example of shaft (unit: mm)

Source :(Erosion and Sediment Control Research Group, 2007)

(3) Anchors

The purpose of anchors in landslide prevention is to stabilize the landslide mass by unifying it with an immovable mass, by transferring the load acting on the anchor head to the anchorage ground via the tension area.

Anchors should be designed to provide the required preventive force by considering the topography and geology, etc., of the landslide site. They should also be designed to ensure that the anchors, the ground in which the anchors are fastened, and the anchor structures (bearing plates, etc.) are secure against the tension force applied.

The various design factors associated with anchors, including the position of the anchors, the position of the anchorage ground, the layout of the anchors, the anchor angles (angle between the driving direction of the anchor and the horizontal plane) and the scale and shape of the structures, should be determined carefully by examining the topography and geology of the landslide site, the moving conditions of the landslide, etc.

Basically, anchors consist of the following three components (Figure. 2.29).

- Anchor head (including the reaction structure)
- Tension area
- Anchorage area (anchor body and the anchorage ground)

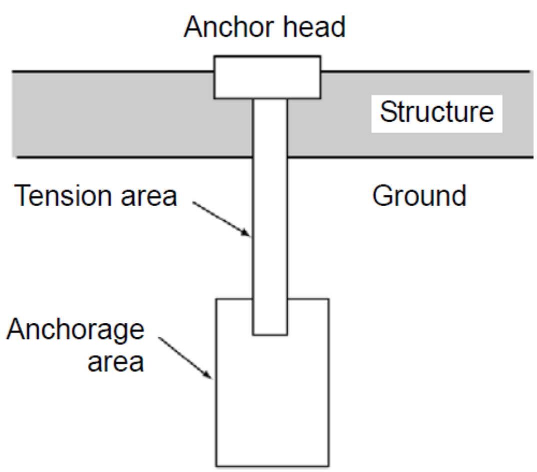


Figure 2.29: Components of anchors

Source :(Erosion and Sediment Control Research Group, 2007)

Erosion control using river structures, etc.

Erosion control using river structures, etc. are planned to protect river banks and stabilize the landslide foot area when riverbed degradation and river bank erosion due to flowing water undermine the stability of the landslide mass and may induce a landslide as a secondary cause.

River structures that are constructed to prevent landslides are sabo dams, groundsills, revetments, and groynes, etc. Redirection of a river may be planned in some cases.

If sabo dams or ground sills are constructed in a river or a stream immediately below the landslide site, collapse and erosion at the landslide foot area may be prevented by sedimentation, an effect similar to that of embankment loading.

Sabo dams and groundsills should be constructed on stable bedrock at a position immediately below the landslide site not affected by the landslide. If the construction of a group of sabo dams or groundsills is planned for the landslide site, similar structures may also be planned for the position immediately below the site not affected by the landslide in some cases.

Sabo Dam

(Wakayama Pref. 2017) Sediment-related disasters are natural disasters in which mountain or cliff is collapsed, and water mixed with soil and stone flow out of the river. These sediment-related disasters are triggered by heavy rainfall, earthquake and volcanic eruption. They hazard to our life, property, etc. Sediment-related disasters embody a "debris flow disaster", a "landslide disaster", a "slope failure disaster", a "volcanic disaster", etc. The measure for preventing these sediment-related disasters is "Sabo".

The promotion of both structural ("hard") measures and non-structural ("soft") measures can prevent sediment-related disasters. Structural ("hard") measures are constructions of facilities, such as Sabo dam or retaining wall work behind the houses, and non-structural ("soft") measures are establishment of warning and refuge systems. Using structural ("hard") measures with non-structural ("soft") measures, Sabo works is aimed to protect human life and properties and contributes to "the development of safe land".

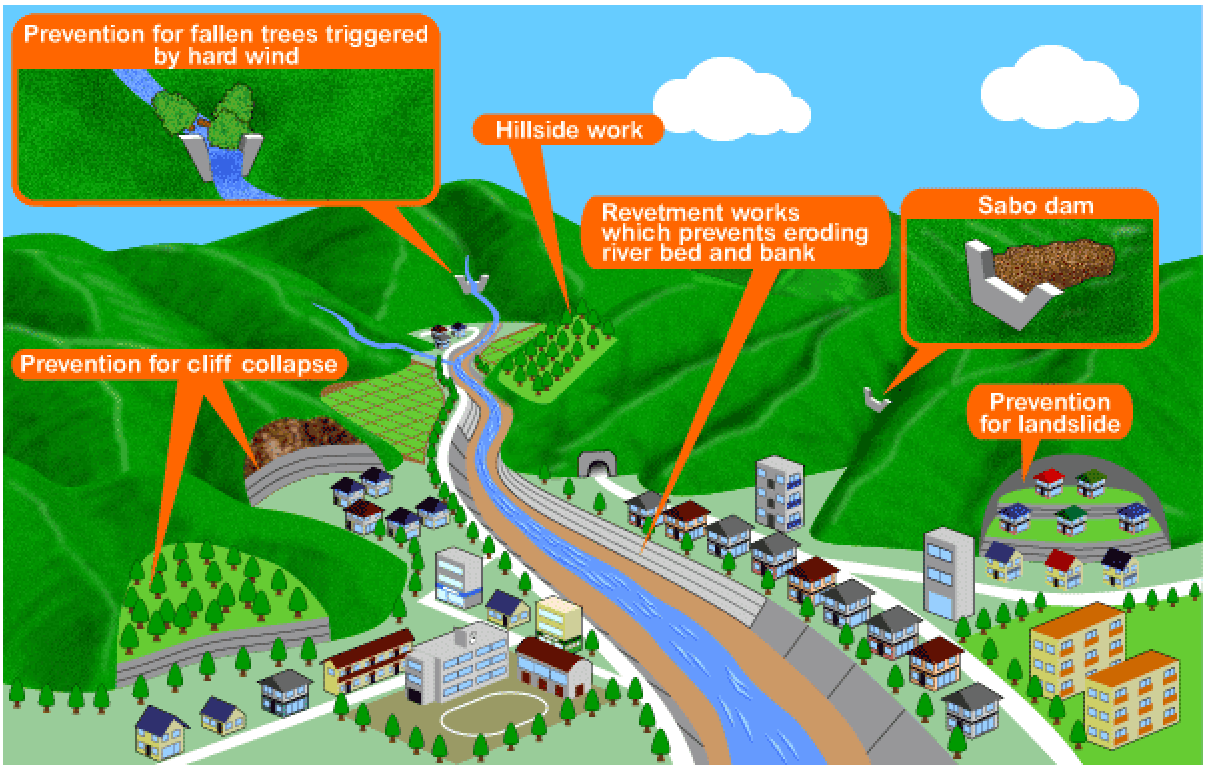


Figure 2.30: Sabo Works

Source :(Wakayama Pref.2017)

Sabo dams built in the upstream areas of mountain streams accumulate sediment and suppress production and flow of sediment. Those built at the exits of valleys work as a direct barrier to a debris flow which has occurred. A sabo dam with slits is particularly effective in capturing a debris flow because it has a larger capacity of sand pool under normal conditions. In case that there is a fear of flow-down of driftwood, a slit sabo dam is built as a preventive measure

2.2.6 GIS and Mapping

One of the most important aspects of disaster management is the map. Mapping is the process of establishing geographically where and to what extent particular phenomenon is likely to pose a threat to people, property, infrastructure and economic activities.

Hazard Mapping

Probability of hazard occurrence varies from place to place.

(Asian Disaster Preparedness Center (ADPC) The use of mapping to synthesize data on natural hazards and to combine these with socioeconomic data facilitates analysis. It improves communications among participants in the hazard management process and between planners and decision-makers. Two important techniques in use are

• Multiple hazard mapping and

• Critical facilities mapping

Multiple Hazard Mapping (MHM)

This is usually carried out with new development in mind. Valuable information on individual natural hazards in a study area may appear on maps with varying scales, coverage, and detail, but these maps are difficult to use in risk analyses due to the inability to conveniently overlay them on each other for study. Information from several of them can be combined in a single map to give a composite picture of the magnitude, frequency, and area of effect of all the natural hazards.

- Regional scale hazard mapping uses 1:100,000 to 1:250,000. These are useful during planning stages of regional development.
- Urban land use planners may need medium scale hazard maps of 1: 10,000 to 1:25,000.
- Site investigation for infrastructure projects may require largescale hazard maps of 1:1,000 to 1:5,000.

The multiple hazard map (MHM; also called a composite, synthesis, or overlay map) is an excellent tool for fomenting an awareness of natural hazards and for analyzing vulnerability and risk, especially when combined with the mapping of critical facilities. Its benefits include the following:

- Characteristics of the natural phenomena and their possible impacts can be synthesized from different sources and placed on a single map.
- It can call attention to hazards that may trigger others (as earthquakes or volcanic eruptions trigger landslides) or exacerbate their effects.
- A more precise view of the effects of natural phenomena on a particular area can be obtained. Common mitigation techniques can be recommended for the same portion of the study area.
- Sub-areas requiring more information, additional assessments, or specific hazard-reduction techniques can be identified.
- Land-use decisions can be based on all hazard considerations simultaneously.

