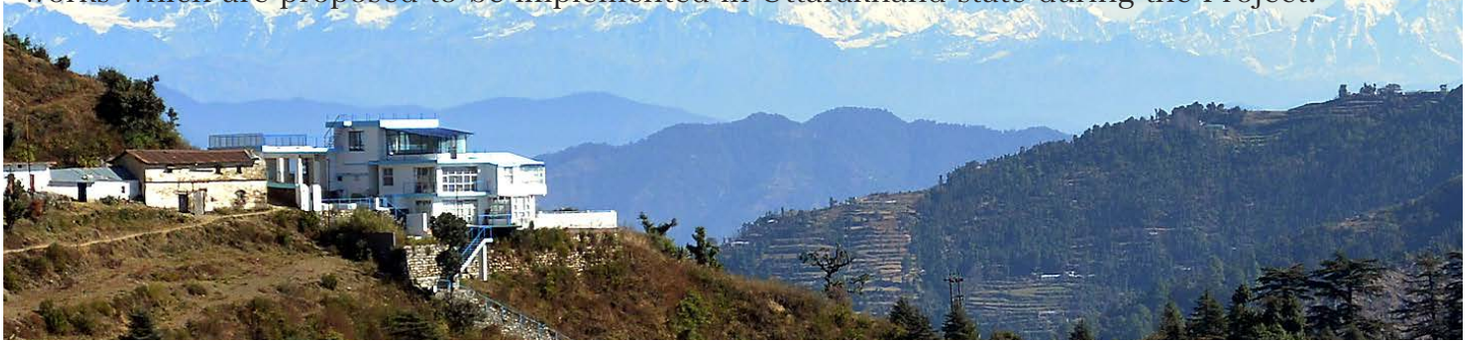
Japanese technology to conserve Himalayas

- JICA Technical Cooperation Project -

The Project for Natural Disaster Management in Forest Areas in Uttarakhand

JICA: Japan International Cooperation Agency

In June 2013, the mountainous regions of Uttarakhand witnessed massive flood and landslides, taking the lives of more than 6,000 people and damaging more than 4,200 villages. In order to introduce Japanese technology of countermeasure works for managing disasters in hilly areas and rehabilitate the devastated areas, Uttarakhand government and Japan International Cooperation Agency(JICA) signed an agreement, to implement a Technical Cooperation Project named “The Project for Natural Disaster Management in Forest Areas in Uttarakhand”.
This brochure is intended to introduce and discuss the Japanese techniques of erosion control works which are proposed to be implemented in Uttarakhand state during the Project.



Main Characters

Mr. Osam (Chief)

Chief Adviser of the Project
He always looks forward to explaining the erosion control works to all.

Mr. Yama (Expert)

Japanese Specialist of erosion control work
He gives guidance and advice on erosion control work to Indian engineers who are involved in the Project.

Ms. Garima (Assistant)

Project Assistant
She is good at Japanese, but does not have much knowledge on erosion control works. She is in the process of learning about the Project.

Japanese Experts deputed by JICA, UKFD officials, Indian Engineers, Project staff, Survey companies and Japanese people working in the field of erosion control works, are a part of the Project. Japanese techniques related to erosion control would be disseminated to Indian counterparts through various activities and discussion with them.

※ Please note that there is some fiction mixed in the brochure.

Contents

1. Why do we need erosion control works?

By the way, Chief, what is the significance of erosion control works?

Oh, Garima san !

Sorry for not briefing you about it!! I' ll explaint it to you in detail!!

Nature is in the proses of constant change on its own.It adapts to the changes maintaining the balance and stabilities. However, with an increace human activites, the mountains have become largely unstable leading to disasters..

Yes, we had a huge flood disaster in 2013 in Uttarakhand. Many people lost their lives and properties.

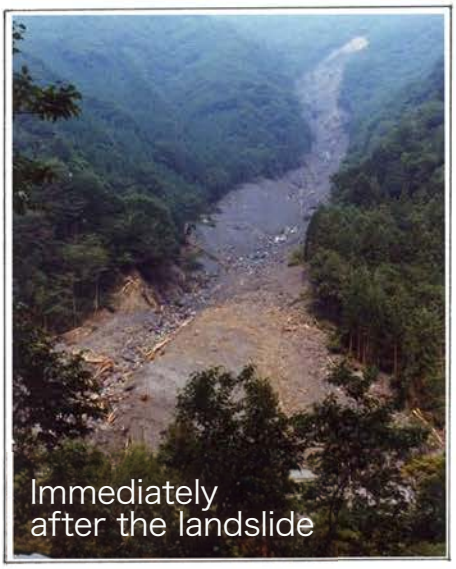
Also, people live in the hills, and number of things to be protected such as their properties and roads are increasing.

I can not hold anymore!

Here is Yama san who is in charge of designing.

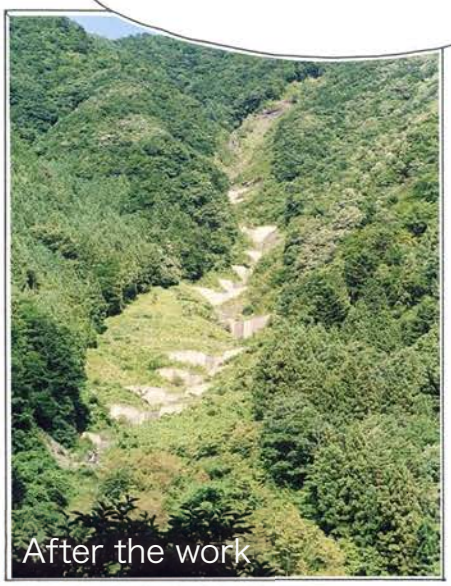
! ?

When it is required to protect peoples' lives and properties in the areas where self recovery of nature is not possible, erosion control works are executed to prevent slope disasters or to rehabilitate the devastated areas.



As the three pictures below were taken from a single location. They depict a timeline from a major disaster to complete rehabilitation of the area as a result of erosion control works.

Yes, it looks like nothing had ever happened there.Even the construction works aren't visible.



© Ooigawa Forest Conservation center

I took these photos!

These were taken at Ooigawa,Sizuoka Prefecture, from 1982 to 2007.There was a huge landslide over there. The Forest Agency has undertaken erosion control works for more than twenty years!!

OK, I'll explain some more about erosion control works to you next time.

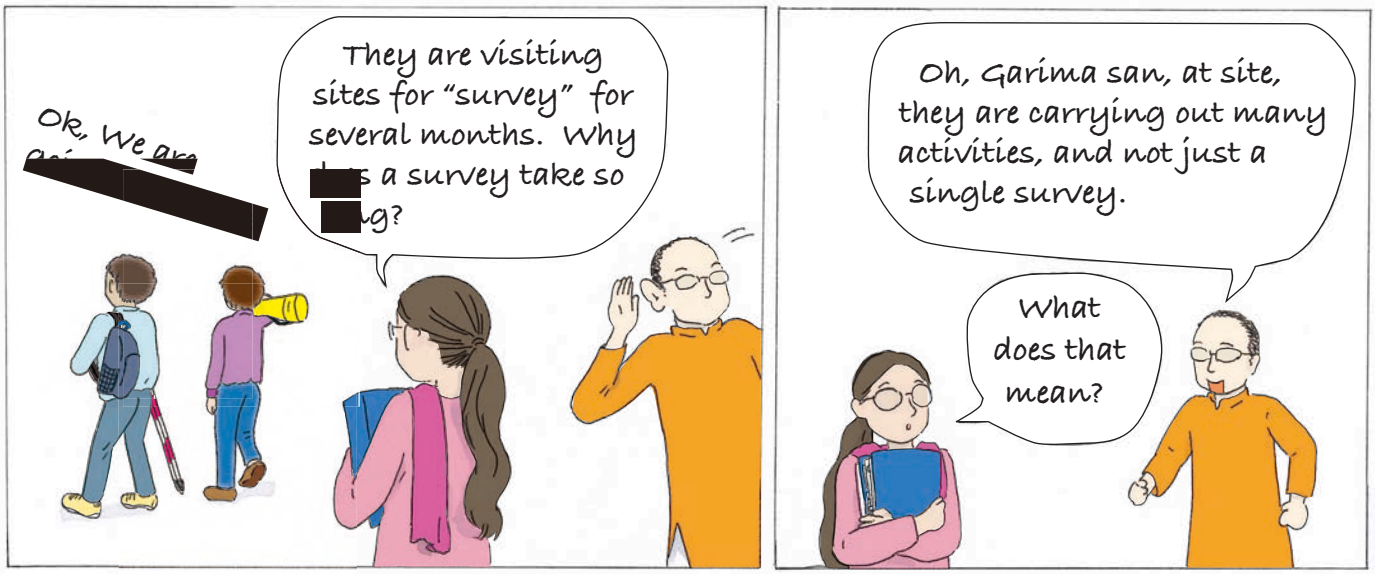
Thank you! That is really good of you!

I started to explain first...

Chief! Sorry to interrupt. but I thought you were really busy...?! Please check the documents. I need your signature on these! And...

2. Why do surveys take a long time?

2. Why do surveys take a long time ?



Erosion control works are usually done on volnerable slopes. In addition, these are expected to stay and perfom their functions during heavy rain which occurs once in several decades. also, budgets are very limited. A good survey helps in deciding the most economical as well as effective measure.

Preliminary Survey is to know geographical features, soil, climate, hydrological features of the target area from existing documents, aerial photography etc.

Site Investigation is to check the outcome of the preliminary survey on the field, and to obtain additional information about the site.

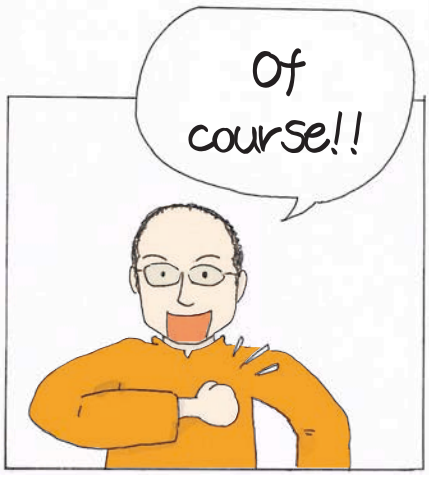
Plannning The initial plan is projected combining torrent work, hillside work and forest maintenance work appropriately.

Detailed Survey is to obtain more detailed information about the site.

Basic Design The outline of the erosion control work for the site is planned.

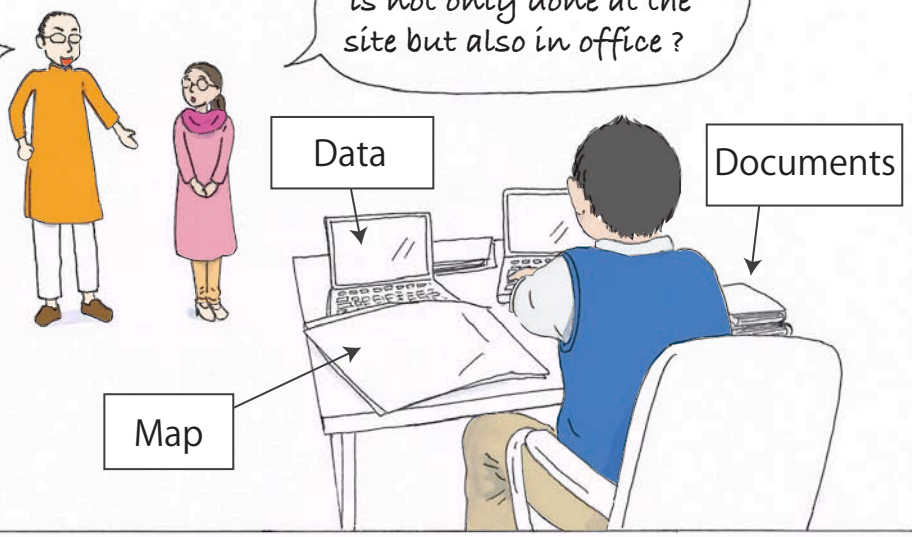
Detailed Design Works to be carried out are designed in detail.

Well... the words are bit new to me. Could you explain their meanings?



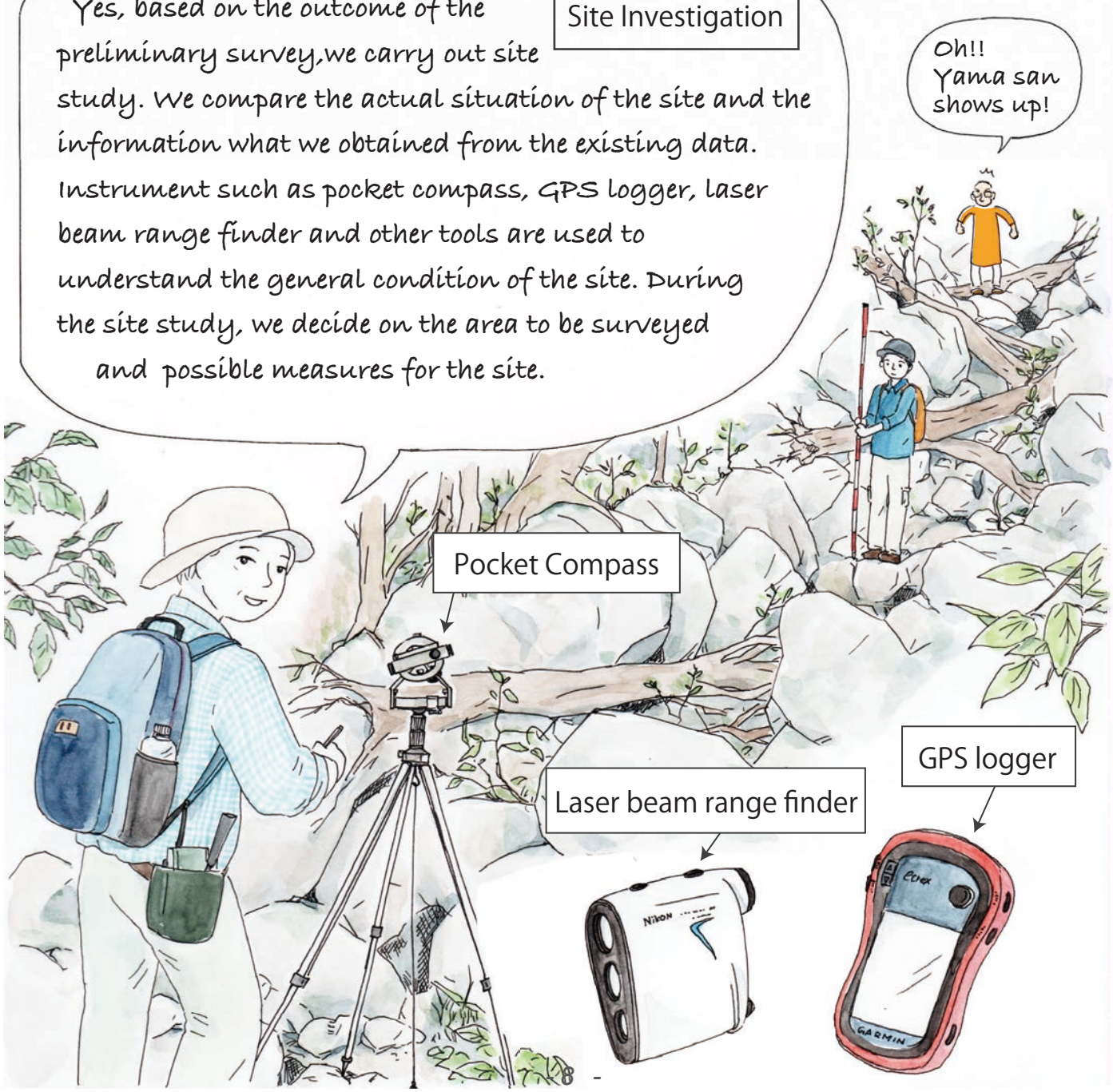
Preparatory Survey

It is basically carried by refering existing documents and data of the site as a desk top survey.
Already existing data such as geographical feature, hydrology, precipitation, and others can save time and effort.

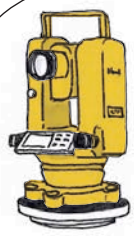


Site Investigation

Yes, based on the outcome of the preliminary survey,we carry out site study. We compare the actual situation of the site and the information what we obtained from the existing data. Instrument such as pocket compass, GPS logger, laser beam range finder and other tools are used to understand the general condition of the site. During the site study, we decide on the area to be surveyed and possible measures for the site.



I will explain !



Theodolite

After finalising the area of the site, survey using theodolite is initiated. On surveying, we need to have actual contour image where erosion control works are to be done. So that longitudinal leveling and cross-sectional surveying can be carried out effectively. Site visit is frequently necessary to instruct the correct work area.