The use of a multiple hazard map also has several implications in emergency preparedness planning:

- It provides a more equitable basis for allocating disaster-planning funds.
- It stimulates the use of more efficient, integrated emergency preparedness response and recovery procedures.
- It promotes the creation of cooperative agreements to involve all relevant agencies and interested groups.

The base map upon which to place all the information is the first consideration. It is usually selected during the preliminary mission. If at all possible, it is best to use an existing map or controlled photograph rather than go through the difficult and time-consuming process of creating a base map from scratch.

The scale used for an MHM depends on the hazard information to be shown, availability of funds and the scale of the base map. If a choice of scales is available, then the following factors should be considered:

- Number of hazards to be shown.
- Hazard elements to be shown
- Range of relative severity of hazards to be shown.
- Area to be covered.
- Proposed uses of the map.

Much hazard information will be in forms other than maps, and not readily understandable by laymen. It must be "translated" for planners and decision-makers and placed on maps. The information should explain how a hazard may adversely affect life, property, or socioeconomic activities, and must therefore include location, likelihood of occurrence (return period), and severity. If some of this information is missing, the planning team must decide whether it is feasible to fill the gaps. Development and investment decisions made in the absence of these data should be noted.

Despite the importance of multiple hazard maps in the integrated development planning process, planners and decision-makers must remember that the credibility, accuracy, and content of an MHM are no better than the individual hazard information from which it was compiled. Furthermore, since it contains no new information - it is merely a clearer presentation of information previously compiled - the clarity and simplicity of the map is the key to its utility.

Critical Facilities Mapping (CFM)

This is carried out for development within existing infrastructure in mind. The term "critical facilities" means all man-made structures or other improvements whose function, size, service area, or uniqueness gives them the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if they are destroyed or damaged or if their services are repeatedly interrupted.

The primary purpose of a critical facilities map (CFM) is to convey clearly and accurately to planners and decision-makers the location, capacity, and service area of critical facilities. An extensive number of such facilities can be presented at the same time. Also, when combined with a multiple hazard map, a CFM can show which areas require more information, which ones require different hazard reduction techniques, and which need immediate attention when a hazardous event occurs. Some of the benefits of a CFM are:

- The uniqueness of service of facilities in the area (or lack of it) is made clear.
- Facilities that may require upgrading and expansion are identified.
- The impact of potential development on existing infrastructure can be assessed before a project is implemented.
- Any need for more (or better) hazard assessment becomes apparent.

Combining critical facilities maps and multiple hazard maps

There are many advantages in combining a CFM, with a MHM, and integrating both into the development planning process. For example, if a critical facility is found to be in a hazardous area, planners and decision-makers are alerted to the fact that in the future it may confront serious problems. Its equipment, use and condition can then be analyzed to evaluate its vulnerability.

If appropriate techniques to reduce any vulnerability are incorporated into each stage of the planning process, social and economic disasters can be avoided or substantially lessened. Avoiding hazardous areas, designing for resistance, or operating with minimal exposure, can make new critical facilities less vulnerable.

Mitigation strategies for existing critical facilities include relocation, strengthening, retrofitting, adding redundancy, revising operations, and adopting emergency preparedness, response, and recovery programs. The benefits obtained by combining a CFM and an MHM include:

- Project planners and decision-makers are made aware of hazards to existing and proposed critical facilities prior to project implementation.
- The extent to which new development can be affected by the failure or disruption of existing critical facilities as a consequence of a natural event can be determined.
- More realistic benefit-cost ratios for new development are possible.
- Sub-areas requiring different assessments, emergency preparedness, immediate recovery, or specific vulnerability reduction techniques can be identified.

Mapping techniques and tools

Community knowledge

A simple mapping of local experience can be achieved using local knowledge. Tools used in rural development activities such as

- Participatory Rural Appraisal (PRA)
- Rapid Rural Appraisal (RRA)

can be very useful in this work. The method is cost effective and the outcome reflects the local perception of hazard. The information can overlay local contour maps.

Surveys on historic events

There may be reports compiled on historic events, which may focus on varying issues depending on its original purpose. However they may contain useful information.

Scientific investigation and research

Usually carried out through teamwork with experts from an array of different disciplines. For example, landslide hazard mapping would require skills of geologists, geo-technical engineers, geomorphologists, topohraphy and so on.

Data over large areas for extensive time periods are collected. These are multidisciplinary studies and each discipline would provide tools and techniques, which become more sophisticated and more accurate over time.

Computer modeling using such data has opened up new vistas for hazard prediction. Geographic Information Systems (GIS) modeling is one outstanding example. Remote sensing by satellite (RS) refers to the viewing of the earth's surface using sensing devices fixed onto satellites in orbit. Such data have already proved useful in flood prediction in Bangladesh for example. The future holds promising prospects for this area of study.

CHAPTER3: METHODOLOGY OF STUDY

This study aims to study the Disaster Management System in Japan, to gather the knowledge of Civil Engineering to prevent and reduce the impact of the disaster in Japan and to identify better ways of Civil Engineering method for prevention and reducing the impact of disasters that can be applied to Thailand. In addition, also prepare recommendations for improvement of DDPM in Thailand.

3.1 PROPOSED RESEARCH ACTIVITIES:

- Review of related literature.
- Collect the data and documentation of good practices and innovations.
- Presentation and discussion.
- Attendance to seminars/orientations.
- Visit to various institutions/organizations/site area.

3.2 DATA COLLECTION

The study of documents associated by the concepts and theories related to this study. Studies from academic papers, Research papers, textbooks, journals, articles, internet reports, and academic essays. Also study the work documents and related documents. Most of the information is secondary data.

Field visits Observations, Discussion during course of action etc. Presentations and lectures, Participation in exercises and drills in Japan. These methods are the acquisition of primary data.

3.3 DATA ANALYSIS

The data analysis will analyse the data collected from the research documents and Field visits Observations, Discussion during course of action etc. Presentations and lectures, Participation in exercises and drills in Japan and then provide a descriptive summary. Descriptive using logical reasoning, consisting of deductive logic and inductive logic, using the framework in Chapter 2 as a guide to case study analysis.

CHAPTER4: RESULT

4.1 DISASTER MANAGEMENT IN JAPAN

For effective disaster management, national Government, local governments and wide range of relevant partners designated public corporations work out disaster management plans and carry them out appropriately, based on the Disaster Countermeasures Basic Act.

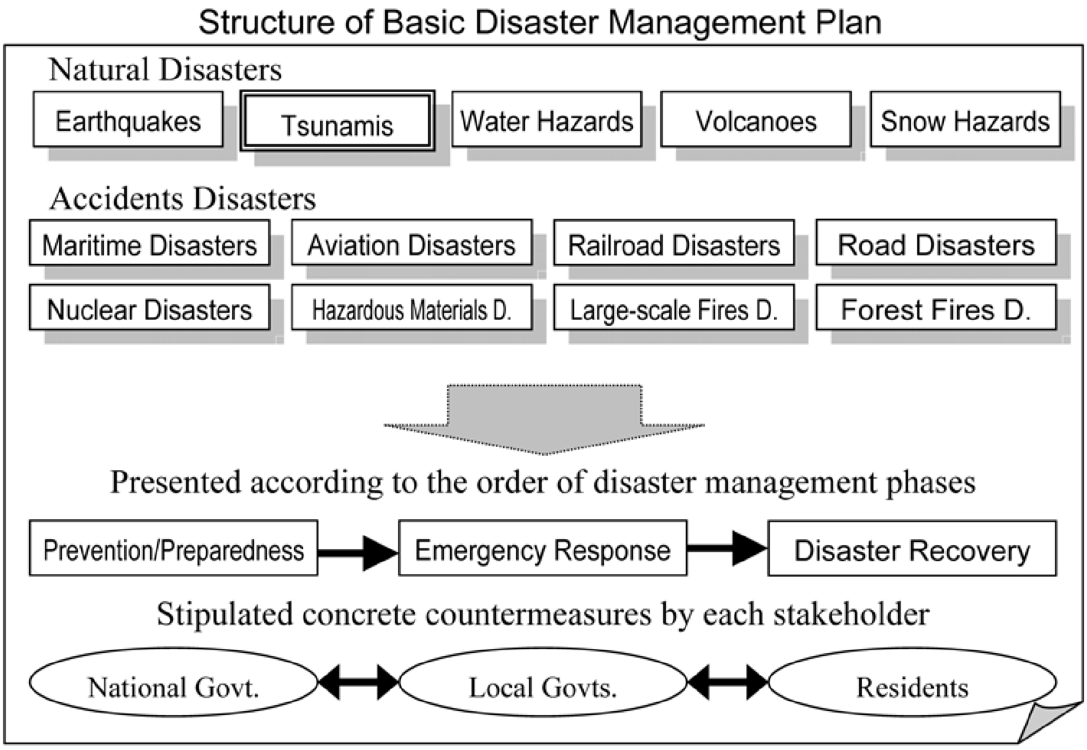


Figure 4.1: Structure of Basic Disaster Management Plan

Source: (Cabinet Office, Government Of Japan 2014).

Basic Disaster Prevention Plan is the master plan and a basis for disaster reduction activities in Japan. Basic Disaster Prevention Plan is prepared by the Central Disaster Management Council in accordance with Article 34 of the Disaster Countermeasures Basic Act. The plan clarifies the duties assigned to the Government, public corporations and the local government in implementing measures. For easy reference to countermeasures, the plan also describes the sequence of disaster countermeasures such as preparation, emergency response, recovery and reconstruction according to the type of disaster. Basic Disaster Prevention Plan has been reviewed annually and amended as needed. In a review in February 2008, the Basic Plan was revised based on the lessons learned in the recent disasters and the deliberation in the Central Council including the viewpoints of necessity to take follow-up measures of priority issues and to facilitate nationwide movement for disaster reduction. Besides, of the Basic Disaster Prevention Plan, Disaster Management Operation Plan is made as a plan for each designated government organization and designated public corporation, and Local Disaster Management Plan is drafted as a plan for each prefectural and municipal disaster management council, based on the Basic Disaster Management Plan

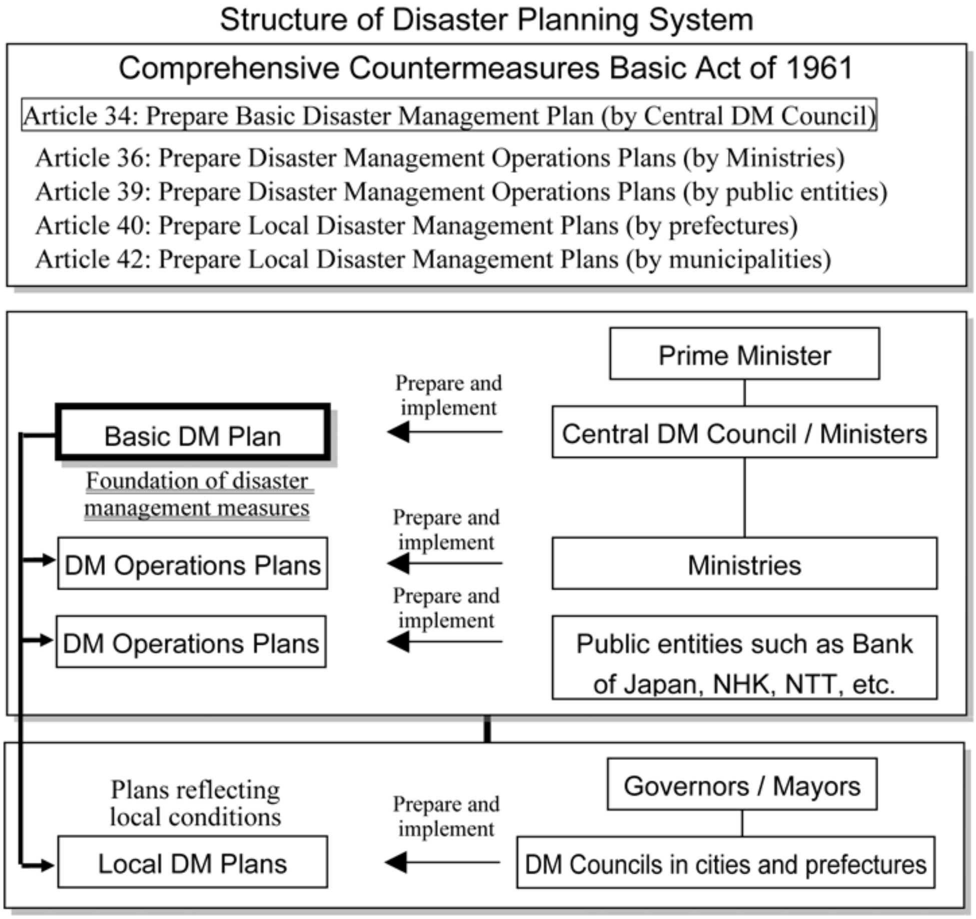


Figure 4.2: Structure of Planning System

Source: (Cabinet Office, Government Of Japan 2014).

4.2 DISASTER MANAGEMENT IN THAILAND

The disaster management system in Thailand is based on the 2007 Disaster Prevention and Mitigation Act and the National Plan on Disaster Prevention and Mitigation 2015. The national Committee on Disaster Prevention and Mitigation, is composed of disaster management related ministries, agencies as well as the academia, is the top policy making body. The National Committee is chaired by the Prime minister. Department of Disaster Prevention and Mitigation is the Secretariat and executive arms of the National Committee.

Disaster Management Strategies

- Mainstreaming Disaster Risk Reduction into planning and development at all levels.
- Effective and integrated emergency management system.
- Strengthening and enhancing the efficiency of sustainable disaster recovery
- Promoting and strengthening international cooperation on disaster risk management

Disaster in Thailand

Flood

In general, floods are most often caused by torrential downpours or accumulated precipitation over the long period. These rain events will eventually trigger flash flood or sudden flooding, and overbank flow and inundation. Floods have been the most frequented natural disaster in Thailand and have imposed tremendous hardships for households, claimed hundreds of lives and caused heavy damage to public and private property. The main causes of floods in Thailand are the influence of the following weather phenomena; southwest monsoon which prevails over the Andaman Sea and Thailand’s land mass during May till September, northeastern monsoon which prevails over the Gulf of Thailand and southern region ; monsoon through and the elongated region of relatively low atmospheric pressure pass across northern, northeastern and central regions as well as tropical cyclone (tropical storm, tropical depression and typhoon).

Figure 4.3: Flood in Nakhon Sri ThammaratProvince, Thailand 2017

Drought

The phenomenon of drought occurs as the consequence of the sharp decrease in the amount of rainwater, water stored in reservoirs or other natural water sources, or in the underground water level over the period of time, to the extent that it has resulted in the lack of sufficient water supply to meet the demands of humans and animals and for vegetation. This subsequent drought induced shortages of water for domestic consumption and for industrial and agricultural purposes in any area for an extended of time can have significant and widespread impacts on people and communities as well as causing extensive damage to overall economy of the country. In addition, the global phenomenon such as climate change or the long – term change of weather over the period of time has shorten the rainy season or in other words it has prolonged the dry season, thus most of the upper parts of Thailand have received consistently below average precipitation, and further has caused the abrupt and unusual decrease in storage within Thailand’s major reservoirs. This phenomenon has subsequently brought about the lack of sufficient available water resources to meet the demands of water usage for domestic and agricultural purposes particularly in the unirrigated areas. Moreover, the simultaneous and rapid pace of modernization, urbanization, and industrialization will inevitably be resulted in an increasing demand for water and decreased supply.

Figure 4.4: Drought in Thailand 2016

Landslides

Generally, a landslide occurs simultaneously with or following the flash floods created by the continuous heavy downpours which have saturated and destabilized the land mass in such areas. Eventually, the aforesaid land mass and rocks move down a slope under the influence of gravity. At present Thailand has experienced an increasing occurrence and intensity of landslides due to diversified preconditions and contributing factors particularly the anthropogenic activities including deforestation, cultivation of cash crops in a sloping area, destruction of a land's surface, etc.

Figure 4.5: Landslides in Krabi Province, Thailand 2011

Earthquakes and Tsunami

Earthquakes are common natural disasters that can cause widespread and catastrophic destruction, mass casualty, and many social and economic disruptions. The primary effect of earthquake is the violent ground motion over the period of time, triggered by the sudden movement of the plates where the earth's crust lies on, particularly at a location of plate boundaries or the fault zones. Recently, Thailand has more often experienced earthquakes triggered by the active faults either in the country or in the neighboring countries, particularly the northern and western regions which sit directly above an active tectonic faults. The very recent examples included, inter alia, an occurrence of a magnitude 6.3 earthquake in Chiangrai Province on 5 march 2014 and has produced hundreds of aftershocks. This earthquake inflicted considerable damage to houses and other property of the people. In addition, the undersea megathrust earthquake can triggered the deadly and massive waves of destruction known as tsunamis. These powerful walls of water can travel far away from their source at very high speed, and upon approaching shore they slow down but grow in size. With their divesting force, tsunamis can cause tremendous loss of life and extensive destruction to property along the shoreline of inhabited areas as had happened in the coastal communities of Thailand's southern provinces along the Andaman Sea rim in 2004 where the death toll reached 5,395 and 2,817 missing.

Figure 4.6:Tsunami Thailand's southern provinces along the Andaman Sea rim in 2004

Storms

Storms can be referred to as an atmospheric disturbance manifested in strong wind accompanied by rain, or other precipitations, or as a wide with a speed from 89 – 102 kilometers per hour according to Beaufort scale. Storms can cause a great deal of damage to homes and other structures as well as considerable loss of life. The damage caused by storms will vary according to their wind flow velocity and intensity. If the storm is categorized as a depression it will produce the torrential rains accompanied by floods, and incase a depression deepening into tropical cyclone or typhoon it's accompanied phenomena such as torrential rains, floods, and storm surges. Tropical cyclone can inflict the destructive impact on wide area as wide as hundreds of square kilometers (particularly the area located on or nearby its path.