Oh! I see.

We make rough plan considering plan view, longitudinal view and cross-section view after the survey.

Do you think the bearing capacity of the bed-rock is sufficient to construct the check dams?

There are so many lines in the drawings!

These are contour lines.

Geological survey (in-situ test*1) is necessary to check the thickness of the soil layer and the depth of the bed-rock.

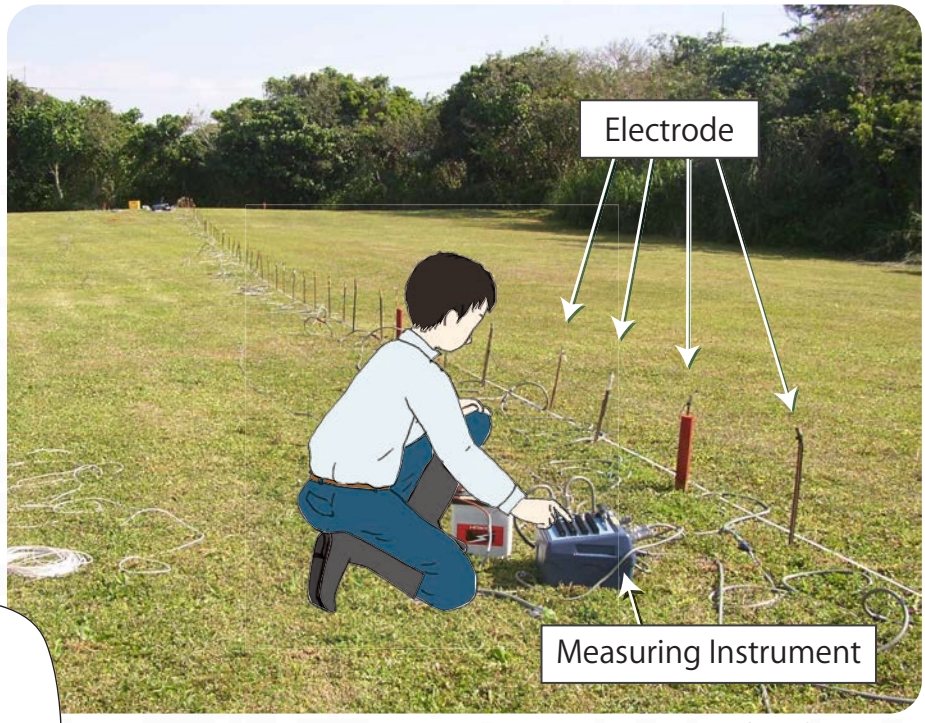
It is also better to carry out groundwater survey.

*1 In-situ test : general term for tests where soil is examined in its natural condition and at the place of occurence . Features of the soil are directly examined using ground or borehole.

Detailed Survey

Electric Prospecting

It is a test to determine the condition of the ground. During the test, electrodes are inserted into the ground at equal intervals, and electrical resistance between the electrode is measured. Cables connect the electrodes and the measuring instrument gives electricity and measures the value.



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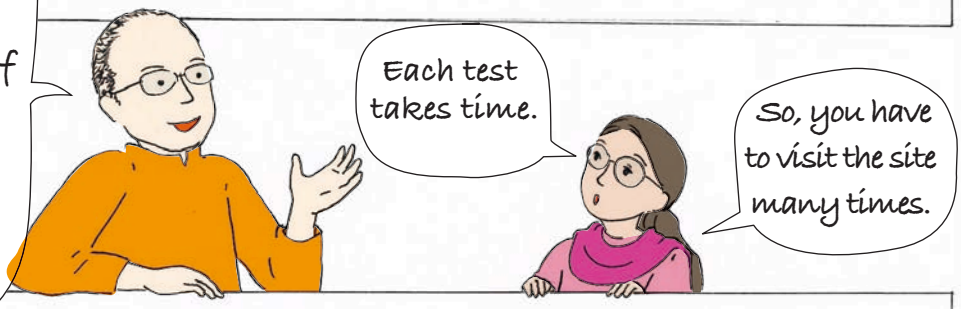
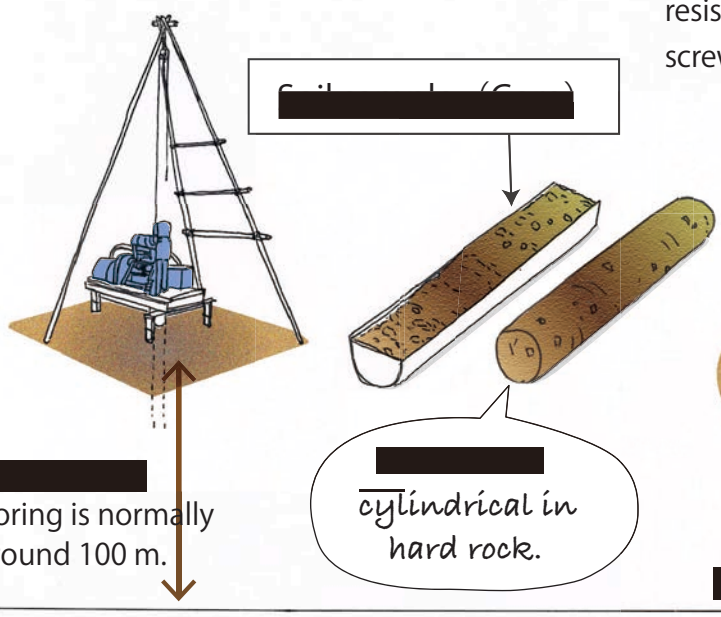
At the site where erosion control works are planned, in-situ tests are carried out if it is necessary to understand the feature of the soil and the condition of the water. And accordingly, We make counter measure basic plan with the initial information.



Boring Test

is a test to examine the ground by directly boring a hole into the ground and obtaining samples of soil layer.



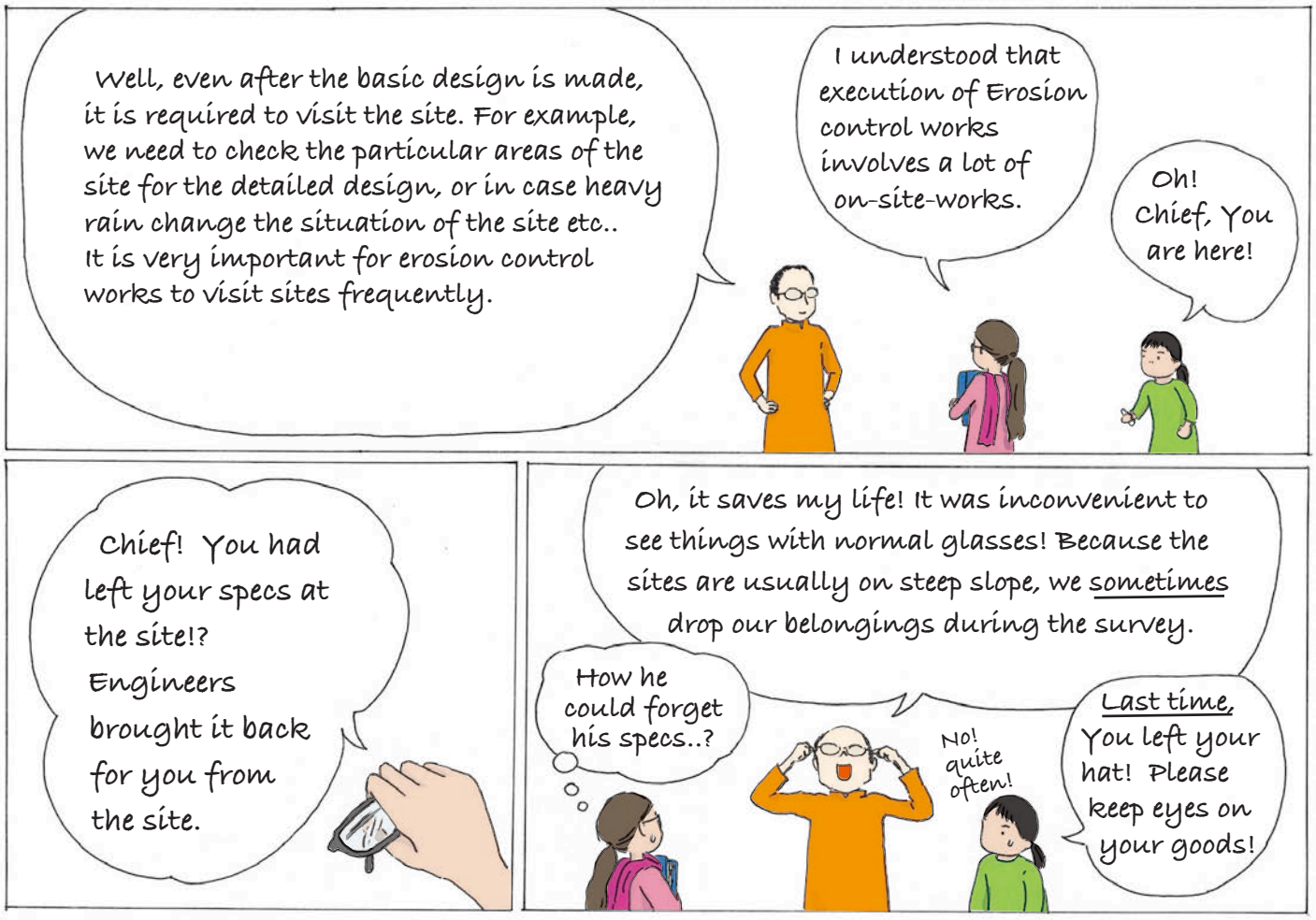
[redacted] boring is normally around 100 m.

[redacted] cylindrical in hard rock.

Swedish Sounding Test

is a test that measures the hardness or firmness of the ground. First, it measurs the subsidence volume of ground by adding weight step-by-step till 1KN(10kg), then its resistance is measured by screwing an iron tip with screw shape into the ground. It is relatively an easier method to measure the [redacted]th of [redacted]il [redacted]out [redacted]g [redacted]er.

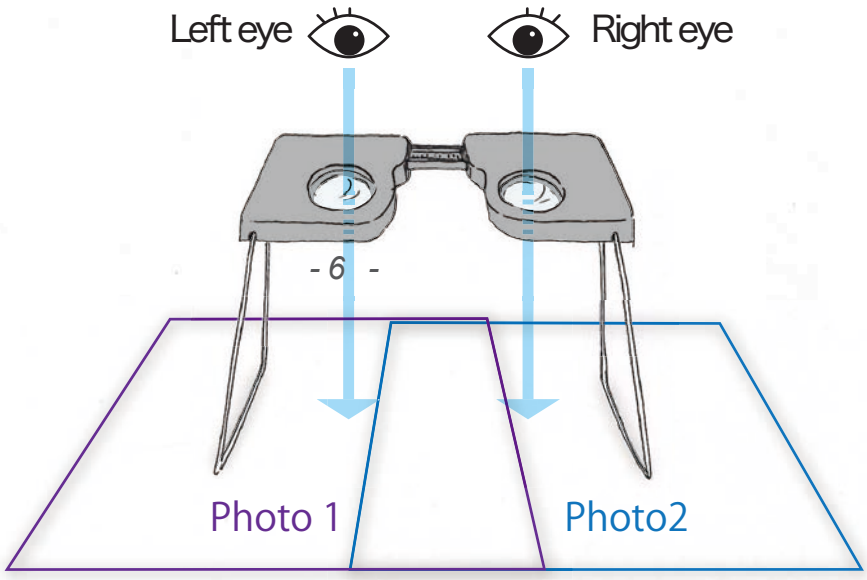
[redacted] m.

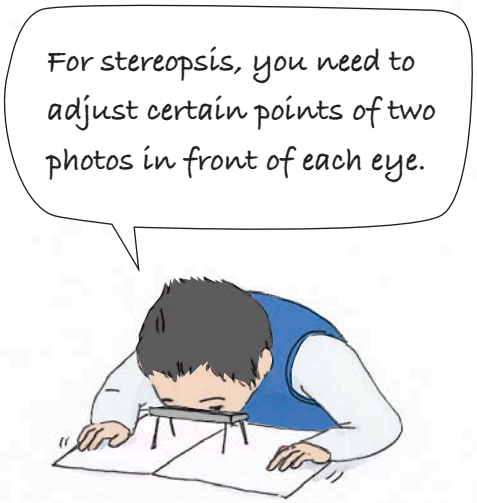


Survey tools

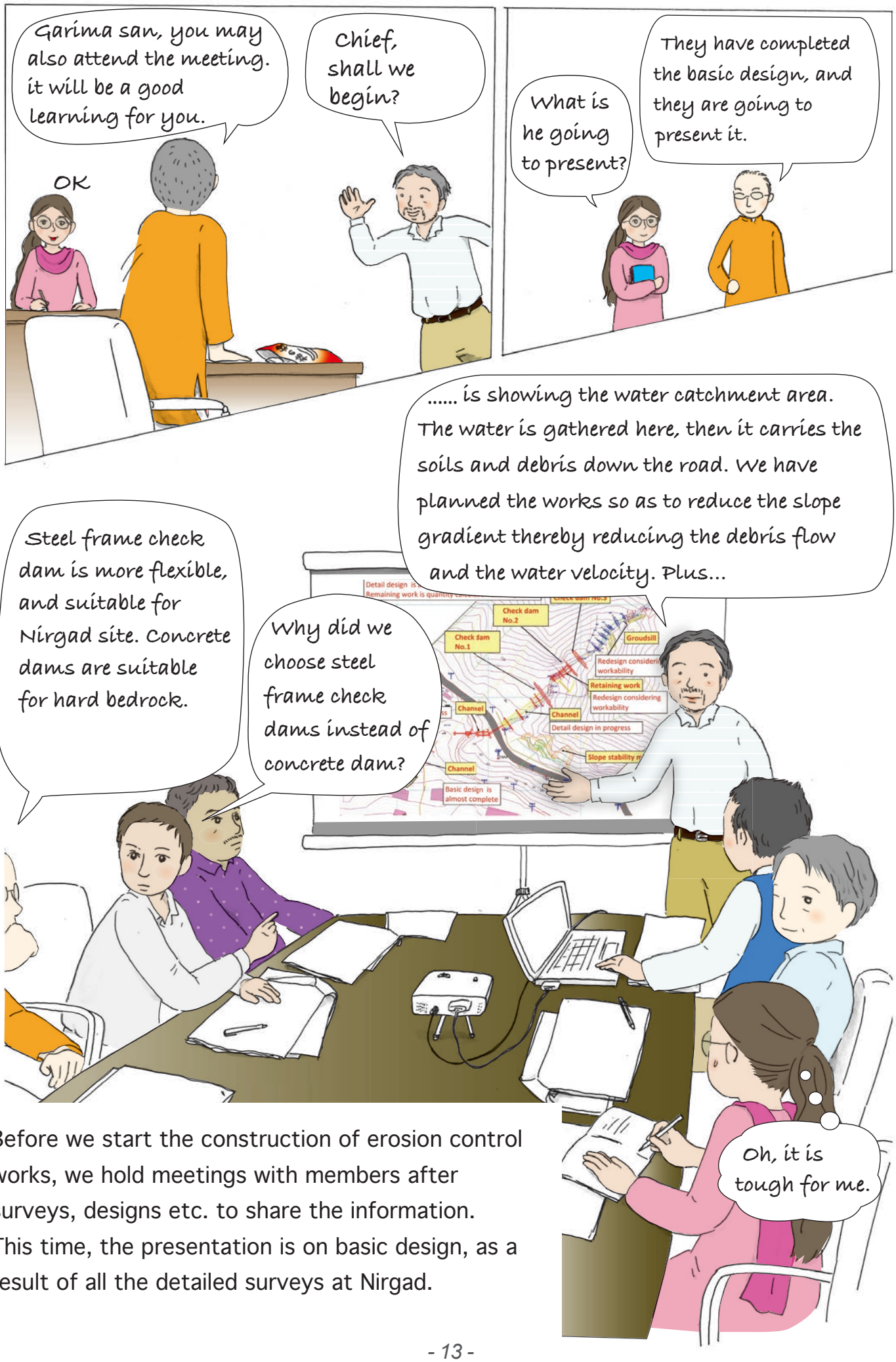
Stereo-scope

It is a device to see two dimensional photos in three-dimensions. Two pictures of the same object, taken from slightly different points of view, are viewed one by each eye, producing the effect of a single picture with 3D image. It enables viewing the ups and downs of the target area clearly.