Fires

Fire outbreaks or incidents of fire have so far been the most common disaster. Fire is a sources of heat energy that serves a lot of useful purposes as long as it is under control. But once it goes out of control, the radiant heat will quickly ignite surrounding flammable fuels and allowing the fire to continuously spread to everywhere the sources of fire present. And if the raging fire cannot be contained, it will rapidly grow and extend and exacerbate an already bad situation. In case of fuel – driven combustion or a case where large amount of fuel vapor has been released, the more intense the fire will be in term of heat output. The substances easily catching fire or inflammable substances include fuels, chemical substances, or any other flammable liquids, solids or gases what can promptly initiate spontaneous combustion when ignited by flame or heat, or induce a combustion automatically.

Forest Fires and Haze

Forest fire is an enclosed and freely spreading combustion that consumes the natural fuel of forest, that is, grass, weeds, brush and trees. At present, Thailand has experienced more intense and larger forest fires than in the past, thus, becoming a factor that has severely disrupted the balance of ecosystem. Forest Fire has enormously generated impacts on flora and fauna, soil properties and water sources including human life and property as well as on social, economic and tourism activities. In addition, forest fire can cause toxic blanket of haze taking a serious toll on people's health and livelihood in a widespread manner. An example of this phenomenon, among others, includes temporary shutdown of Mae Hongson airport due to the thick haze from forest fire obscured visibility.

Transportation Hazards

The continuing economic and social development in Thailand, in turn has brought about unintended and undesirable consequences including, inter alia an increasing trend and exacerbating of road traffic accident to the extent that it has become one of the highest ranking causes of fatalities among Thai population Besides, road traffic accidents have inflicted an economic burden on the family of the deaths or injuries and a society, the medical costs, the national human capital resource loss, etc. One of official report concluded that road traffic accidents have accounted for 90 percent of overall transport incidents. Most common causes of road traffic accident in Thailand include reckless driving, violation of traffic regulations, drunk driving, not wearing safety helmet on motorcycles, unsafe condition of vehicle and road, and unsafe environmental conditions.

4.3 DRR BY CIVIL ENGINEERING METHOD IN JAPAN

From the visiting researcher 2016B have to study in many agencies and projects in Japan include:

- Presentations by ADRC on Japan disaster management system.
- NADA Municipal Ward Office, Kobe.
- Participation in “1.7 Great Hanshin-Awaji Earthquake Memorial”, Kobe.
- DRI Museum at Kobe.
- Presentation on “Sentinel Asia” ADRC HAT, Kobe
- Japan Meteorological Agency, HAT, Kobe.
- Japan Meteorological Agency, HQ Tokyo.
- Tsunami Storm Surge Prevention Station, Osaka Prefecture.
- Presentation and visiting Kamenose Land Slide, Nara Prefecture.
- Participation in International Disaster Reduction Alliance Forum(DRA), Kobe.
- Participation in International Recovery Forum(IRF), Kobe.
- Presentation by OSASI TECHNOS INC on “Voice of Earth).
- Research Centre for Urban Safety and Security, Kobe University.
- Participation in Iza! Kaeru Caravan at JICA, HAT Kobe.
- Visiting National Museum of Ethnology, / Life Beyond the Tsunami Osaka Prefecture
- DRI Library, HAT Kobe
- Honjo Life Safety Learning Centre, Tokyo.
- Visit and brief by NIED, Tsukuba City.
- Development Bank of Japan(DBJ) brief on Disaster Financing System, Tsukuba city.
- Brief on BCP by Mitsubishi Corporation Insurance Co Ltd, Tokyo.
- Disaster Management Bureau, Cabinet Office, Tokyo.
- Visit and brief by Tokyo Rinkai Disaster Prevention Park, Tokyo.
- Osaka City Abeno Life Safety Learning Centre, Osaka Prefecture.
- Lecture on Best Practices for Reducing Flood Disaster in Japan, Kobe University
- Visit / brief about Dondo Dam by MoAFF, Miki City Hyogo Prefecture.
- Visiting Miki Disaster Management Park Stadium, Miki City, Hyogo.
- Hyogo Prefecture Emergency Management and Training Centre, Miki City.
- E-Defense, NIED, Miki City.
- Hyogo Prefecture Disaster Management Centre, Hyogo.
- Hyogo Prefecture Police, Hyogo.
- Lecture on DM System and Education by Hyogo Prefectural University.
- Lecture on Disaster Education by Hyogo Prefectural University.
- Lecture on Landslide by Kobe University.
- Community Based Town Watching and Hazard Mapping by BOKOMI

- Participation in Community drills
- Presentation by BOKOMI, Kobe.
- Visit and brief by Rukko Sabo Office, MLIT, Kobe.
- Visiting Hokudan Earthquake Memorial Park. Awaji Island. Hyogo Prefecture.
- Visiting Fukura Port Tsunami Disaster Prevention Station(Uzumaru), Awaji Island.
- Participation in 3rd Global Summit of RIDRR by GADRI, Kyoto Prefecture.
- Visit and brief on Tsunami Evacuation Tower by CMD, Sendai City, Miyagi Prefecture.
- Visit and brief by Ishinomaki Community Centre, Ishinomaki, Miyagi Prefecture.
- Lecture by IRIDeS, Tohoku University, Tohoku Region.
- Briefing by Sendai City Hall / CMD, Sendia, Miyagi Prefecture.

4.5.1 Engineering for Flood

Best Practices for Reducing Flood Disaster in Japan, Kobe University

Dr. Kobayashi-san has presented the best practices for reducing flood disaster in Japan. Kobayashi-san explained preparation of hazard maps, projection of future climate and Nishinomiya Evacuation Drill using Numerical Simulation. He also explained his experience on Mekong river project.

The Distributed Rainfall-Runoff / Flood Inundation Simulation model is intended for the Kansai area (Yodogawa), the Kanto area (Tonegawa, Arakawa, Tamagawa) , and the Chubu area (Kisogawa, Shonaigawa).

“ Flood hazard map” are tool to show inundation risk area, evacuation sites, etc. to residents in an easy-to-understan way base on inundation risk area map product by river administrators. The map aims to help residents quick and safe evacuation. The hazard map making become mandatiory by the ammendament of Flood Control Law in 2015.

This model focuses on the traceable rainfall-runoff mechanism, and the flood mechanism.

Using it makes it possible to calibrate the depth in any drainage basin, and the flow and current state of any river channel. There were many reasons to develop this model. One of the reasons is the necessity to accurately, and objectively estimate the flood risk throughout Japan.

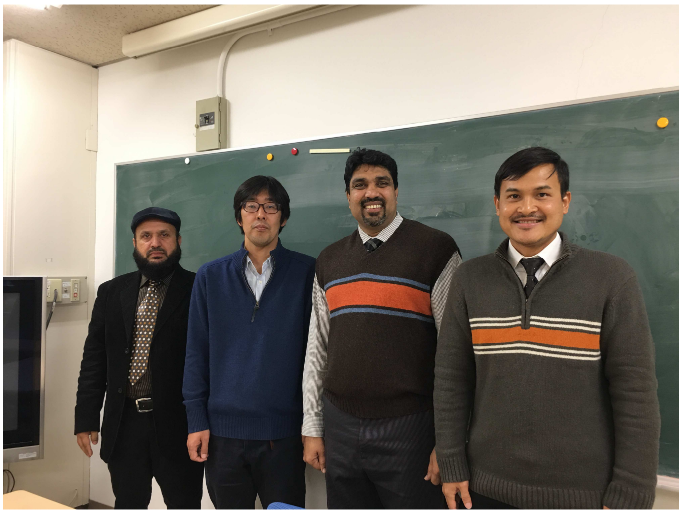


Figure 4.7: Presentation the Best Practices for Reducing Flood Disaster in Japan,

By Dr. Kobayashi KOBAYASHI Kobe University

This model focuses on the traceable rainfall-runoff mechanism, and the flood mechanism.

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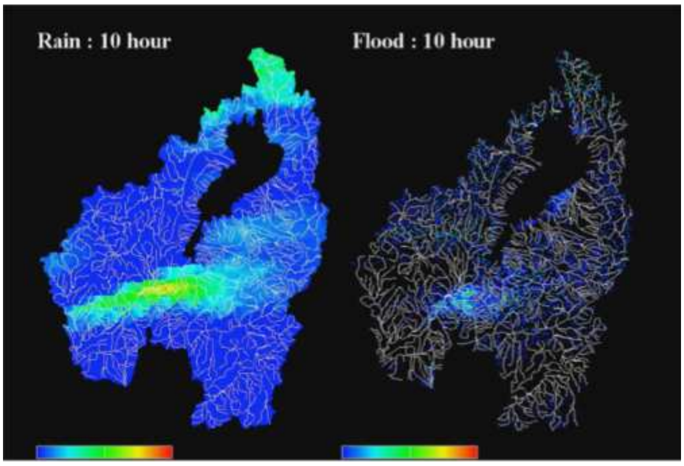

Figure 4.8: An example of the Uji flood simulation (13-14 August 2012) using DRR/FI model.

Source: (Kobe University, Research Center for Urban Safety and Security, Risk Communication Research Department)

Floodgate System and Sewerage projects in Osaka

Visit Nishi Osaka area to see the Shirinashigawa floodgate opening. After short presentation on the operation and management of the flood gate, we practically watch opening and closing of the flood gate.