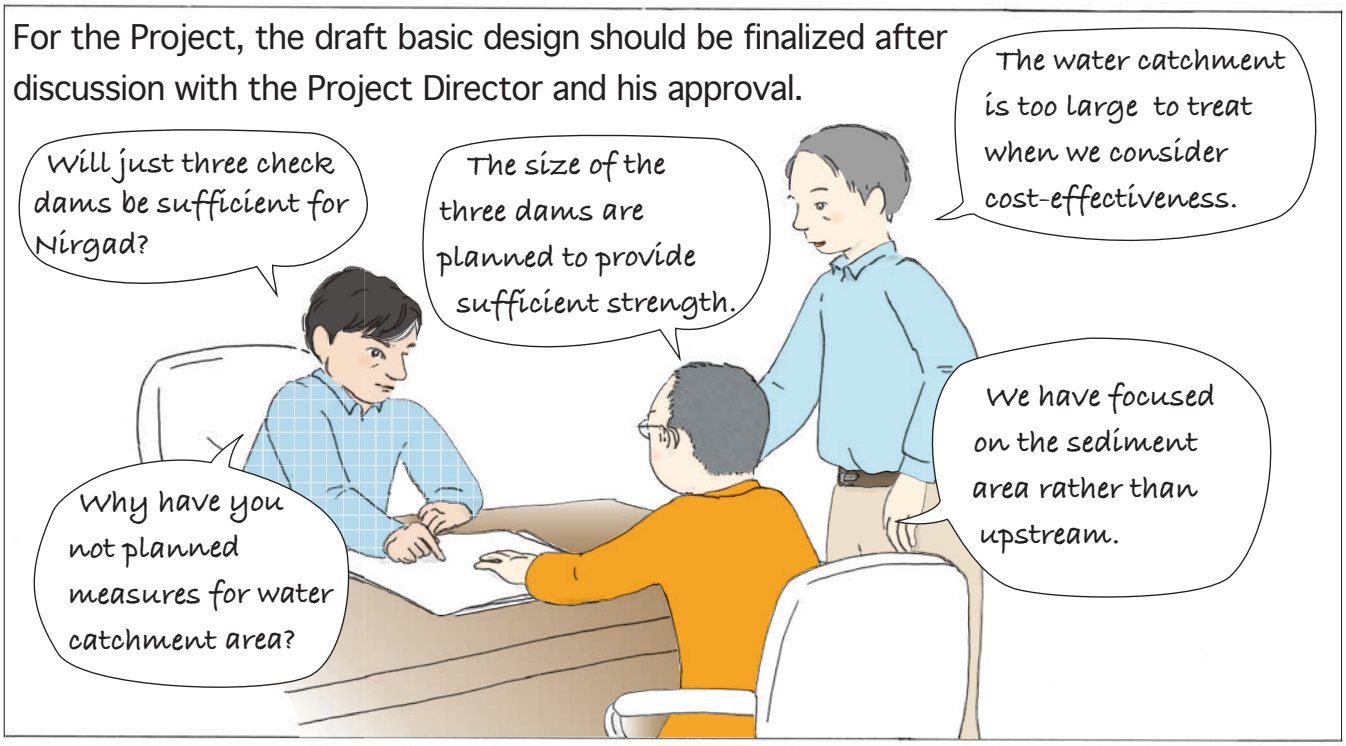


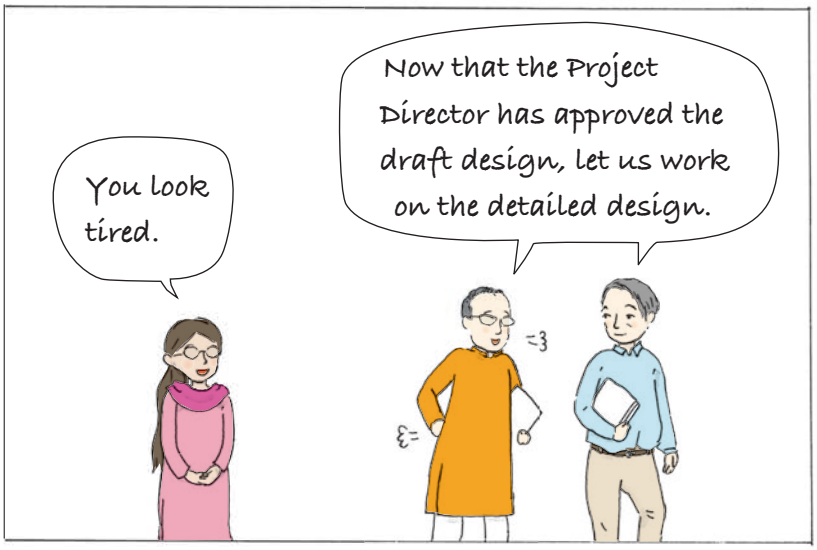
3. Sharing information and accountability.



Before we start the construction of erosion control works, we hold meetings with members after surveys, designs etc. to share the information. This time, the presentation is on basic design, as a result of all the detailed surveys at Nirgad.

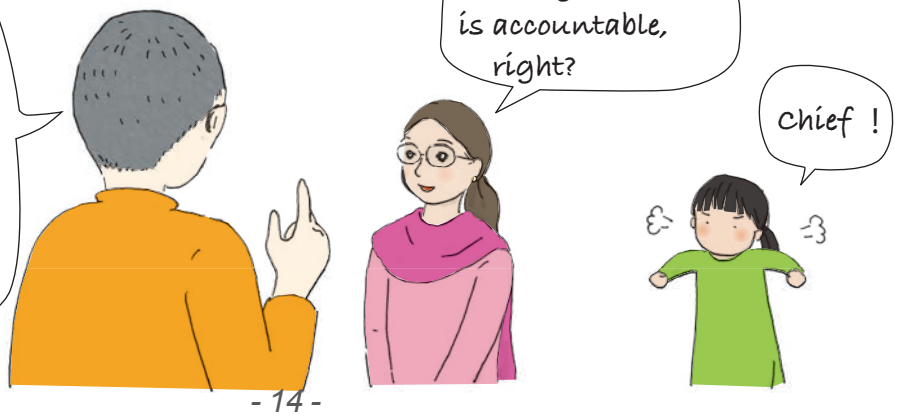
For the Project, the draft basic design should be finalized after discussion with the Project Director and his approval.





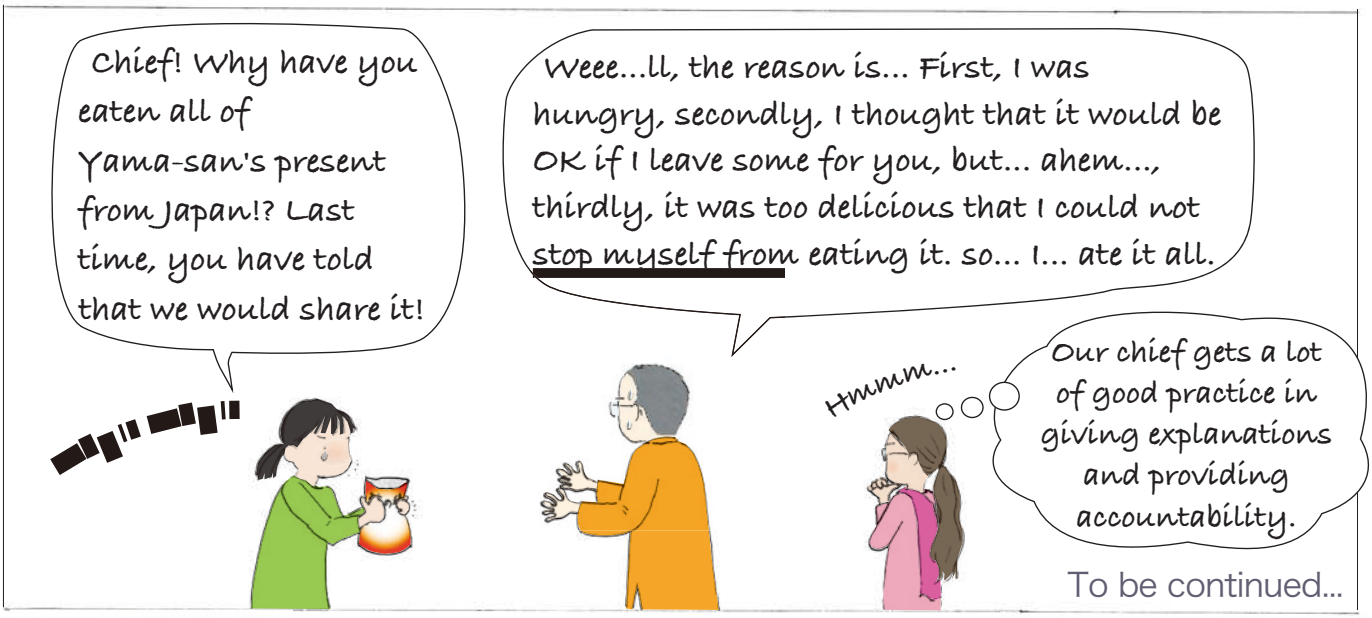
The general public needs to be briefed about the erosion control work. Therefore, being the head of the Project, the Project Director needs to know the detail of the plan.

Also, discussions with other related persons would definitely improve the plan by incorporating their various ideas.



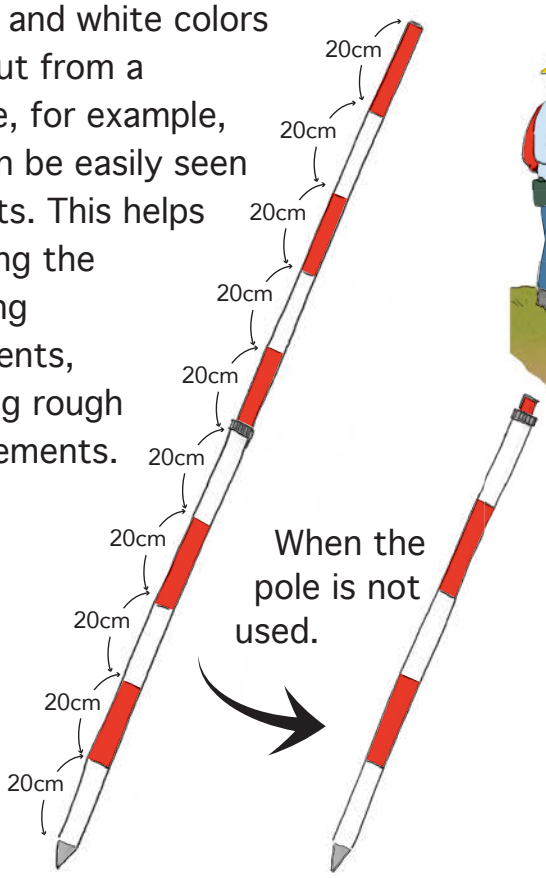
***Accountability**

It is a responsibility assigned to the organization to explain its plan, activities, and results to the general public.

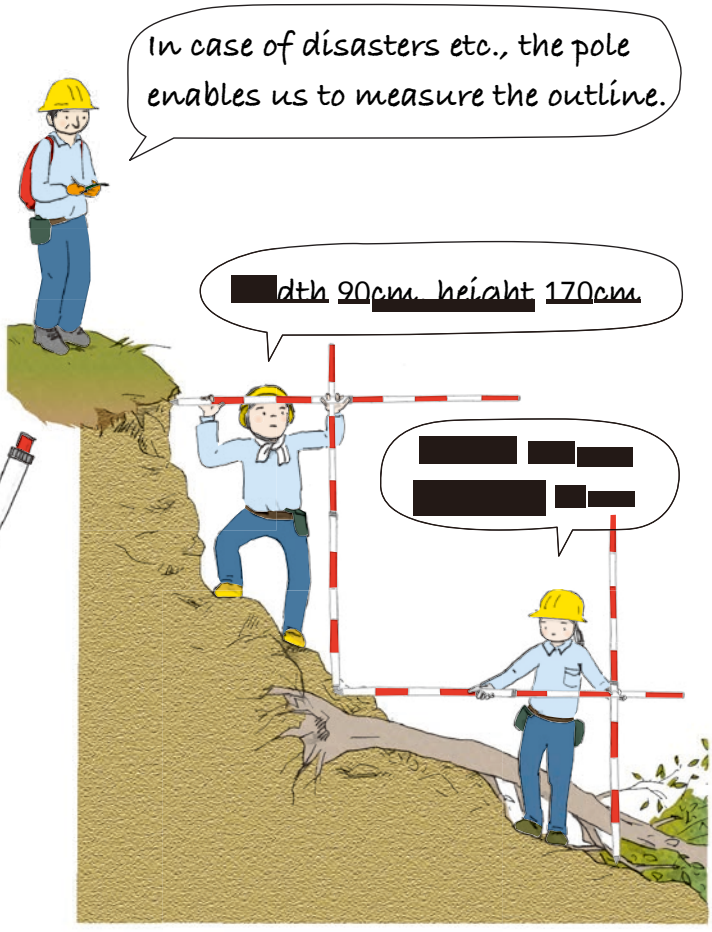


Information survey tools
Surveying Pole

In Japan, most surveying poles are colored red and white. The poles vary in the materials from which they are made of, such as wood, aluminum, resin etc. but the size is generally 2 m, with the color banded red and white at intervals of 20 cm. The red and white colors stand out from a distance, for example, they can be easily seen in forests. This helps in viewing the surveying instruments, providing rough measurements.



When the pole is not used.



4. Torrent work (Check dam)

What are the functions of check dams?

Hmm.....

?

Oh, Chief !

You look worried. What happened to you?

It is not that serious, actually... I am looking at the design that I received during the last presentation, but now, I cannot remember what these rectangles mean...

Ah! These rectangles! These indicate check dams and ground sills.

Check dams and ground sills...? Are these what I saw in the photo some days ago?

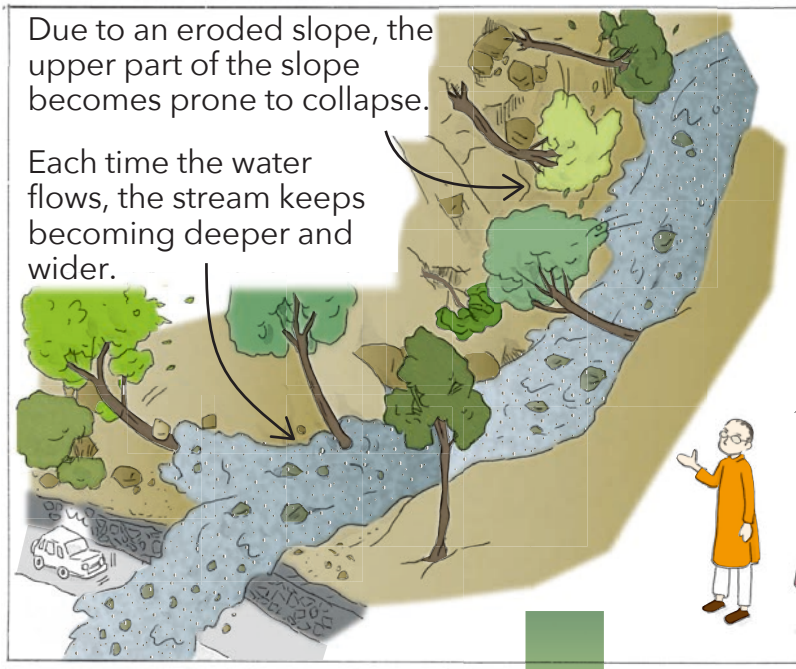
About check dams... It will take while to explain.Would you like to understand the same?

Yes, I would like to know more.

Before torrent works installation

Due to an eroded slope, the upper part of the slope becomes prone to collapse.

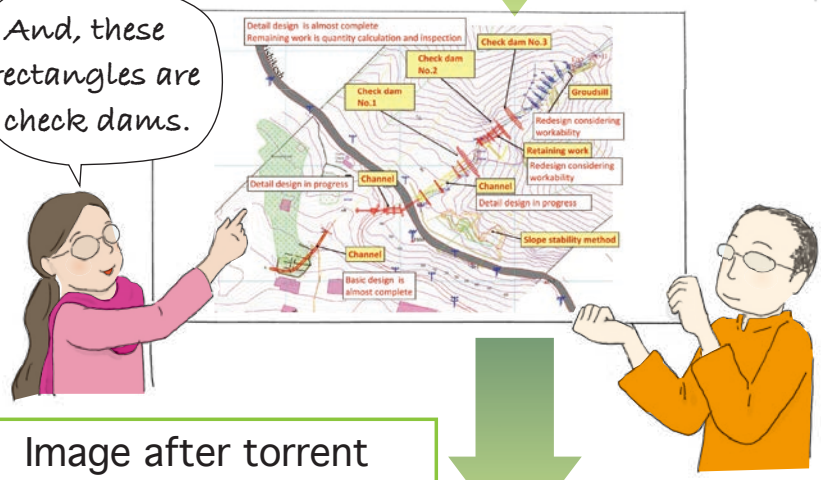
Each time the water flows, the stream keeps becoming deeper and wider.



This illustration shows the devastated area before torrent works are installed. At the area where water has gathered from the upper stream, the water overflows from the stream and washes sediment down to the road and land, in the form of debris.

It sounds dangerous...

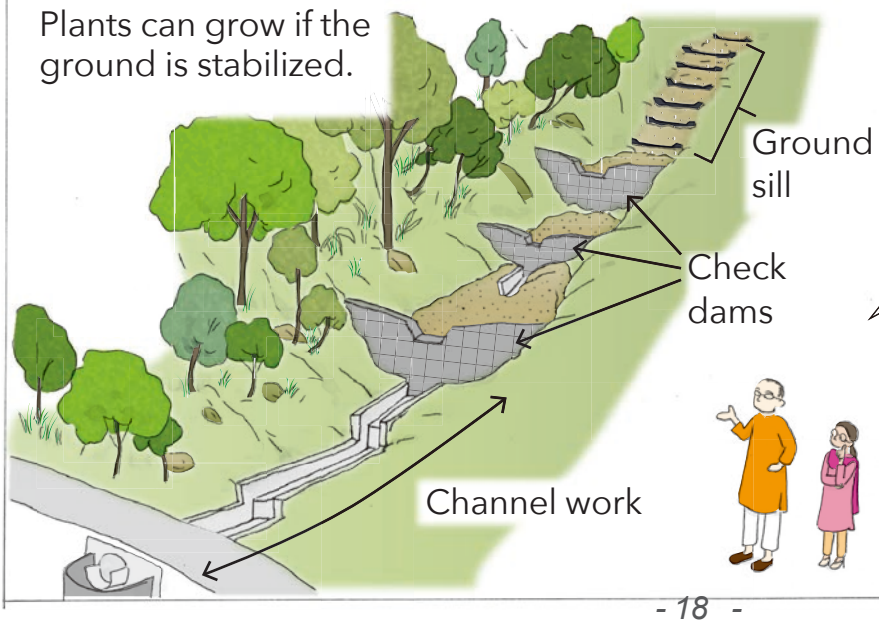
And, these rectangles are check dams.



Plants cannot grow unless the ground is stable. In order to control the water flow and stabilize the soil, a basic plan of torrent work was designed.

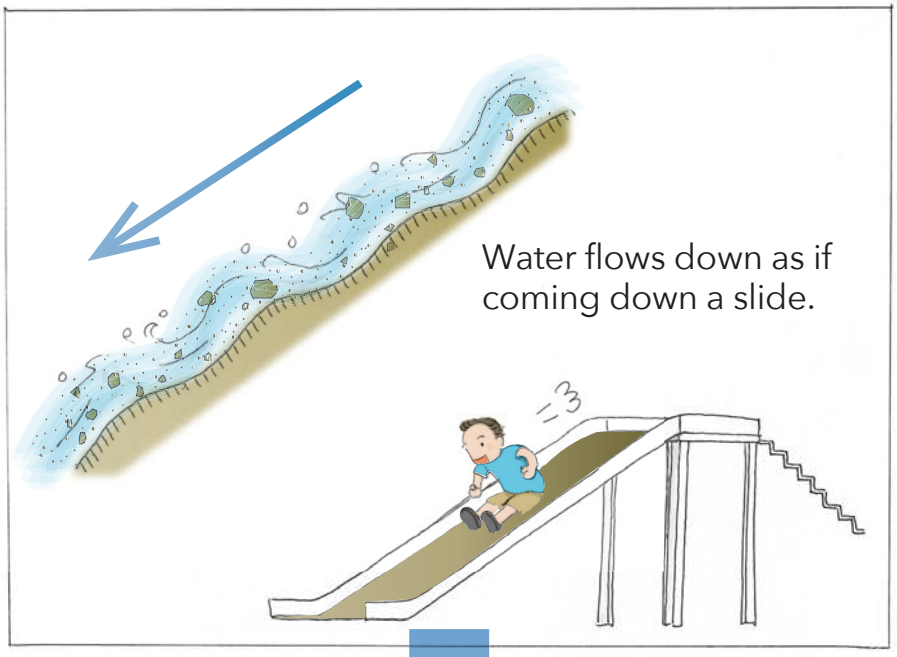
Image after torrent work construction

Plants can grow if the ground is stabilized.



At the upper stream, the ground sill will hold the soil movement, letting it stay at the existing angle. Below the ground sill, three check dams will change the angle of the stream gently. Further, the channel work will allow the water to be safely discharged down to the lower stream.

What do you mean by "check dams will change the angle of the stream gently" ?

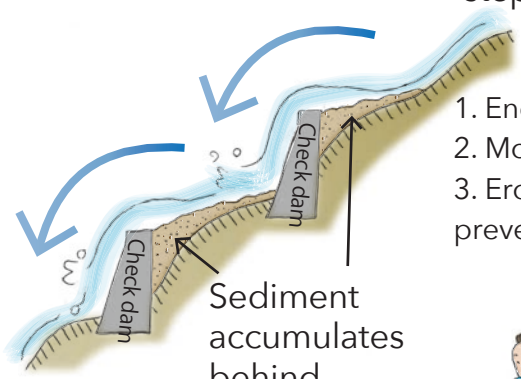


Water flows down as if coming down a slide.

Please look at these two pictures.
The above is the situation without any work on it, and the one below is after installing two check dams. The sediments will be accumulated behind the check dams and the slope becomes like stairs. Although steps are created, the slope gradient of these steps are gentle.

Water flows down like it was stepping down the stairs.

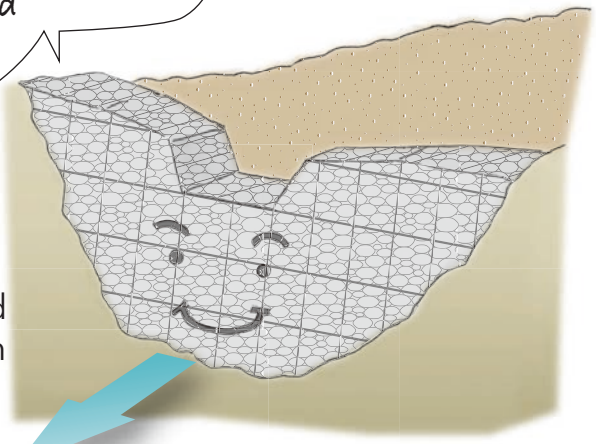
1. Energy of the water is reduced.
2. Movement of the sediment is reduced
3. Erosion of riverbed and slope is prevented



Sediment accumulates behind check dams.

So, you are saying when the slope is changed from slide to stairs, the water becomes less accelerative, right?

Furthermore, a check dam has important functions, such as giving support to both bank with its accumulated sediment, and discharging water in a safe direction.



Sediments will be accumulated behind the check dam, and this gives support to both banks, and strengthens them.

A check dam is installed facing the safe direction of the watercourse.

By the way, how do you decide where the check dams should be installed? Does every steep stream need them?

Oh!?

It is difficult to explain this in a word. Considering the current devastated condition of the er... the slope, and riverbed, just, er, under the area of, I mean....

Ooh...

?

?

?

All streams don' t need check dams, but there are some standard procedures to determine where the check dams should be planned.

Ooh... Ooh...

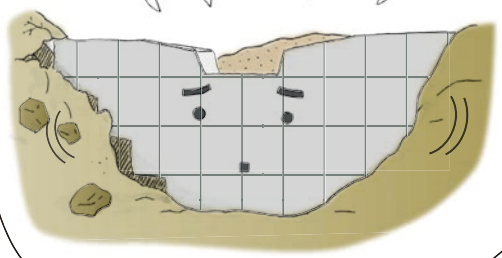
Ooh...

Yama san !

First, the ground on both banks and the riverbed should be firm enough to hold a heavy check dam and the sediment that will be accumulated behind the check dam.

I need firm ground to hold myself and the sediment behind me.

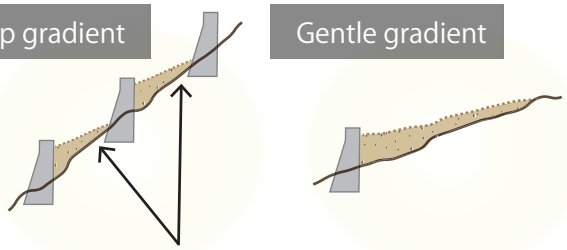
Help!



In case the check dams are planned in the form of stairs, the gradient of the riverbed and how to prevent the erosion should be taken into account

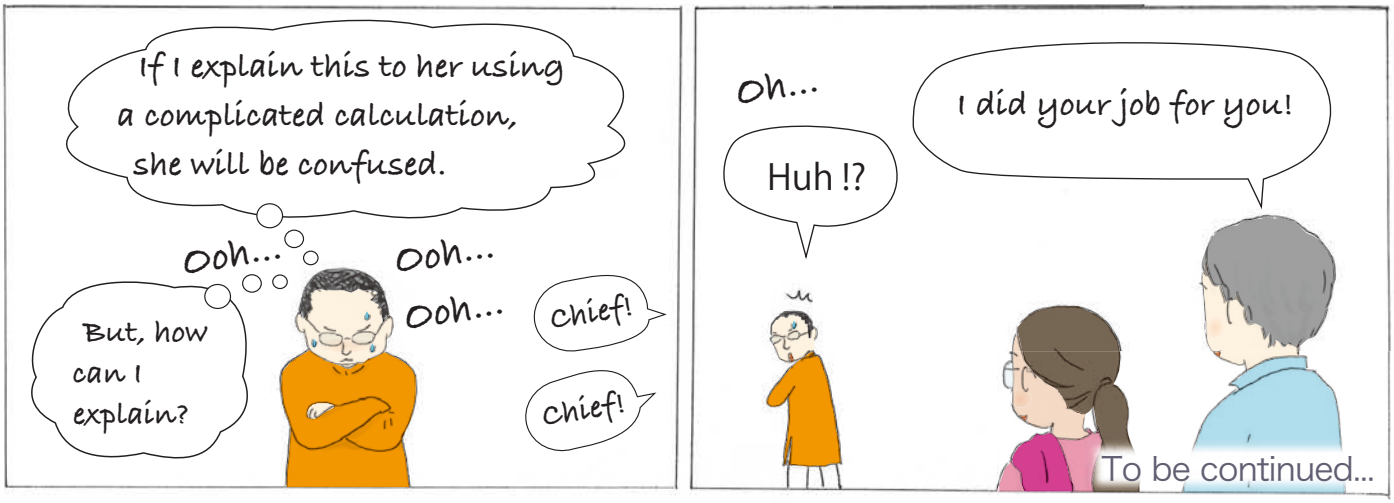
Steep gradient

Gentle gradient

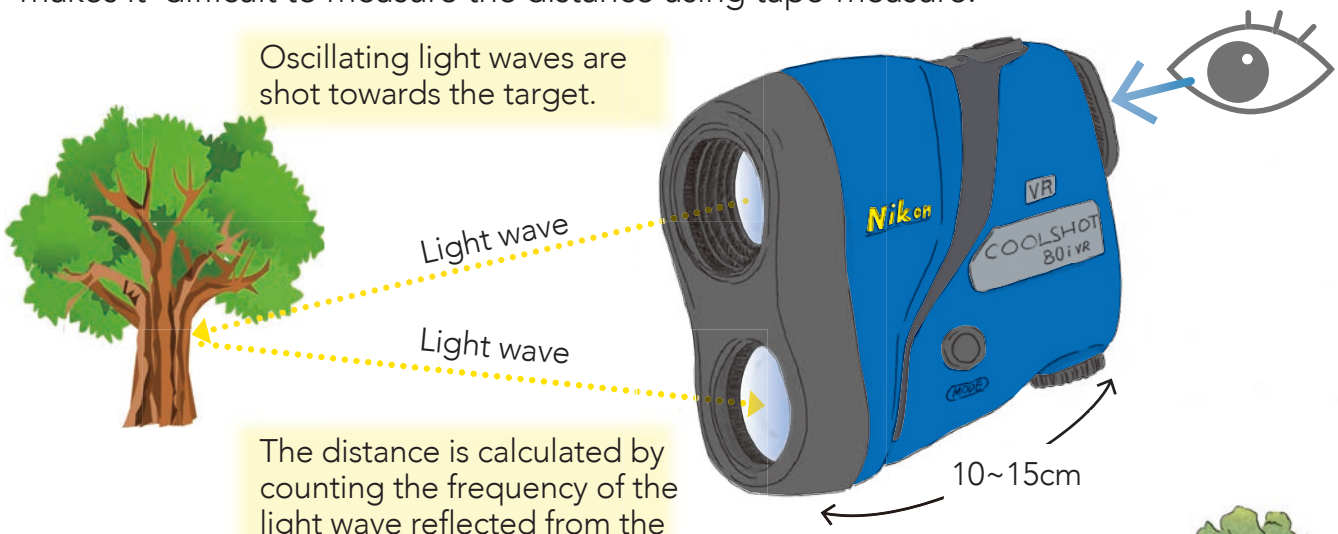


Accumulated sediment should reach the foot of upper check dams.

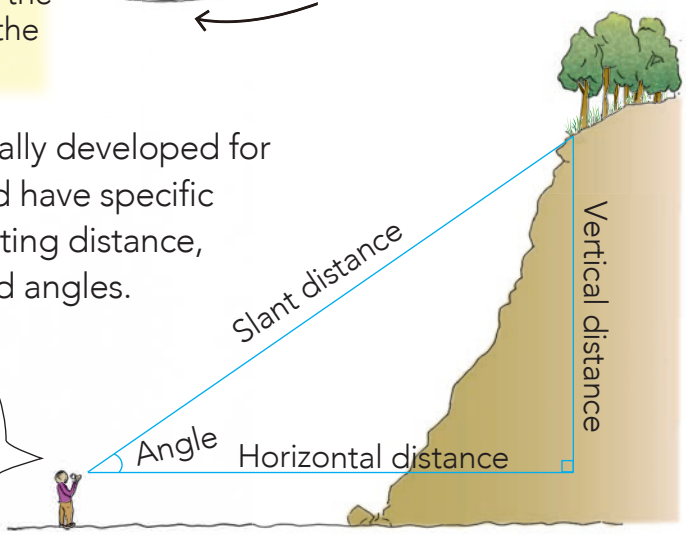
I see. The condition of both banks and the riverbed, the design of the whole area.... Many factors need to be considered.
It seems this kind of planning needs both experience and special knowledge.



A laser range finder is a kind of electronic distance meter. It shoots light waves and measures the distance sensing the reflected light. There are many kinds of laser range finders. For example,a total station range finder is used in surveys, a military model can measure tens of kms, and there is one equipped for satellites. Depending on their performance and function, these are used in different applications. For a field survey of erosion control works, a handy-sized laser range finder is useful as compared to a high-performance large-sized model. Although it can measure comparatively shorter distances, it can be used to measure distances at a site that is big, uneven, and has a steep angle ground, which makes it difficult to measure the distance using tape-measure.

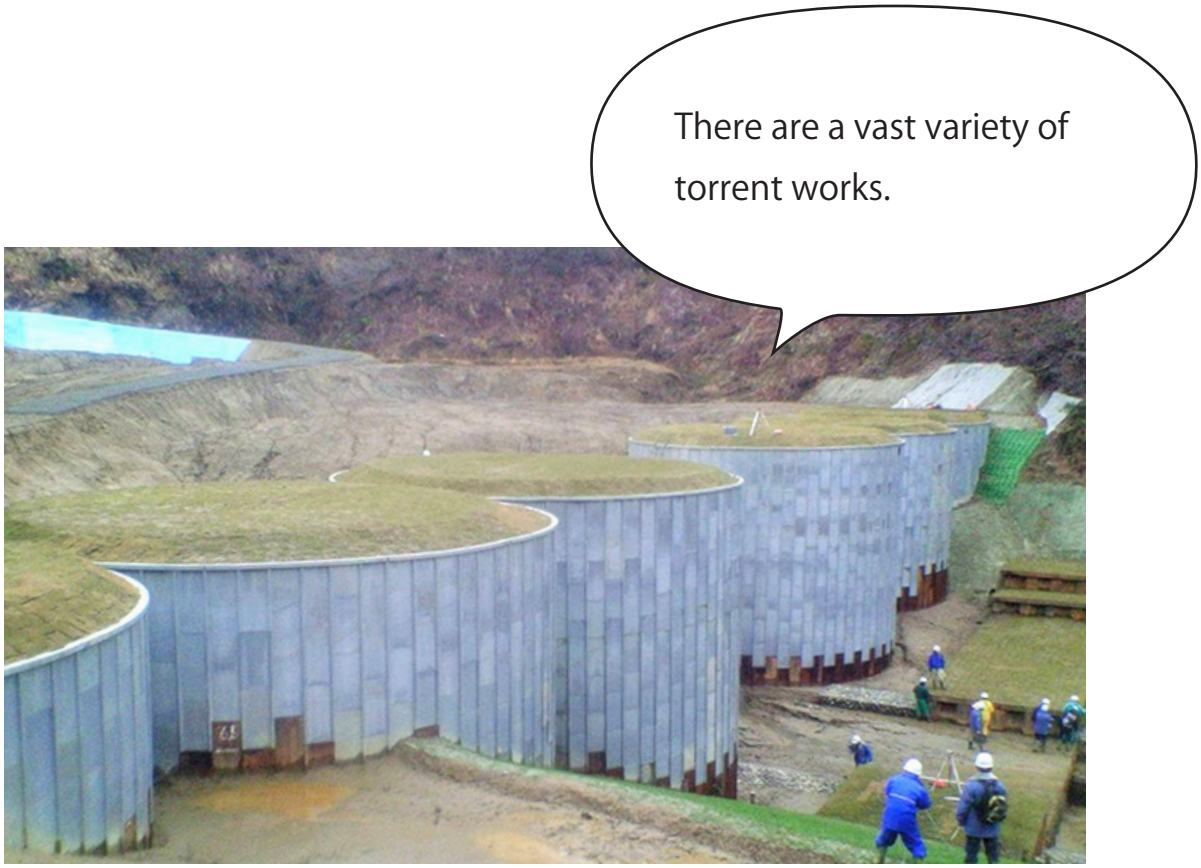


In the Project, laser range finders especially developed for golfers are used. These are compact and have specific functions. These are able to measure slating distance, horizontal distance, vertical distance, and angles.