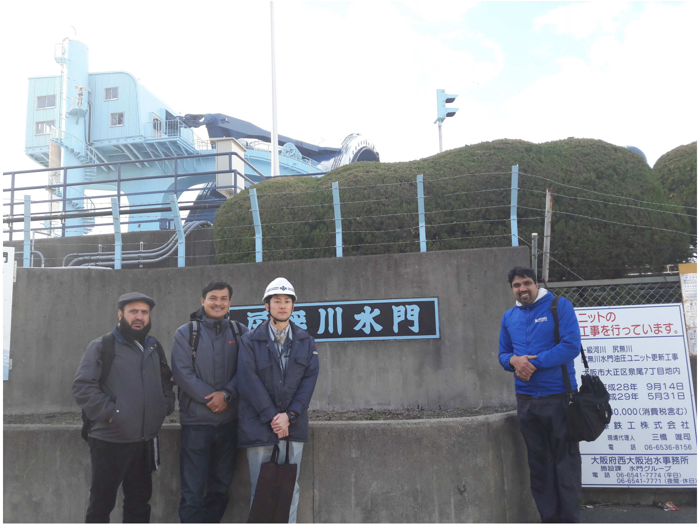

Figure 4.9:Shirinashigawa floodgate

- Osaka city has been implementing countermeasures against 60mm/hour rainfall which is estimated once 10 years, however, inundation still occurs when we have concentrated heavy rain.

  Therefore, we pursue the construction of major trunk sewers such as Yodo Grand Floodway as well as construction and expansion of pumping facilities as drastic countermeasures against flooding. In addition, as a lot of time is required for construction of such a big scale stormwater discharge facility, we also pursue localized flood control measures.

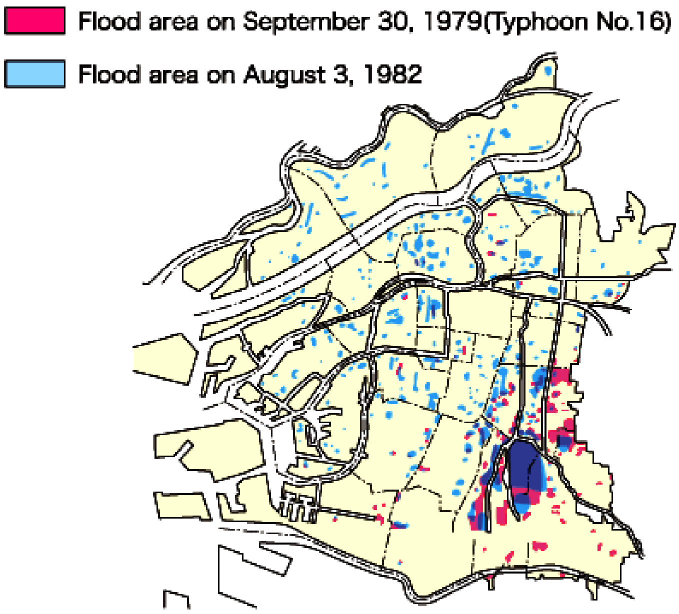

Figure 4.10: Flooding Area

Source: (GESAP)

- The area where stormwater cannot be discharged by gravity flow.

  The area where stormwater cannot be discharged by gravity flow Osaka plain is an alluvial plain which is the result of the sediment deposition from Yodo river. 90 % of the city area is prone to flooding by heavy rain and stormwater has to be drained by pumps. In addition, most stormwater cannot seep into the ground due to high pavement ratio. Stormwater exceeding the capacity of sewers may flow into the sewer networks and caused inundation.

Thus, flood control is one of the most important roles of the sewerage system.

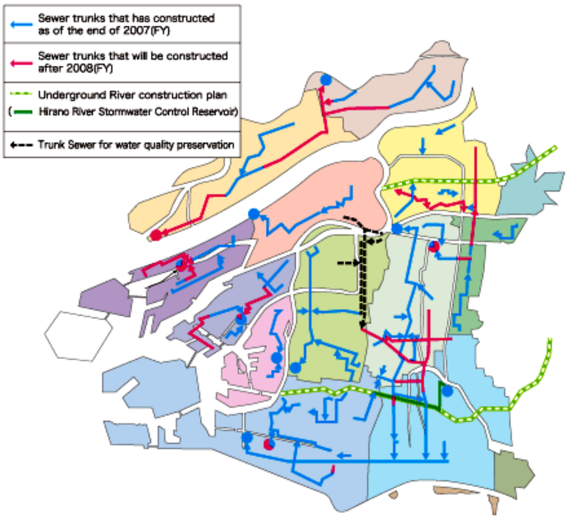

Figure 4.11: Locations of Major Trunk Sewers

Source: (GESAP)

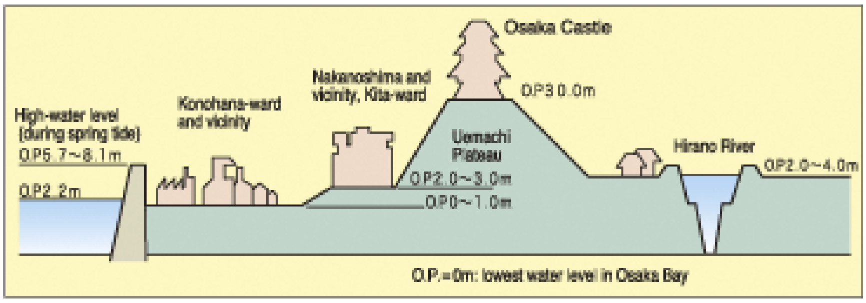

Figure 4.12: Ground Level Diagram of Osaka City

Source: (GESAP)

Flood Control Measures

In Osaka City, almost all the city area is now served by sewerage system. However, the recent rapid urbanization has decreased the amount of farmland and vacant lots which formerly served to retain stormwater.

This has led to a significant increase in the stormwater runoff rate, causing even areas equipped with a sewerage system to flood during heavy rainfall.

To address this problem, a fact-finding investigation has been conducted to obtain data concerning stormwater runoff coefficient and other values. Using a result obtained, stormwater runoff rate was calculated with Brick's formula, based on which the existing factors to be considered in planning were being reviewed (runoff coefficient: 0.5 - 0.6 → 0.7 - 0.9, average ground gradient: 1‰ → 5 - 15‰) so as to meet the requirements of heavy rainfall (60 mm per hour) which occurs approximately once every 10 years.

Thus developed new design values have being utilized to construct stormwater drainage facilities including large-scale trunk sewers and pumping stations, which has reduced extensive flooding.

Stormwater runoff control facilities such as stormwater reservoirs have also been constructed to reduce stormwater runoff volume.

Naniwa Grand Floodway

The city of Osaka launched the Naniwa Grand Floodway construction project in 1985 as a drastic flood control measure for Hirano ward and neighboring areas located in the southeastern part of the city.

In the trunk sewer construction, the shield tunneling method was employed for underground tunnel excavation to minimize obstruction to traffic.

The flood control facility consists of a 12.2 km long trunk sewer (8.5 km trunk sewer section plus 3.7 km quasi-trunk sewer section) with a maximum inside diameter of 6.5 m and Suminoe Pumping Station, with a design drainage capacity of 75m3/s commenced full-scale operation on April 1, 2000.

The Naniwa Grand Floodway, which has a storage capacity of approximately 300,000 m3, also contributes to combined sewer system improvement because it conveys stored stormwater to Hirano Sewage Treatment Plant and is able to reduce the pollution load discharged.

Rain water on the rooftop of Suminoe pumping station is drained into the artificial stream in the recreational garden. The open spaces above the facilities are also used to provide a playground and other recreational spots where residents can spend enjoyable time.

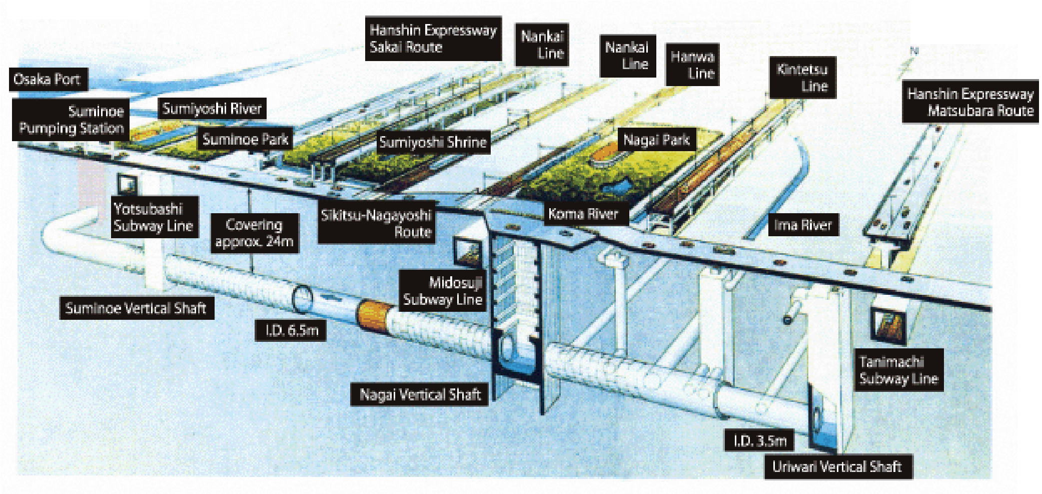

Figure 4.13: Naniwa Grand Floodway

Source: (GESAP)

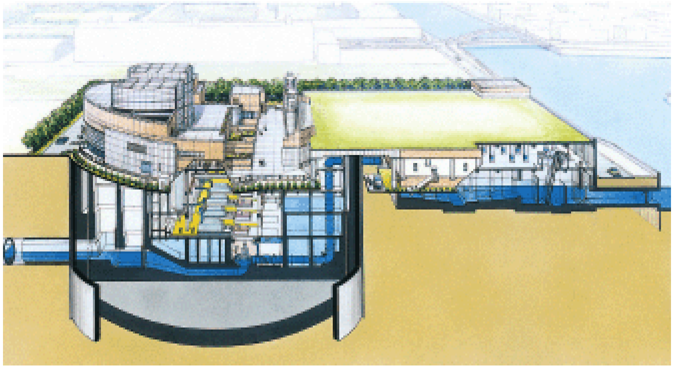

Figure 4.14: Cross Section of the Suminoe Pumping Station

Tosabori-Tsumori Trunk Sewer

The west-central section of Osaka City, an area which serves as the nucleus of commercial activities, is the place where the city launched its first sewage works and installed sewerage system in 1937.

This large-scale trunk sewer, with a total length of 6.7 km and maximum inside diameter of 6.25 m, is comprised of the main trunk sewer running north to south 5.4 km and connected quasi-trunk sewers stretching over 1.3 km. The shield tunneling method was employed for constructing the trunk sewers in order to minimize obstruction to traffic. Stormwater collected via the trunk sewer is discharged into the Kizu River, which is close to Osaka Bay, from the pumping station (pumping capacity: 89 m3/s) constructed at the Tsumori Sewage Treatment Plant.

The trunk sewer began full operation on Apr.1.2003.

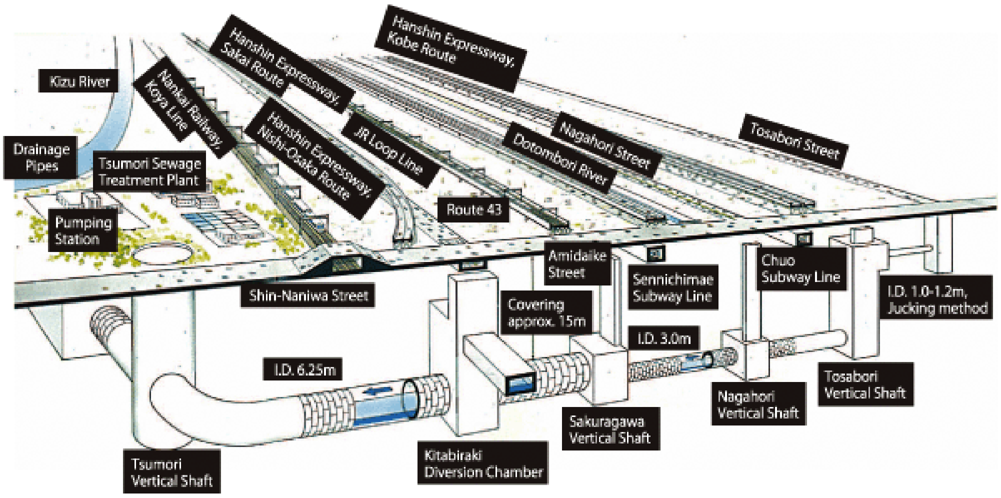

Figure 4.15: osabori-Tsumori Trunk Sewer

Source: (GESAP)

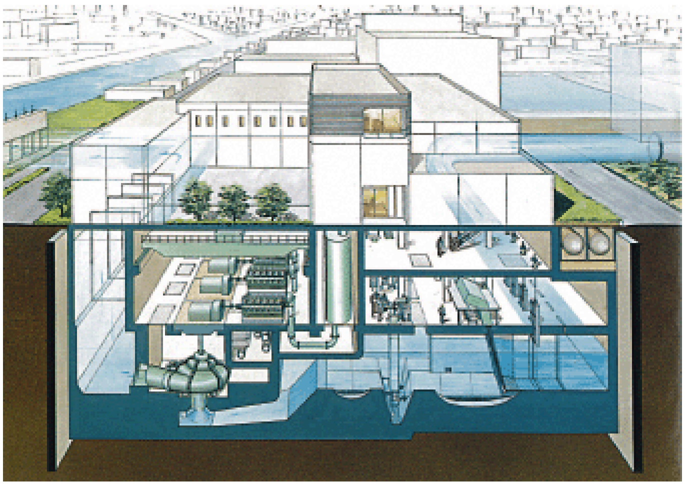

Figure 4.16: Cross Section of the Tsumori Pumping Station

Source: (GESAP)

Yodo Grand Floodway

The construction of the Yodo Grand Floodway was planned as a drastic flood control measure for the northern area of the Yodo River. This large trunk sewer will be total 22.5 km in length and 7.5 m in maximum inside diameter, exceeding the size of Naniwa Grand Floodway.

This Grand Floodway consists of two trunk sewers in order to provide flexibility in handling concentrated heavy rain including sudden showers. It is so designed that excess stormwater in other trunk sewers overflows into the Grand Floodway.

At the end of the Grand Floodway facing Osaka Bay, it is planned to construct a new pumping station with a drainage capability of 105 m3/sec.

The whole construction of the Floodway employs the shield tunneling method to minimize obstruction to traffic.

Construction was started in 1991 and the completed section has already been utilized since September in 1997 as a temporary stormwater reservoir (storage capacity: 145,000 m3, March in 2007).

Figure 4.17: Yodo Grand Floodway under construction

Source: (GESAP)

4.5.1 Engineering for land slide and Sediment-related disasters

Kamenose Land Slide, Nara Prefecture

The Kamenose land slide area is located on the right bank of a valley formed by the Yamato River as it flows from the Nara Basin to the Osaka. We were briefed about the history of land slide, its occurrence and damages. Various Mitigation measures taken by the Central Government were explained electronically, visually and later on visited practically, which included construction of tunnel, ex –collapsed train tunnel and water well and detection devices etc.

Figure 4.18: Presentation and visiting Kamenose Land Slide, Nara Prefecture.

Ground water regime of the Kamenose Landslide Area.

The geological structure of the Kamenose landslide area has been determined in detail through test boring, seismic and electric prospecting’s, and other geological observations by the research group of the Kamenose landslide.

Permeability of each stratum was estimated through the sounding of the active permeable layers, and the measurement of the infiltration capacity of the ground surface at different locality, as well as through the observation of core samples. It -was found that the sliding earth (mainly weathered andesite) is much more permeable than the underlying layer (tuff, breccia, and granite), and that the ground water can be treated as phreatic ground water. The contour map of the water table was made according to the observations at boreholes, wells, and springs. It was found that the troughs and steps of the water table are closely related to the structure of the impermeable layers. It was also found that the troughs of the water table do not necessarily mean the concentration of the ground water flow.

The water balance of the landslide area was estimated according to the investigation of the infiltration characteristics with an infiltrometer and a runoff plot, and according to the comparison of the volumes of the rainfall and the direct runoff of the brook. It was found that the recharge of the ground water accounts for about sixty percent of the rainfall. The soil moisture profile observed with a neutron soil moisture meter suggested that the rain water penetrating into the ground is stored mainly as unsaturated soil moisture when the rainfall is less than 50 mm. The direction of the ground water flow was estimated through the ground water tracing and the investigation of the water quality. The distribution of the discharge of surface flow and underground flow was determined based on a detailed observation of the discharge of streams and springs.

However the water balance showed that there must exist unknown ground water veins with the discharge much larger than the known one. The land water of the landslide area was classified according to its chemical properties, related to the different phases of the hydrologic cycle, and then identified as shallow water, circulating ground water, stagnant ground water, or upwelling water from great depths.

More detailed investigation must be carried out concerning the movement of the unsaturated soil moisture and its influence on the landslide motion. The origin and the quantity of the ground water extraordinarily rich in HC03- found in the tunnel and some boreholes have not been sufficiently investigated. The effect of the drainage works with the collector wells and the drain tunnels on the ground water regime and to the landslide motion must be evaluated quantitatively through succeeding investigations. (OKUNISHI, 1970)

Landslide ground Water Drainage Works and Surface water drains and Anchors

Deep foundation works would be enforced according to the thrust of the landslide and depth of the sliding surface under such conditions that ordinary piles would not work well enough. In the Kamenose area, these works have been carried out mainly with ferroconcrete piles of 3.5x4.0 meters in diameter and 30x60 meters in length. At present, the works are enforced with larger structures of 6.5 meters in diameter and 100 meters in length.