An ultrasonic range finder is also used in the area where trees or plants block the view, such as in forests.

5. Types of torrent works



©Shingo Kitaura

I'm disappointed I could not complete my explanation about torrent works...

Chief!

Could you come and check the model? The model makers modified it according to our feedback.

Oh! Have the modifications been made?

It looks like a real erosion Control model now.

This model makes erosion control work easy to understand, even if you have never seen the works, right ?

Yes, I can imagine how the work at the site looks like now.

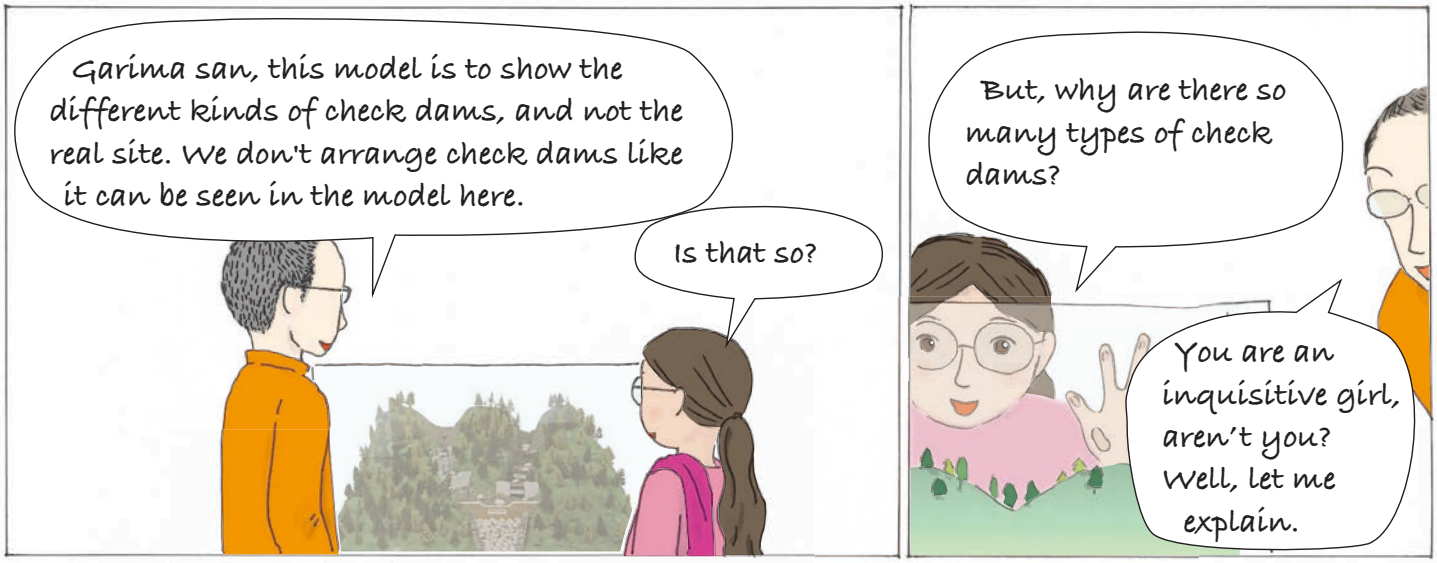
When the Project Director said,

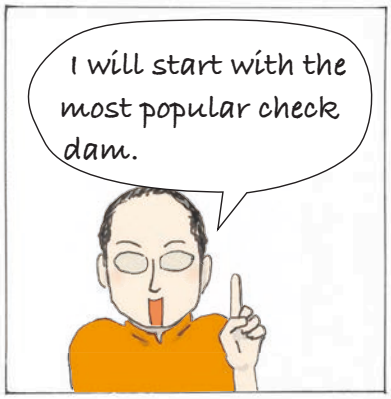
We should make models.

I was uncertain how the quality would be, but the models have come out pretty good.

These erosion control work methods are new to India and the model makers have never seen them. It is commendable they made it of this fine quality.

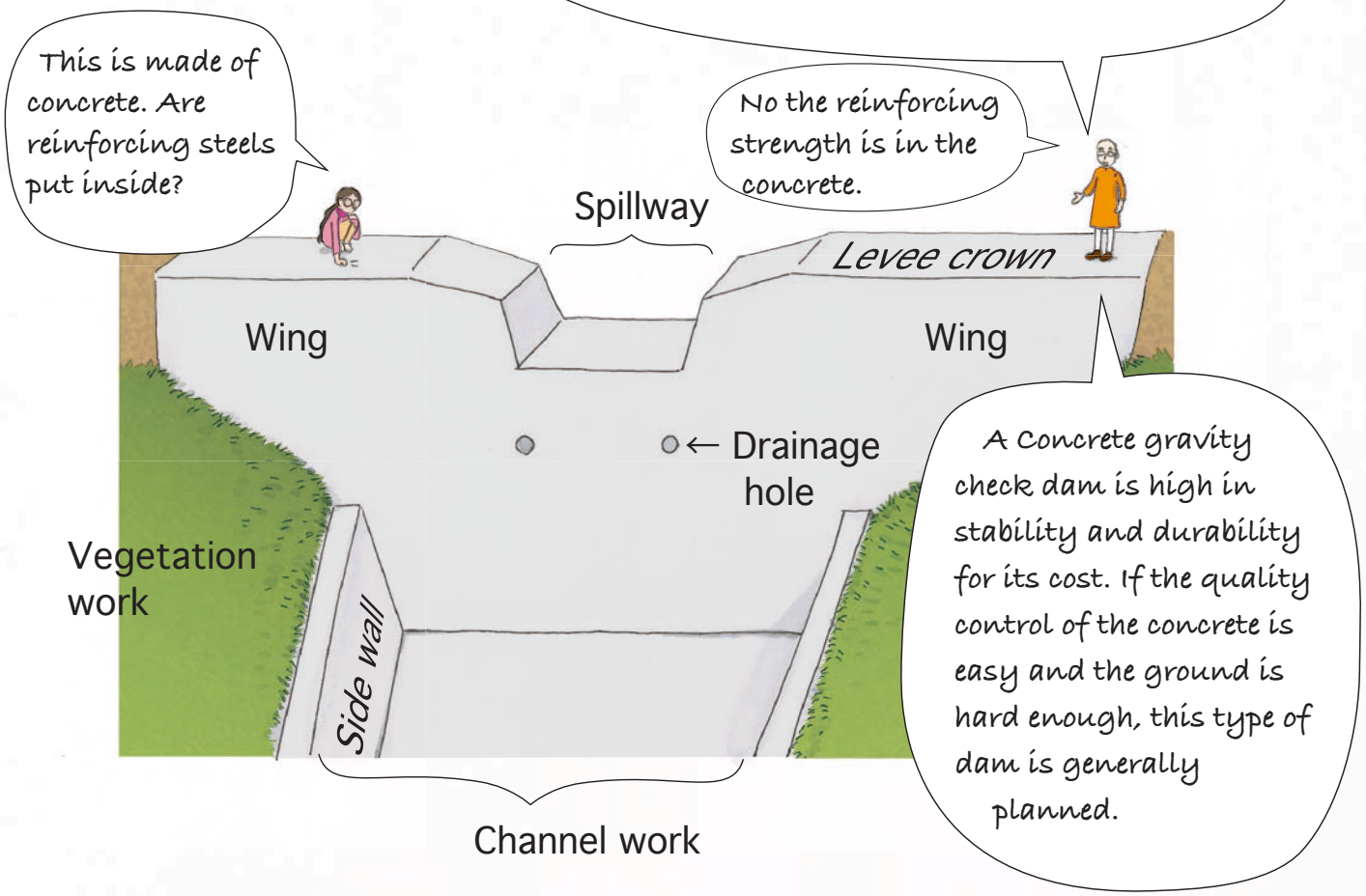
Excuse me, but the shapes of all these check dams are different. Do you arrange different types of check dams at one site in Japan?

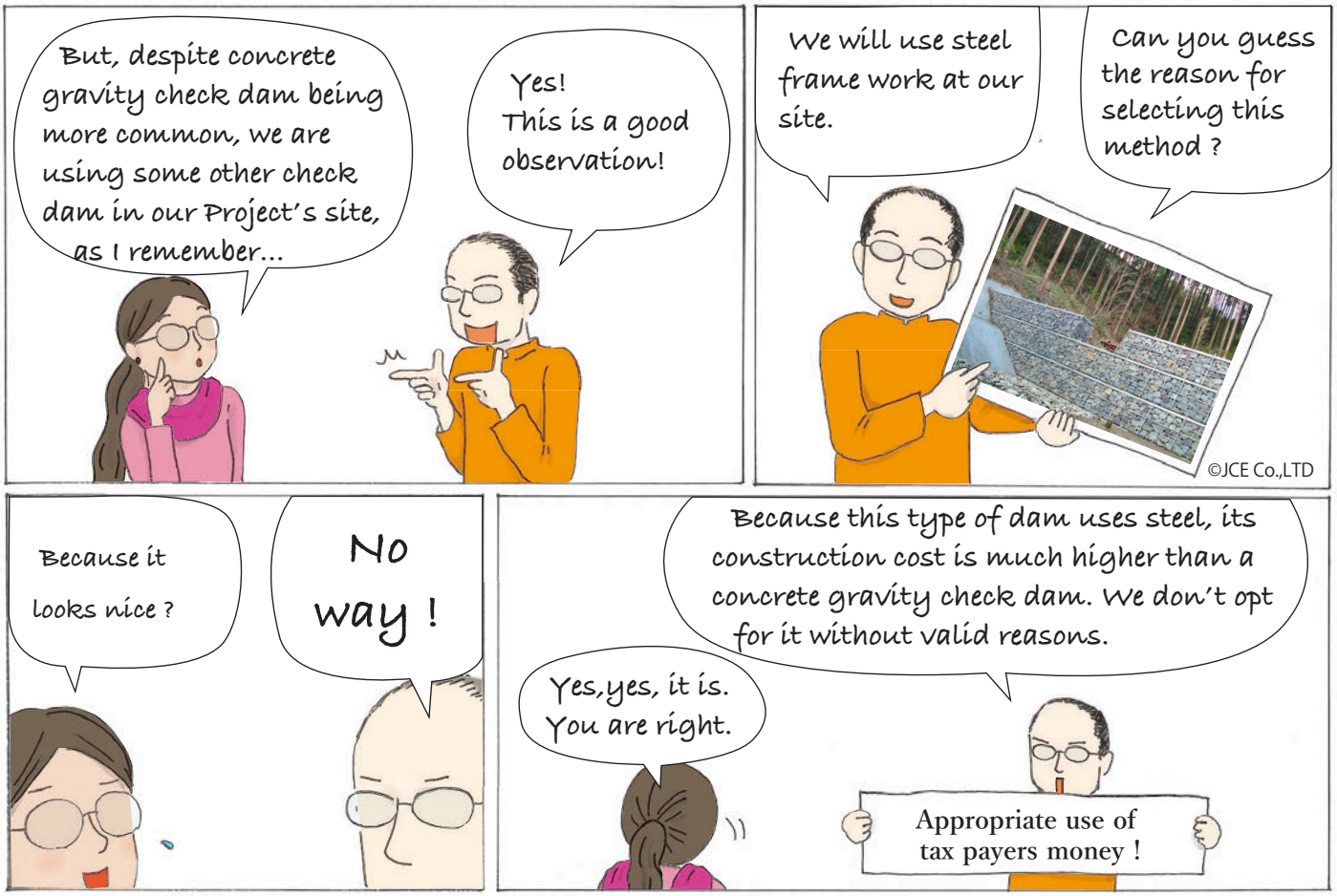




Gravity Check Dam (Concrete)

Concrete gravity check dams are the most common check dams in Japan. When the size of the dam is big, we can further add a front **apron** that reduces the impact of falling water from the spillway, or we can add a **counter dam** whose size is smaller than the main dam.
The dam, along with the sediments accumulated behind the dam, changes the angle of the stream gently, gives support to both banks and strengthens them.

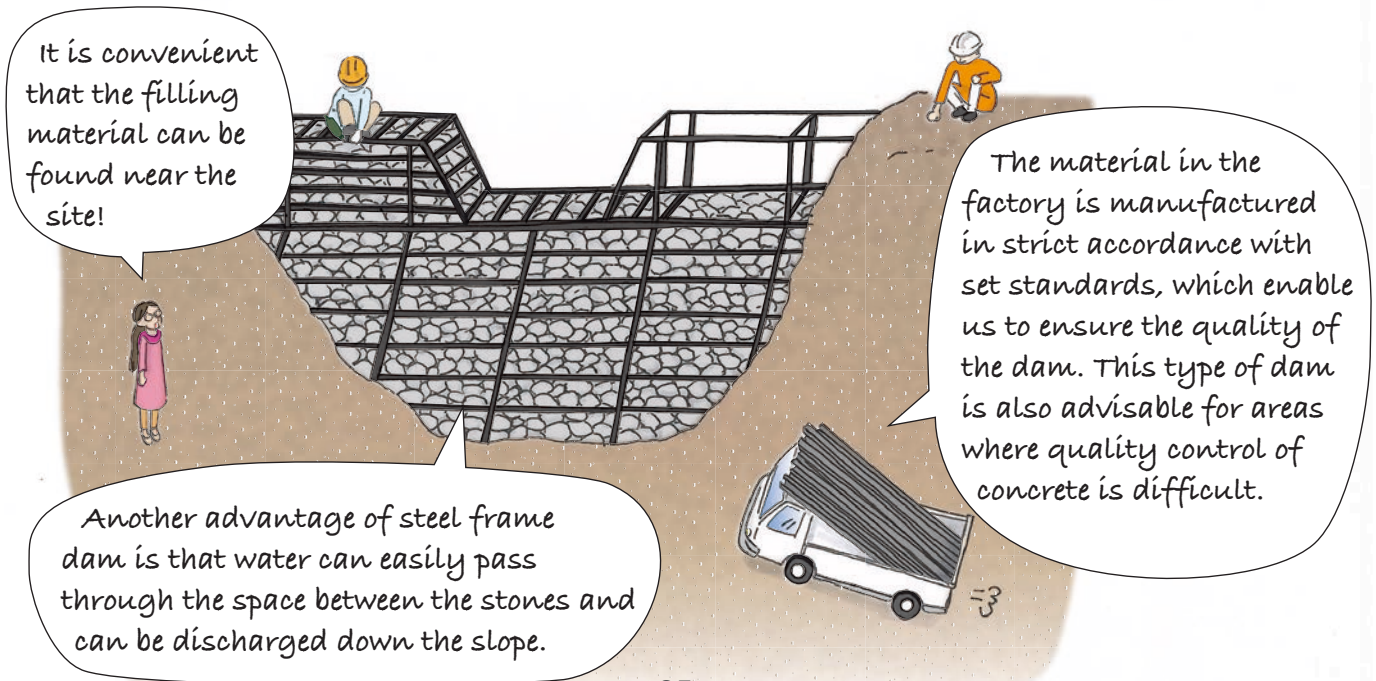




Steel Frame Dam

A steel frame dam is built using the material that is manufactured in factories. Then, the steel frame is filled with stones that are collected near the site.