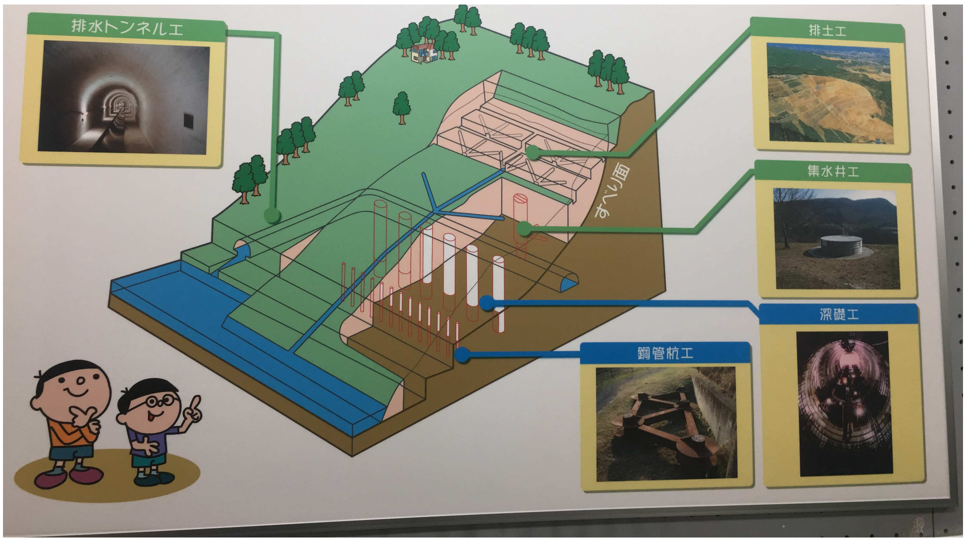

Figure 4.19: Ground Water Drainage Works In the Kamenose area.

Figure 4.20: Ground Water Drainage Works In the Kamenose area.

Figure 4.21: Surface water drains and Anchors

Visit and brief by Rokko Sabo Office, MLIT, Kobe.

From visit Rukko Sabo Office. Rukko Sabo Office has given briefed introduction of MLIT via video conferencing. Hathoki-san from Rukko Sabo Office also explained the history of sediment disaster and its mitigation measures by MLIT.

Figure 4.22: Sabo dam at Rokko mountain Kobe.

Countermeasures adopted in the Sabo works. Structural measures and nonstructural measures are applied to mitigate sediment hazards, termed ‘hard’ and ‘soft’ measures, respectively, in Japan. Hard countermeasures include construction of SABO dams, channels and hillside works, and restoration of vegetation. Soft countermeasures include conservation land-use practices, warning systems, and preparedness, such as emergency planning and evacuation measures.

New nailing network system.

Japan, topography, geology, from the social conditions of the natural conditions and land use, such as weather, is a leading slope disaster zone in the world. Therefore, so far has been developed various disaster prevention method In recent years, with increasing awareness of the environment and landscape, also for slope stabilization measures, there is a growing interest in the construction method of conservation taking advantage of the green on the slopes. "Non-frame construction method" is, as a new slope stabilization method that meet the demands of this era. Non-frame construction method reinforcing material (rock bolts), Bearing plate. Head consolidated material consists of (wire rope).

Figure 4.23: nailing network system in Kobe University.

It has become a double corrosion protection structure over the reinforcement length. On request, such as landscape protection, it will be able to paint a member, which exposed to the earth's surface

4.5.3 GIS and Mapping

Sentinel Asia

Makoto Ikeda ADRC has Presentation on Lessons learn from Sentinel Asia Operations: towards more effective human resource development.

Figure 4.24: Presentation on “Sentinel Asia” ADRC

The Sentinel Asia is a voluntary basis initiative led by the Asia-Pacific Regional Space Agency Forum (APRSAF) to support disaster management activity in the Asia-Pacific region by applying the WEB-GIS technology and space based technology, such as earth observation satellites data.

Main Activities

1. Emergency observation by earth observation satellites in case of major disasters

Currently participating satellites are expected to be ALOS (JAXA), IRS (ISRO), THEOS (GISTDA), KOMPSAT (KARI) and others.

2. Acceptance of observation requests

ALOS, IRS, THEOS and KOMPSAT accepts observation requests for major disasters in the Asia-Pacific region from ADRC member organizations and representative organizations of JPT members.

3. Wildfire monitoring, Flood monitoring and Glacier Lake Outburst Flood monitoring

Besides emergency observation of disasters, based on the requirements of emergency-agency and other key users attending the APRSAF meetings, it was identified that as a top priority the Sentinel Asia Project emphasize implementation of satellite-data production systems for wildfire, flooding and glacier lake outburst flood information, while other application fields should be developed offline by relevant research bodies and implemented subsequently. A key component of this plan is to include a dedicated 'node' in the Asian Disaster Reduction Center (ADRC), as well as foster close interactions with related global data dissemination initiatives such as GEONetcast, and those promoted by the IGOS Geo Hazards Theme, GOFC-GOLD, WMO-RARS and CEOS committees. For wildfire monitoring, MODIS (NASA) data are utilized initially, and for flood monitoring TRMM, GPM (NASA, JAXA) and AMSR-E (NASA, JAXA) are expected to be used etc.

4. Capacity building for utilization of satellite image/data for disaster management

In parallel with the activities above, capacity building for technical and emergency-response agencies users of the Sentinel Asia system will be undertaken, primarity under coordination by Indian Space Research Organisation (ISRO), Asian Institute of Technology (AIT) and UNESCAP in Bangkok.

Fast Sharing Data

The vision for Sentinel Asia is that it will be a fundamental service distributing, (in near real-time where possible,) only disaster-related data products/images in the Asia-Pacific region as follows:

- Satellite imagery (and data permitted by data provider) provided by space organizations
- value-added images with extraction of stricken area, etc created from satellite data
- On-site digital camera images
- Wildfire hotspot and rainfall information derived from satellite data
- Meteorological satellite information
- Basic map data
- A millionth digital map provided by NGA (National Geospatial-Intelligence Agency) and LANDSAT images, which cover the entire Asia area and so on
- Fine regional digital maps contributed to the network by national geography organizations, etc.

In addition, through it's close links to Asian Disaster Reduction Center (ADRC) additional information will be available such as:

- Detailed disaster information
- Regional social / economic data

Main products provided by Sentinel Asia are as follows:

- Satellite imagery (and data permitted by data provider) and value-added images with extraction of stricken area, etc.
- On-site digital camera images
- Wildfire hotspot information and data
- Rainfall (short-term and long-term) infromation and data
- Meteorological satellite imagery and data.

Information-Sharing Platform

Sentinel Asia Step2 system adopts the idea of local mirroring, and transfers data from Japan Central Sever to users' local mirrored server not only via Internet but also via communication satellite, WINDS. By using WINDS satellite, Sentinel Asia Step2 system can transfer the large data that is hard to transfer via Internet. We expect that it leads us to enrich the utilization of Sentinel Asia in user country.

Framework

Sentinel Asia is promoted under cooperation among the following three communities: Space Community (APRSAF); International Community (UNESCAP, UNOOSA, ASEAN, AIT etc.); Disaster Reduction Community (ADRC and its member countries).

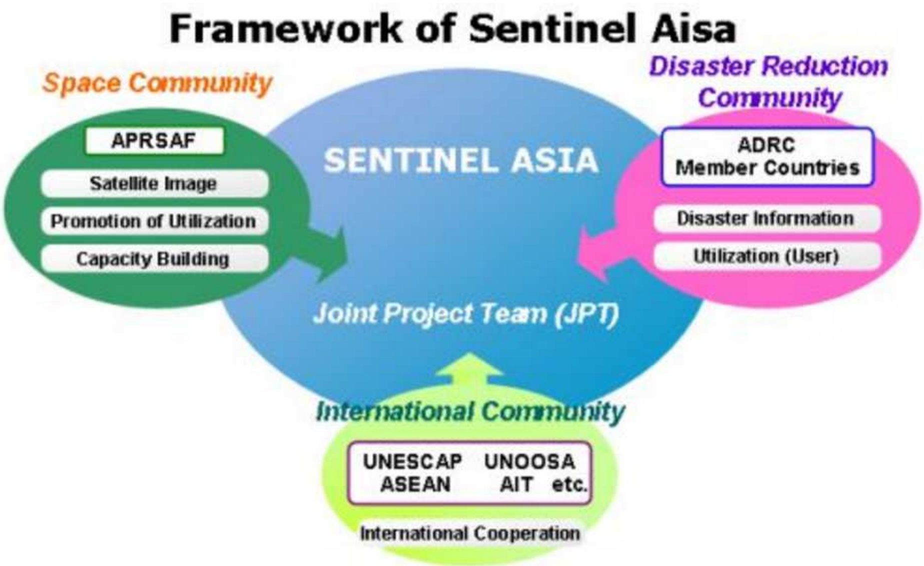

Figure 4.25: Presentation on “Sentinel Asia” ADRC

Source: (Japan Aerospace Exploration Agency (JAXA), 2017)

Joint Project Team (JPT)

To promote Sentinel Asia, the Joint Project Team (JPT) was organized. JPT is open to all the APRSAF member countries, disaster prevention organizations and regional/international organizations who wish to participate in disaster information sharing activities.

Nodes and Working Groups

Operationally Sentinel Asia is composed of two Nodes and three Working Groups.

Data Provider Node:

Data Provider Node provides their own satellite imagery and/or data to JPT members upon the emergency observation request from JPT member to the extent permitted by the data policy of each DPN when disaster happens.

Data Analysis Node:

Data Analysis Node analyzes the satellite data provided by DPN, makes value added product and discloses the result through the Sentinel Asia System within the domestic legislation of each DAN permits.

Wildfire Working Group:

Wildfire Working Group works for the establishment and improvement of early forest fire detection based on MODIS data, development of forest fire expansion forecasting and serving value-added information to forest fire control agencies.