Because a steel frame dam is lighter than a concrete dam, the load on the ground is less, and the dam can be installed on relatively soft ground.



After building a check dam, the ground beneath it sometimes sinks unevenly after a few years . This causes cracks in the concrete, affecting its stability.

However, a steel frame dam will get only partially deformed in the same situation, and stay stable.

Even though the concrete check dam is cost-effective, we felt a steel frame dam is more appropriate for the place where the ground is soft.

Apart from these two dams...

....there are several other kinds of dams. There are many factors that influence the selection of the dam. For example, the type of ground, causes of disaster, scale of construction, use of soil generated at the site, landscape after construction, budget, etc... .

Cell dam

© Forestry Agency, Japan

Slit dam

©JCE Co.,LTD

Are the functions of these dams the same?

Of course not! Their functions, merits and demerits are different. We need to consider each of them and select the best dam for each site.

Cage dam

© Masaaki SAKURAI

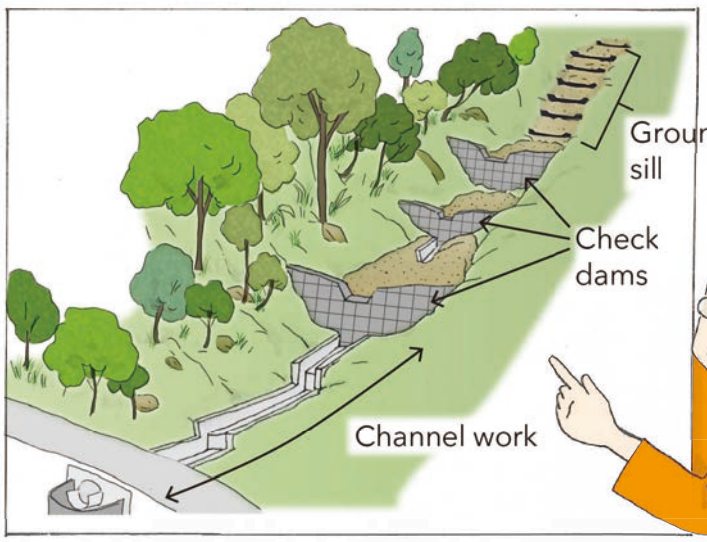
OK. So, if I am able to select the right dam for the right site, I will be a master of **torrent Works**, isn't it ?

!!!

No! No! Even though check dams are big and stand out, there 's much more to torrent work than just the dams. Did you forget our site? I explained to you last time, remember?

Was it so? I may have forgotten...

Nnnn! Let me tell you about torrent work in detail.

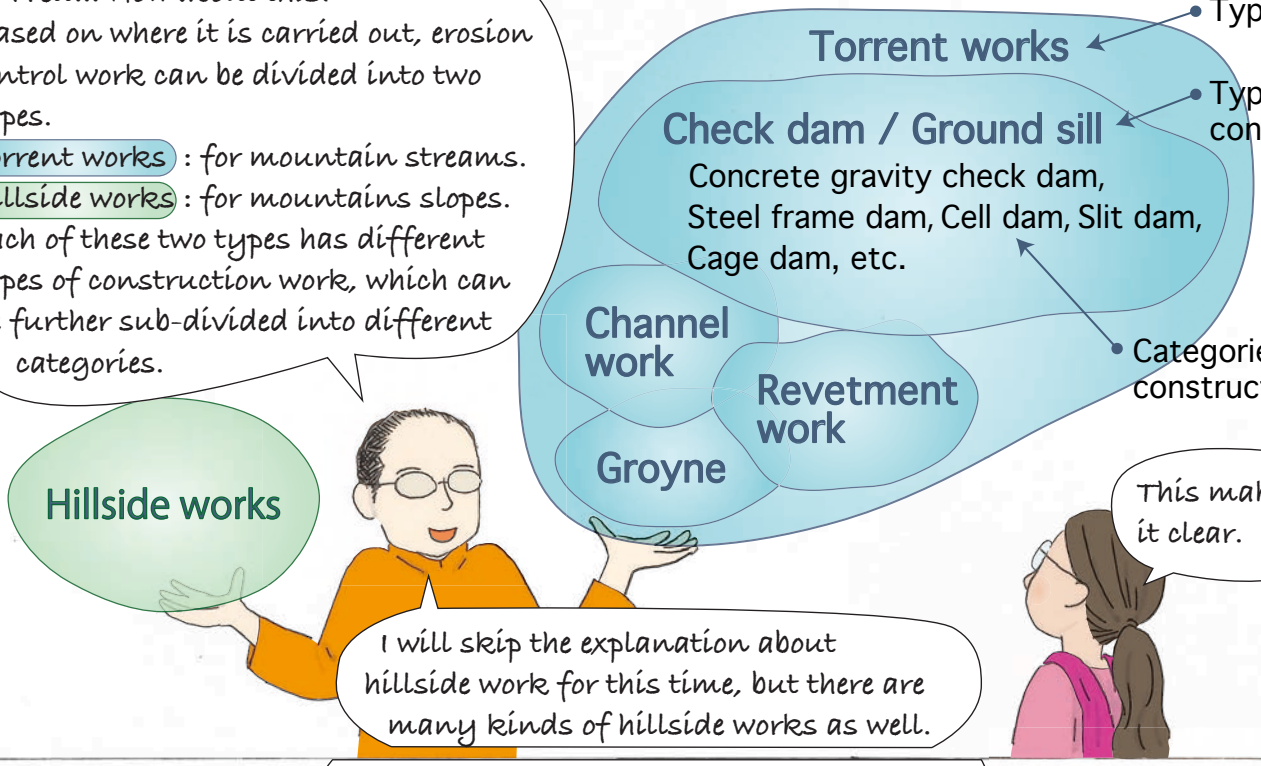


This construction work at Project's site is torrent work, a general term to describe work on mountain streams.

You see, tall dams are called Check dams, while short dams are called Ground sills.

Sorry, but so many words confuse me...

Well... How about this?
Based on where it is carried out, erosion control work can be divided into two types.
Torrent works : for mountain streams.
Hillside works : for mountains slopes.
Each of these two types has different types of construction work, which can be further sub-divided into different categories.



I will skip the explanation about hillside work for this time, but there are many kinds of hillside works as well.

This makes it clear.

Channel work

Let me explain another kind of construction of torrent work. Channel work, for instance, is used to discharge water downward safely, as well as prevent erosion of river banks and river bed.

I remember! This is planned for our site too!

©JCE Co.,LTD

Yes, there, we plan to do channel work so that both banks are protected with concrete or steel frames.

Revetment work

This is another kind of torrent work. The function of the revetment work is to prevent erosion and collapse of torrents.

Is it installed at a place where the water flows?

©JCE Co.,LTD

Yes, it prevents water from eroding the river banks. With the ability to stabilize river banks, it could well be the foundation of hillside works.

Groyne

The last one, Groyne reduces the water velocity. Since this work is used mainly at the wide river with gentle angle, it is seldom used in the hillside.

I see. So torrent works are made of four kind of construction works.

© Masaaki SAKURAI

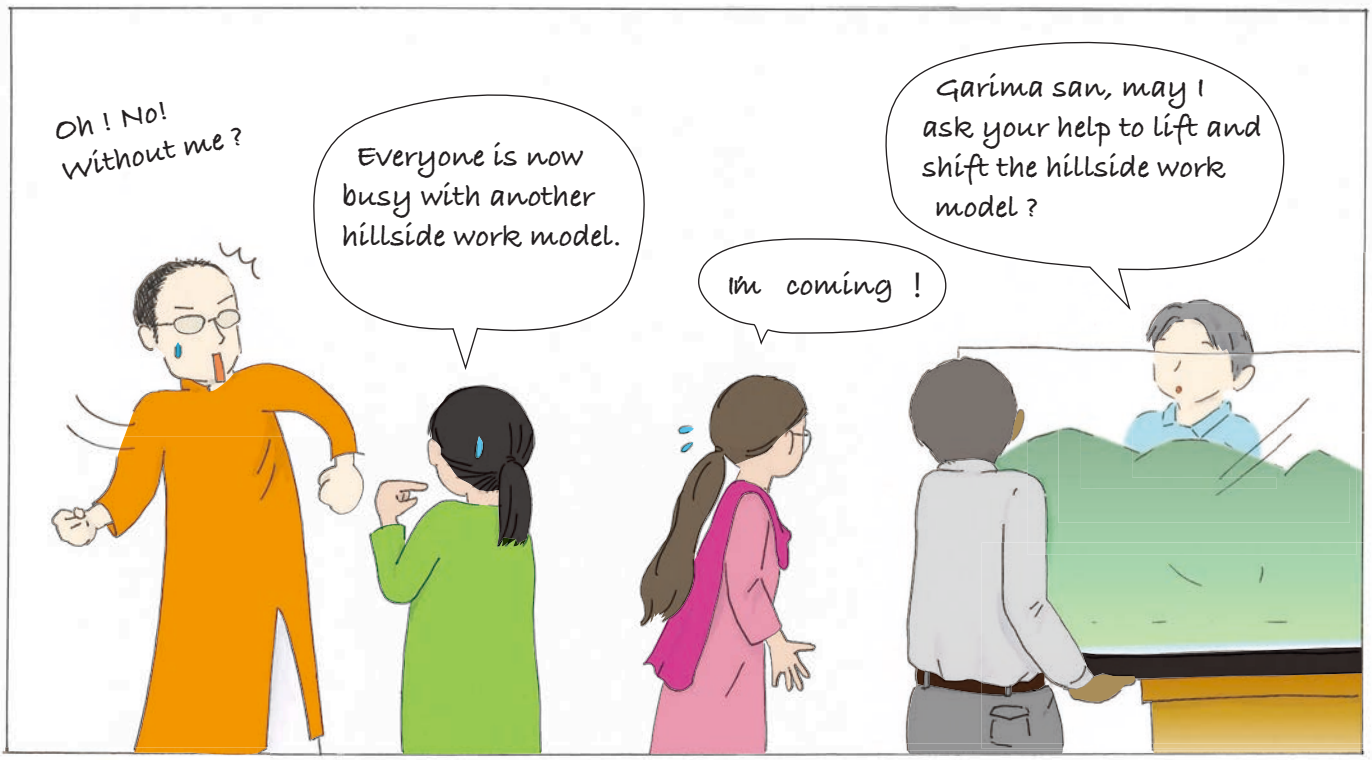
Exactly! There is more to torrent work than just a check dam. How to best combine the right type of construction work and then choose the correct category is a highly specialized skill.

For example, when I was in Shizuoka prefecture, Japan...

Excuse me Chief...

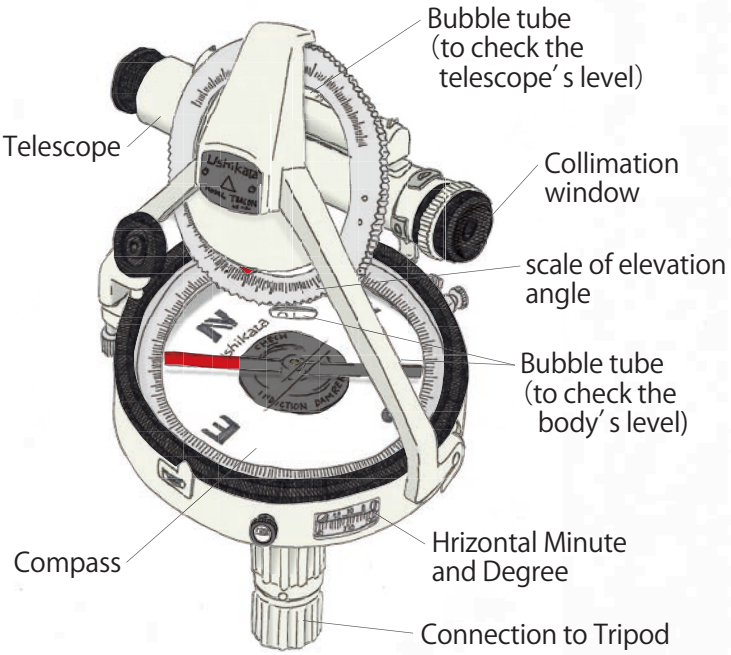
Could you refrain from disturbing us, please ? I am explaining important things to Garima san.

I know. But I regret to tell you that...



Pocket compass

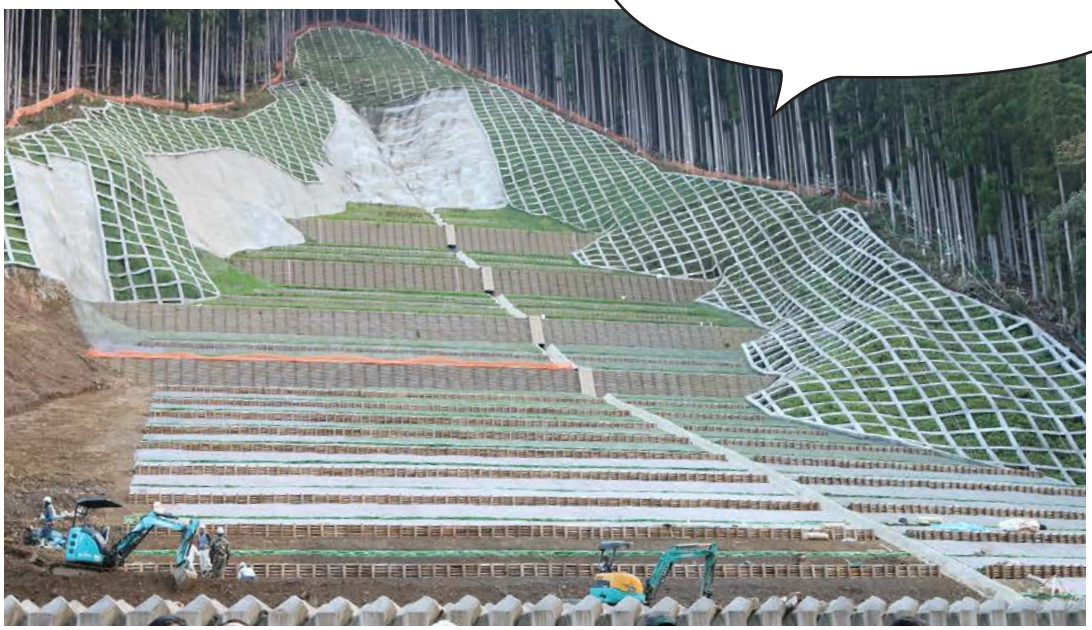
Pocket compass is a popular survey tool that is used in forest and mountainous areas in Japan. It is used to survey X and Y sections and levels. A pocket compass comprises of a telescope and a compass body with degrees calibrated on it, which help is measuring bearing angles. The pocket compass can also be used to measure distance. It is also relatively compact, light and portable, as well as easy to set at site with minimum practice. It is really useful for surveys that don' t need precise and accurate results. For that, a theodolite is used.



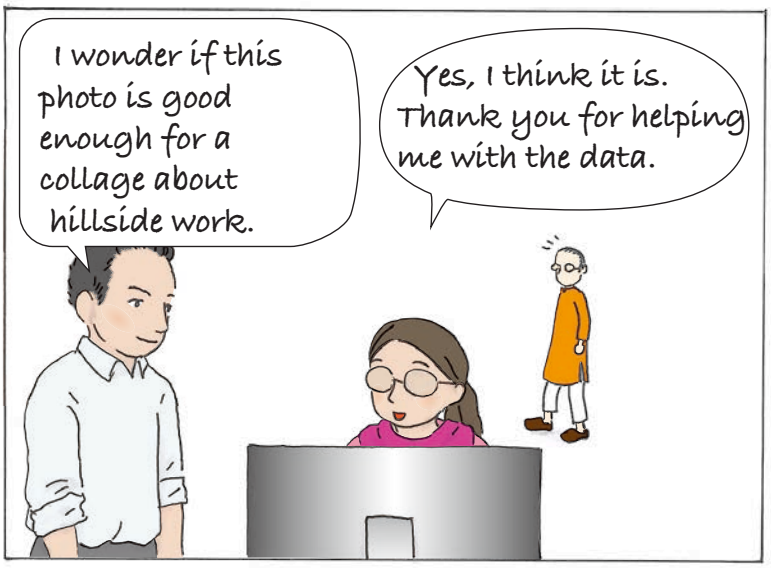
At erosion control work sites, it is common practice to prepare basic designs based on the results of a compass survey. Further, transit surveying is carried out for detailed designing. In present times, it has become popular to conduct surveys using global positioning system (GPS) and unmanned aerial vehicles (UAVs, or drones). Despite this, a pocket compass is an important tool for conducting surveys in forest areas, what with its relatively accurate results. Note: It requires as few as three people to conduct the survey.

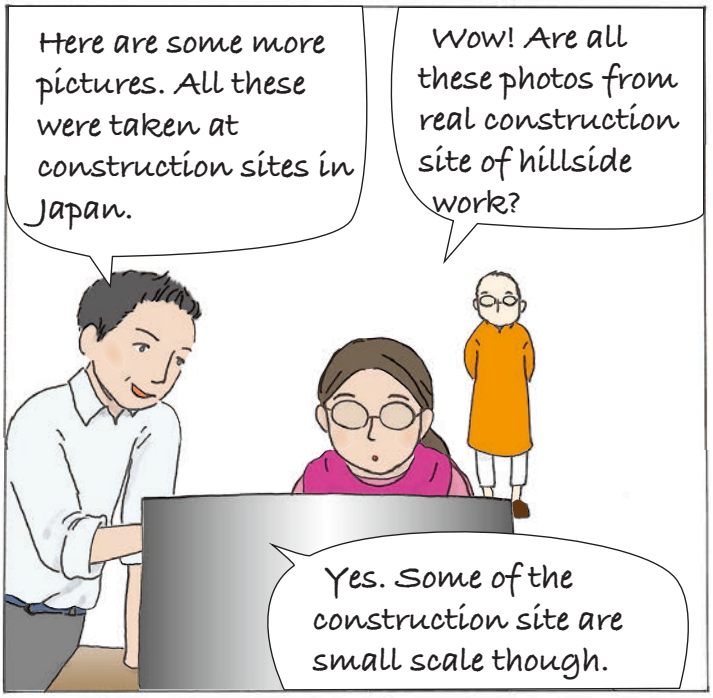
6. Hillside works

What kind of work is necessary to prevent or restore slope devastation?

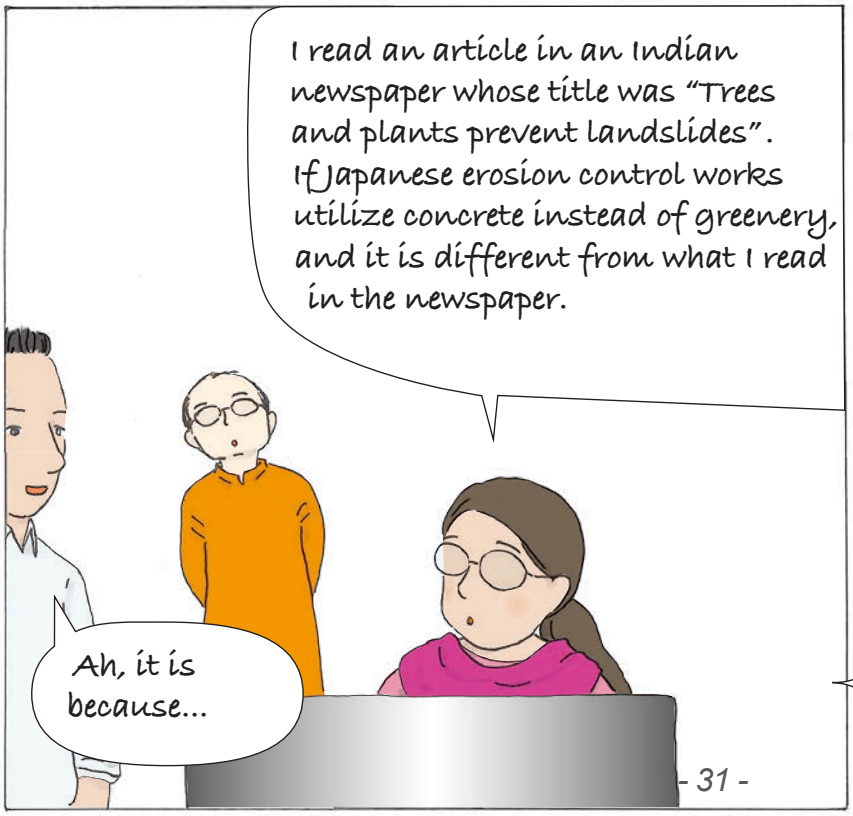


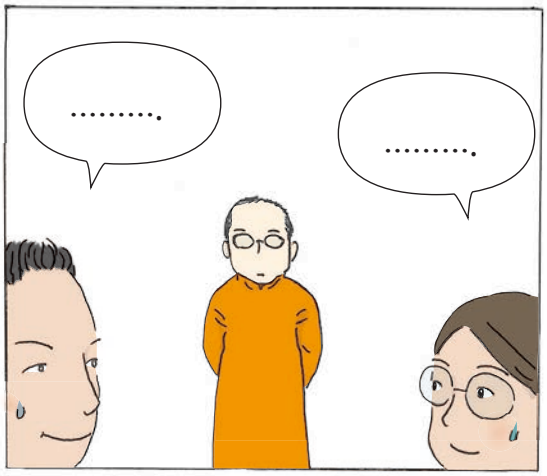

This construction site is so big.
It is spectacular, isn't it?


I wonder if this photo is good enough for a collage about hillside work.
Yes, I think it is. Thank you for helping me with the data.


Here are some more pictures. All these were taken at construction sites in Japan.
Wow! Are all these photos from real construction site of hillside work?
Yes. Some of the construction site are small scale though.


What happened? Do the photos have some problem?
.....


I read an article in an Indian newspaper whose title was "Trees and plants prevent landslides". If Japanese erosion control works utilize concrete instead of greenery, and it is different from what I read in the newspaper.
Ah, it is because...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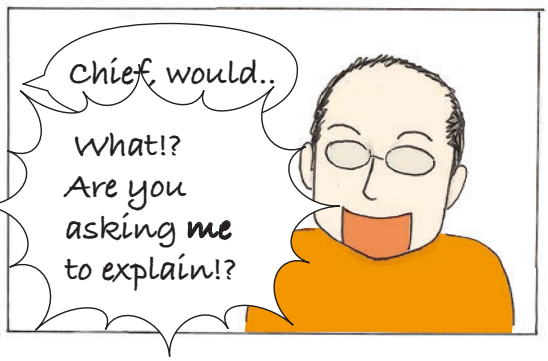
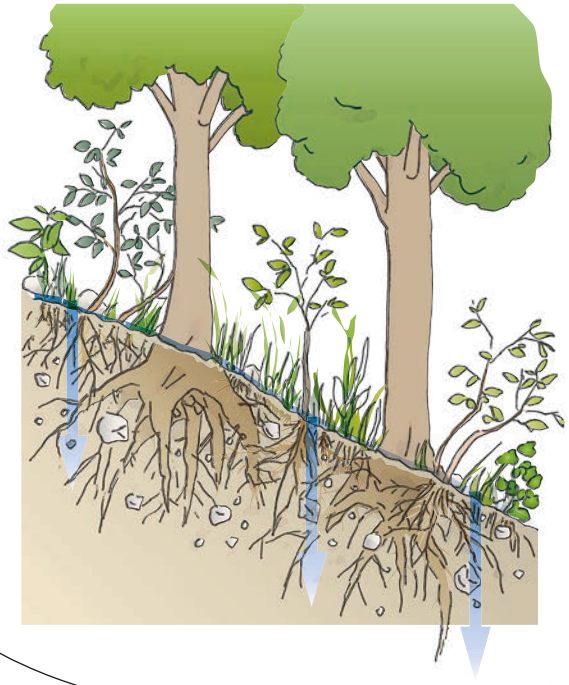

Chief, would..
What!? Are you asking me to explain!?

I was seeking for the chance to explain about for hillside works after I explained about torrent works last time! I will explain even though I'm busy! And,because I' m not mean, I will give you chance to explain with me!

T, Thank you...

I'll come to the point, but, do you know how "greens prevent land slides" as you mentioned just now?

Not exactly...



If the ground is covered with plants, it is like wearing clothes. When it rains, the amount of rain water that runs over the land and the amount of the soil eroded by water are reduced compared to bare land. In erosion control terms, surface erosion is reduced.
Also, plants promote the creation of an ecosystem that creates small gaps in the soil and covers the soil surface with litter thanks to its natural activities. Surface water will easily penetrate into this sponge-like soil and, consequently, the amount of surface water will be reduced.
Further more, plants' root will intertwine together to hold the soil together, and this makes the slope stronger.
We can say that the slope is covered with a green net.

I see...

While landslides are being prevented with this green net, it stays in balance, and disasters will not frequently occur. But...

Heavy rain or earthquakes beyond expectation, land development, road construction, overgrazing and other factors can upset the balance and it can sometimes cause disasters. We should also know that the condition of the surface layer of the soil has little effect on landslides that occur in the deep layers.

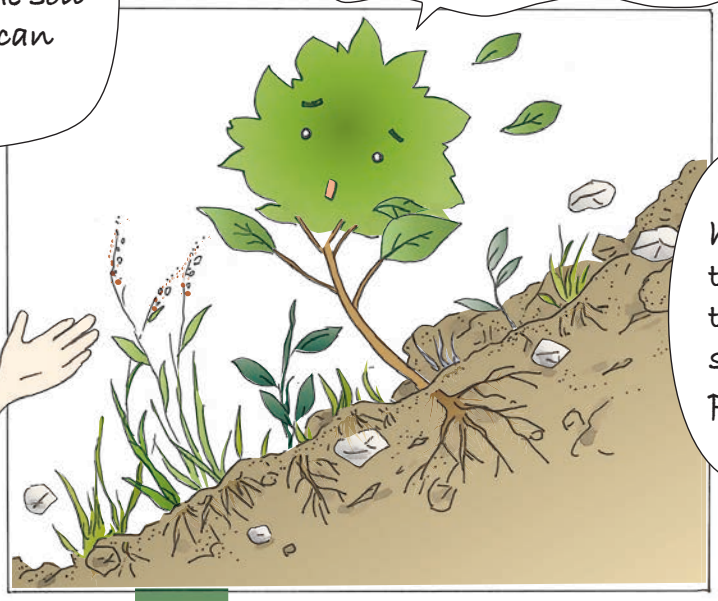
Once a landslide occurs, it will take a considerable number of years before it becomes a natural forest and its soil becomes stable.

Hillside works are carried out to help and accelerate the recovery of forest.

Accelerate? You mean like a fertilizer?

Fertilizing the soil is good, but it is more important to make the soil stable so that plants can take root and grow.

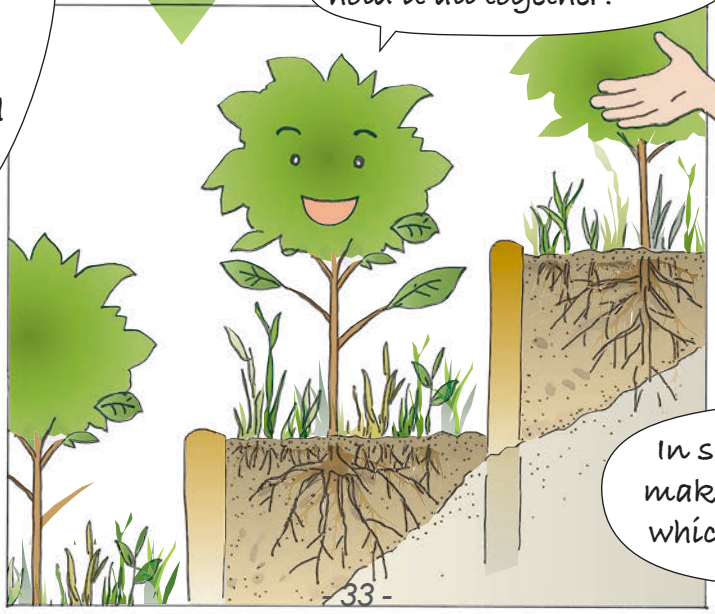
Again, the soil moves, and again, I am uprooted!



With the help of hillside works, we try to stop the movement of the soil, and create suitable conditions for plants to spread their roots wide and deep.

If the soil is unstable and moves every time it rains, it becomes difficult for plants to grow big enough so that their root systems can hold soil together.

My roots can now reach deep into the soil and hold it all together!



In short, hillside works make the foundation on which plants can grow.

Exactly! Foundation works of hillside works is to make sure that plants can grow.

Hillside works are mainly of two types. These are
1. **Foundation works**
2. **Planting works**

I see.

One of the foundation works is **Grading work**. It is to remove unstable soil.

©Kinki Chugoku Regional Forest Office

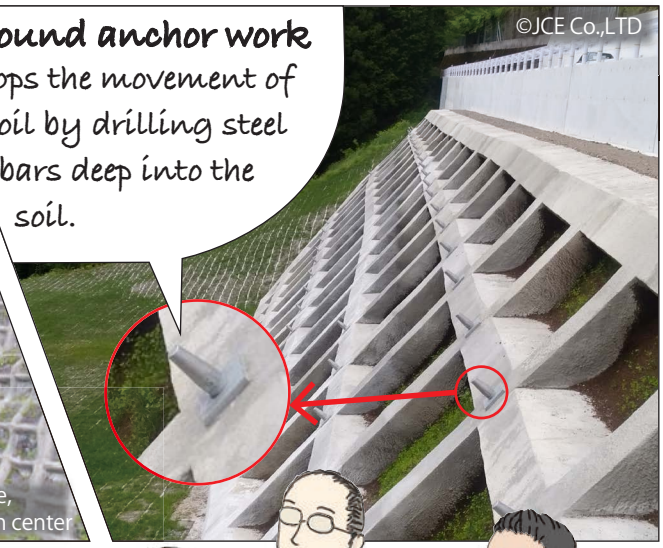
Soil retaining work is to stop the movement of the soil.

© Shingo Kitaura

Controlling water flow and preventing erosion caused by water is **Wather channel works** and **Closed conduit**'s function.

©Kanto Regional Forest Office, Ooigawa Forest Conservation center

Ground anchor work stops the movement of soil by drilling steel bars deep into the soil.



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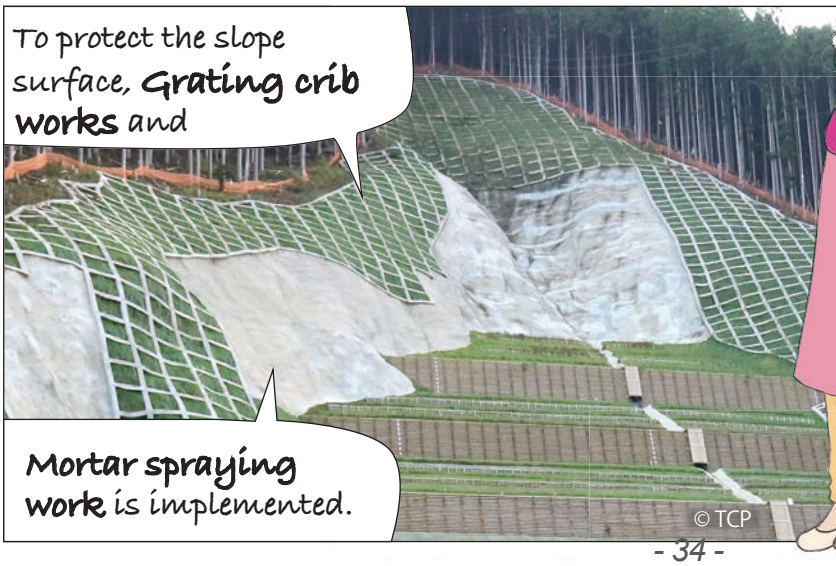
To protect the slope surface, **Grating crib works** and **Mortar spraying work** is implemented.



© TCP

Each type of work has many varieties. We arrange these works keeping in mind the conditions of each site.

In cases where natural recovery of the plants is not expected, **Planting work** is executed alongside the foundation work. This includes planting between revetment works, spraying a mixture of seeds, fertilizer and soil into the spaces between crib works, covering soil with vegetation mats, and so on. To cover devastated land with green fairly quickly, we often use herbs or meadow grass that can grow in barren land for the initial stage of planting work.

Sometimes, without foundation works, seedlings are sprinkled on the site with the help of helicopters.

©Kinki Chugoku Regional Forest Office, Conservation Division

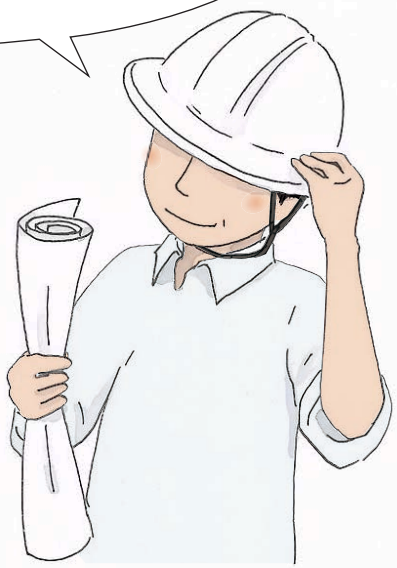
Vegetation mats are applied at many hillside works' sites.