Flood Working Group:

Flood Working Group works for establishment of flood alert, prediction and detection system based on existing initiatives.

Glacier Lake Outburst Flood Working Group:

Glacier Lake Outburst Flood Working Group works for establishment of monitoring, early warning systems and planning and prioritization of disaster management for GLOFs.

4.5.4 Engineering for Earthquake

National Research Institute for Earth Science and Disaster Resilience (NIED), Hyogo Earthquake Engineering Research Center

Based on the data of seismograph networks throughout Japan, NIED develop advanced methods for accurate monitoring of the crustal activity in and around Japan. Also NIED study to construct highly accurate models of large earthquake process through the deeper understanding and accurate evaluation of the various crustal activities beneath Japan, and various detailed investigations at particular locations.

National Research Institute for Earth Science and Disaster Resilience(NIED)has been constructing 3-D Full-Scale Earthquake Testing Facility, nicknamed "E-Defense" in the city of Miki, to the north of Kobe. Construction of this facility began in 1999 and will be completed in 2005. Therefore, this facility will begin to make its contribution ten years after the Hyogoken Nanbu (Kobe)Earthquake.

The world's largest shaking table, which can simulate high level ground motions, is taking shape in Japan. The opportunities and challenges provided through this facility are great. It will be a focus of full-scale testing of structures due to high-intensity earthquakes. It is a vehicle through which hope and optimism for improving the behavior of urban regions due to earthquakes will get an added boost.

Many earthquake-resistant structure were destroyed by recent earthquakes, such as the Kobe Earthquake(1995) in Japan, the Kocaeli Earthquake(1999) in Turkey, Niigataken-Chuetu Earthquake(2004) in Japan and so on..

The reliability of structures during earthquakes must be checked again using rational design methods. For this purpose, existing design methods must be confirmed by full-scale experiments.

Figure 4.26: Large-scale demonstration experiment.

4.5.5 Engineering for Tsunami and storm surge

Tsunami Evacuation Tower and Evacuation Facilities

In areas which may be flooded by a tsunami, we are constructing 13 evacuation facilities in total including six towers, and five buildings with fire station, and two sets of outdoor evacuation stairs for existing elementary and junior high schools.

The evacuation tower at Nakano 5-chome is a two-story steel framed structure over six meters above ground, allowing 300 people to evacuate at any given time. All the facilities are scheduled to be completed by the end of FY 2016.

Easy-to-use structures and emergency supplies for evacuees

With the lessons learned from the Great East Japan Earthquake, we are offering various emergency services that include preparing indoor spaces to protect evacuees from cold weather and hypothermia as well as installing slopes for wheelchairs and strollers to provide easy access for the elderly and those with walking disabilities. We have stockpiled electric generators, blankets, water, foodstuffs, portable toilets, etc. with the expectation that evacuees would stay at the evacuation centers for around 24 hours.

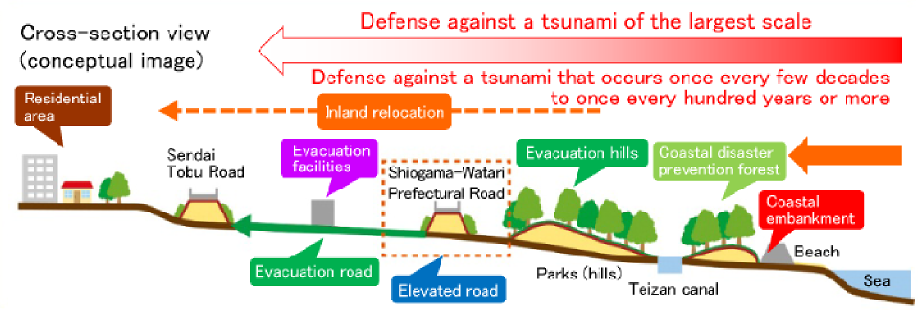

Figure 4.27: Cross-section view of Evacuation Facilities

Source: (Disaster-Resilient and Environmentally-Friendly City Promotion Office, City of Sendai, 2017)

Figure 4.28:Tsunami evacuation tower at Nakano 5-chome

Figure 4.29: Costal embankment

Figure 4.30 Evacuation hill

Figure 4.31 Elevated road

4.6 DRR BY CIVIL ENGINEERING METHOD IN JAPAN FOR ADEPTATION TO THAILAND

Based on the DRR by Civil Engineering Method in Japan which was visited and studied, as shown in 4.5 ,found that all methods can be applied to Thailand. But depending on the context of Thailand. In this study, the researcher did not consider it.

Floodgate System and Sewerage projects in Osaka

- Sewerage projects in Osaka are caused by the context of the problem, which is similar to the problem of drainage in Bangkok.
- At present, Bangkok has constructed a large-scale Drainage tunnel system, but has not solved the problem of unsuitable drainage. In some areas, when the rain is heavy, the water will not drain until it becomes flooded.
- If there is time to study the Floodgate System and Sewerage projects in Osaka, the researchers believe that many thing in this system can be adapted to suit the situation in Thailand.

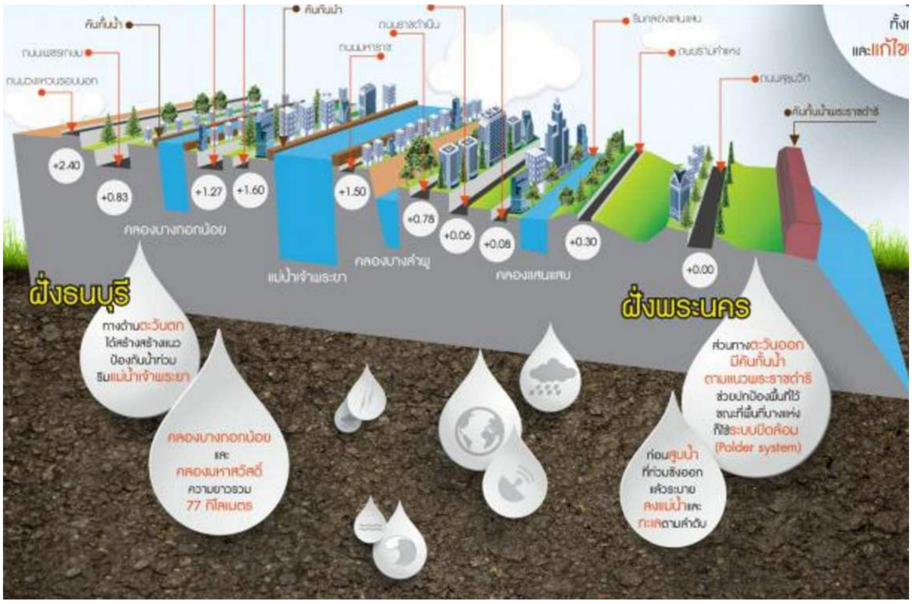

Figure 4.32 The large-scale Drainage tunnel system in Bangkok, Thailand

Source: (Realist Solution Co., Ltd.)

Engineering for land slide and Sediment-related disasters

- Based on the study of Sabo dam, the pattern of sabo dam construction in the past is similar to the water retention in Thailand. It is constructed with natural materials in areas such as wood and stone. (See examples and patterns in the appendix.)
- The construction of the Sabo Dam with concrete like the current layout is not consistent with the context of Thailand. Because it is not worth the investment.

Figure 4.31 check dam for water retention in Thailand

Source: (Kaweewat Sukkasame)

GIS and Mapping

- The techniques and methods of developing the risk map of Japan are very useful and can be adapted.
- Sentinel Asia is a great resource. Should be promoted to be widely known. And should be practiced using such databases. To allow members easy access to information.

Engineering for Earthquake

- Research from the National Research Institute for Earth Science and Disaster Resilience (NIED) is beneficial to the study and development of civil engineering knowledge. Thailand should focus on the development of the Disaster Research Institute to study the development of knowledge and skills in effective prevention and mitigation measures.

Engineering for Tsunami and storm surge

- Costal embankment in Japan is strong and strong. Some sea walls can be adapted to erosion protection in Thailand.

Figure 4.31 Sea wall in Thailand

CHAPTER5: CONCLUSION

A study of the best practice on the prevention and reducing the impact of disasters by Civil Engineering method in Japan for adaptation to Thailand aims to study the Disaster Management System in Japan. To gather the knowledge of Civil Engineering to prevent and reduce the impact of the disaster in Japan, To identify better ways of Civil Engineering method for prevention and reducing the impact of disasters that can be applied to Thailand, including Prepare recommendations for improvement of DDPM in Thailand.

This study also seeks to answer the question "How does japan use civil engineering methods to prevent and reduce the impact? In addition, what is the good practice in Japan appropriate in Thailand?"

From visiting agencies and projects on prevention and mitigation of the effects of natural disasters. Including the search of documents, books and the Internet found that all methods can be applied to Thailand. But depending on the context of Thailand. In this study, the researcher did not consider it.

The things that can be developed and deployed right away are GIS and flood simulation for hazard maps.

Challenges in Research

- Research topics are too broad, with only 88 days of study time
- Researchers lack the skills and expertise to communicate in English.
- Some projects are very far away. It is difficult to study.

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APPENDIX