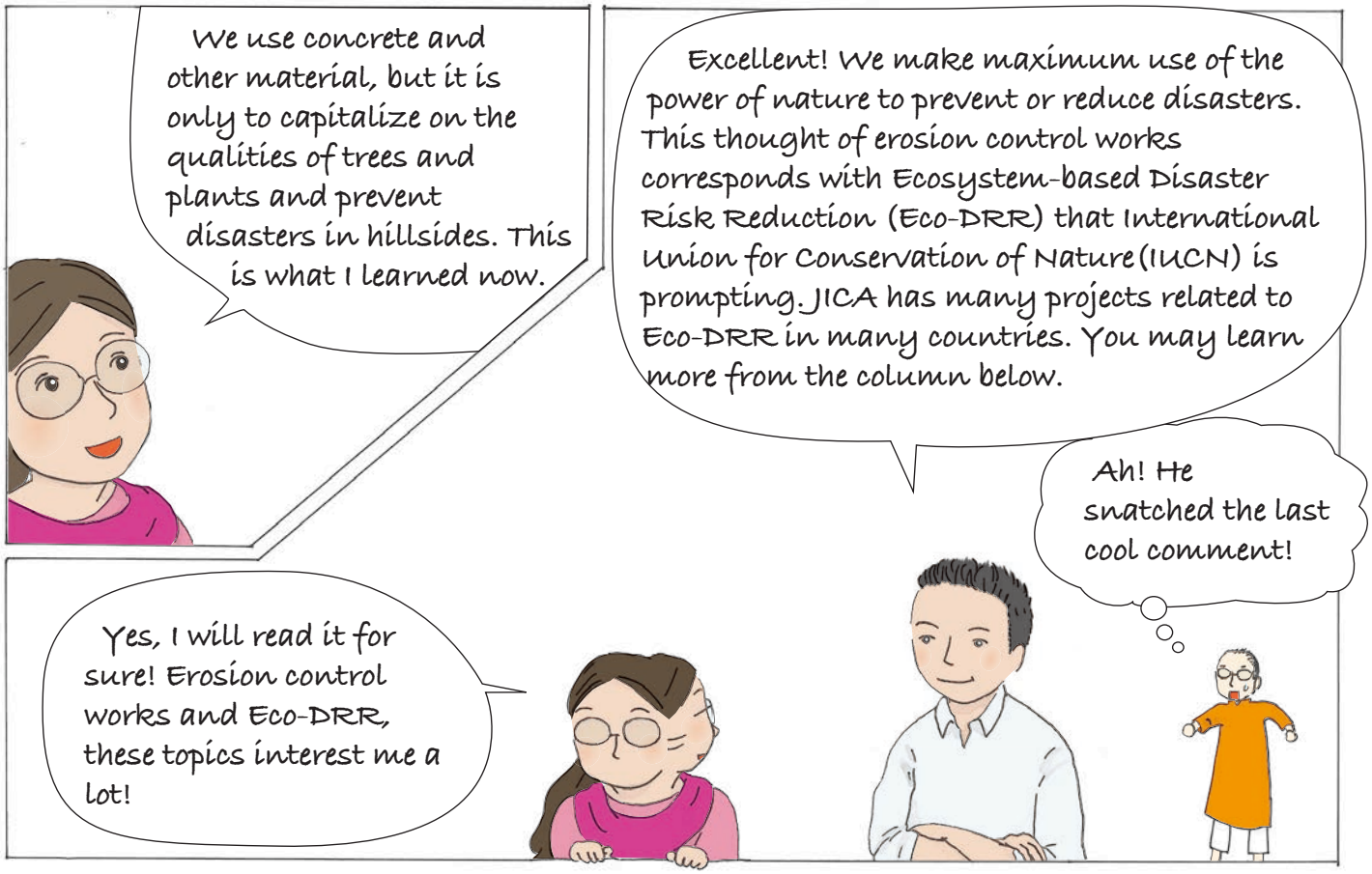
©Kinki Chugoku Regional Forest Office

The larger the size of the disaster site, the bigger the construction size, and the longer the duration. Although large-scale hillside works initially tends to seem like it is covering the land with concrete, you notice the forest cover, which prevents landslide disasters, on the slope decades after the construction.

©Kinki Chugoku Regional Forest Office

There is another technique called Ground reinforcing work that can be implemented in an existing forest.





What is Eco-DRR ?

Eco-DRR is an abbreviation for Ecosystem-based Disaster Risk Reduction referring, to disaster prevention by making use of the ecosystem

Living organisms together with their environment such as forests, coral reefs and wetlands, are called ecosystem. These ecosystems naturally have an ability to prevent and mitigate natural disasters. For example, in forests, fallen leaves and low-growing plants prevent soil erosion. Deep fastened roots of trees play a role in stopping a landslide. Soil adjusts the amount of water flowing in a river by containing rainfall inside and mitigates its flooding. In addition to the function of disaster risk reduction, forests have roles such as to supply timber, firewood, water etc. , To conserve biodiversity, and to absorb greenhouse gases that are the result of global warming.

Eco-DRR performs disaster management by utilizing the functions of ecosystems, and has attracted worldwide attention in recent years, resulting in the approach to disaster prevention and reduction based on ecosystem, which was recommended during the meeting of the Conference of the Parties to the convention on Biological Diversity (CBD-COP12).

JICA has supported projects that focus on the conservation of the forest ecosystem and its effects against disasters in developing countries around the world. In Chile, for example, a Technical Cooperation Project of Erosion Control and Afforestation Project, was implemented from 1993 to transfer *Chisan* (forest conservation) technologies as mountainous disaster counter-measures and has disseminated the technologies transferred across other Latin American countries until now. Also in China, JICA supported to restate forests with the introduction of *Chisan* techniques in Sichuan Province, that has served as the driving force for forest area recovery in China and throughout Asia until now. Recently, in consideration of the growing interest in Eco-DRR in the world, JICA has launched a " Project on Capacity Building for Eco-DRR through Sustainable Forest Management in Macedonia".

JICA will strengthen its efforts towards one of its strategic objectives : "Ecosystem (including forest)-based disaster risk reduction" in future also.

Photo © Forest and Natural Environment Group, Global Environment Department, Japan International Cooperation Agency (JICA)

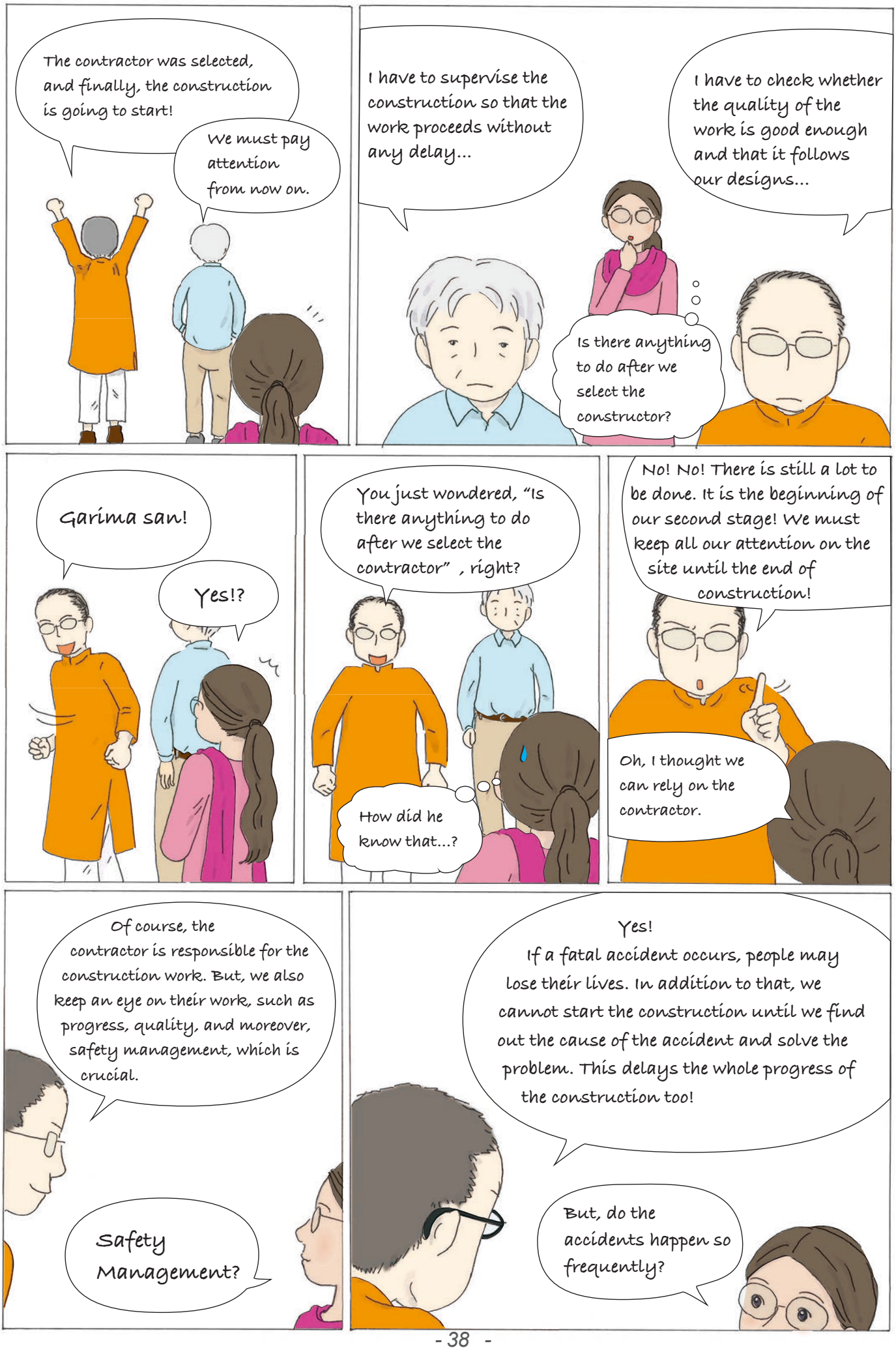
The restoration progresses with JICA cooperation project at Sichuan Province In China

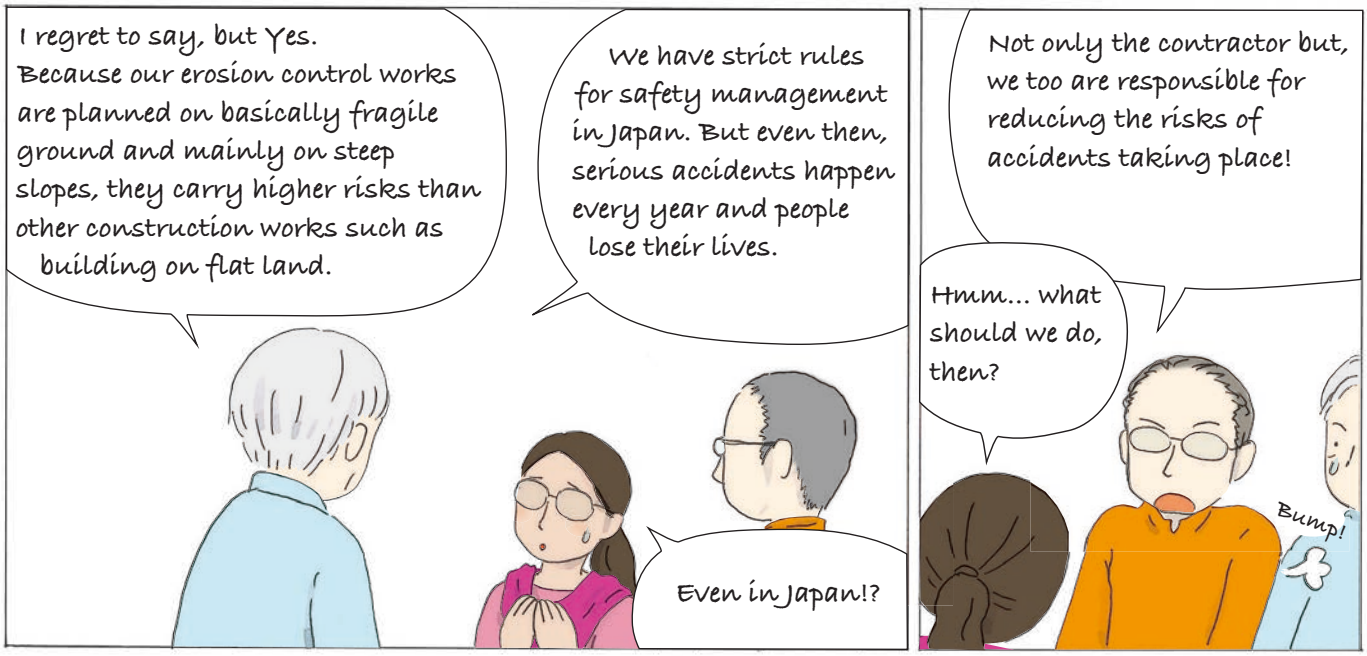
At the time when the project started

Execution of erosion control work

Few years after the construction completed

7. Safety management


The contractor was selected, and finally, the construction is going to start!
We must pay attention from now on.
I have to supervise the construction so that the work proceeds without any delay...
I have to check whether the quality of the work is good enough and that it follows our designs...
Is there anything to do after we select the constructor?
Garima san!
Yes!?
You just wondered, "Is there anything to do after we select the contractor" , right?
How did he know that...?
No! No! There is still a lot to be done. It is the beginning of our second stage! We must keep all our attention on the site until the end of construction!
Oh, I thought we can rely on the contractor.
Of course, the contractor is responsible for the construction work. But, we also keep an eye on their work, such as progress, quality, and moreover, safety management, which is crucial.
Safety Management?
Yes!
If a fatal accident occurs, people may lose their lives. In addition to that, we cannot start the construction until we find out the cause of the accident and solve the problem. This delays the whole progress of the construction too!
But, do the accidents happen so frequently?


I regret to say, but Yes. Because our erosion control works are planned on basically fragile ground and mainly on steep slopes, they carry higher risks than other construction works such as building on flat land.
We have strict rules for safety management in Japan. But even then, serious accidents happen every year and people lose their lives.
Even in Japan!?
Not only the contractor but, we too are responsible for reducing the risks of accidents taking place!
Hmm... what should we do, then?
Bump!


First of all, workers should be equipped properly. Outfits like this is out of question at the construction site for erosion control works!
I see such workers a lot in India.
Without helmet ↓
Bare hands →
← Short sleeves
Shorts →
Sandals →
Oh! No!!!
We should change this! You should protect your skin! Wear safety shoes!
Ugh!!!
And helmet! Gloves!
Helmet ↓
Long sleeves →
Gloves →
Long pants →
Safety shoes →
This is the basic outfit of the construction workers!
Phew...
Uh-huh..

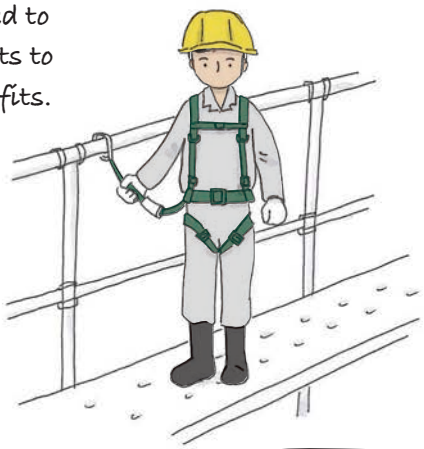
I have to say that it is not enough to put helmets on the head, but wear them properly. Without tightening chin straps, the helmet may slip down if you fall. Wearing it back-to-front is worse than without chin straps!

You should wear your helmet straight, snug, well-adjusted and with chin straps tightened. Otherwise, helmets will not perform their function when it is required - protect your head.

In Japan, the Ministry of Health, Labor and Welfare has standards for helmets, and they recommend the use of certified helmets. According to the standards, helmets have expiration dates from 3 to 5 years after which the material of the helmets starts to deteriorate.

Japan made helmets have inner cushion made with expanded polystyrene!

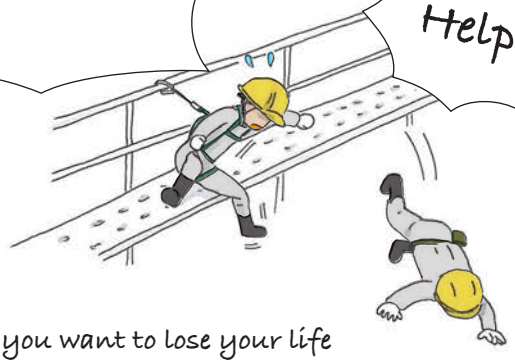
Also,
When people work at a height, they absolutely need to add safety belts to their basic outfits.



But it doesn't seem too comfortable..

Ow!!

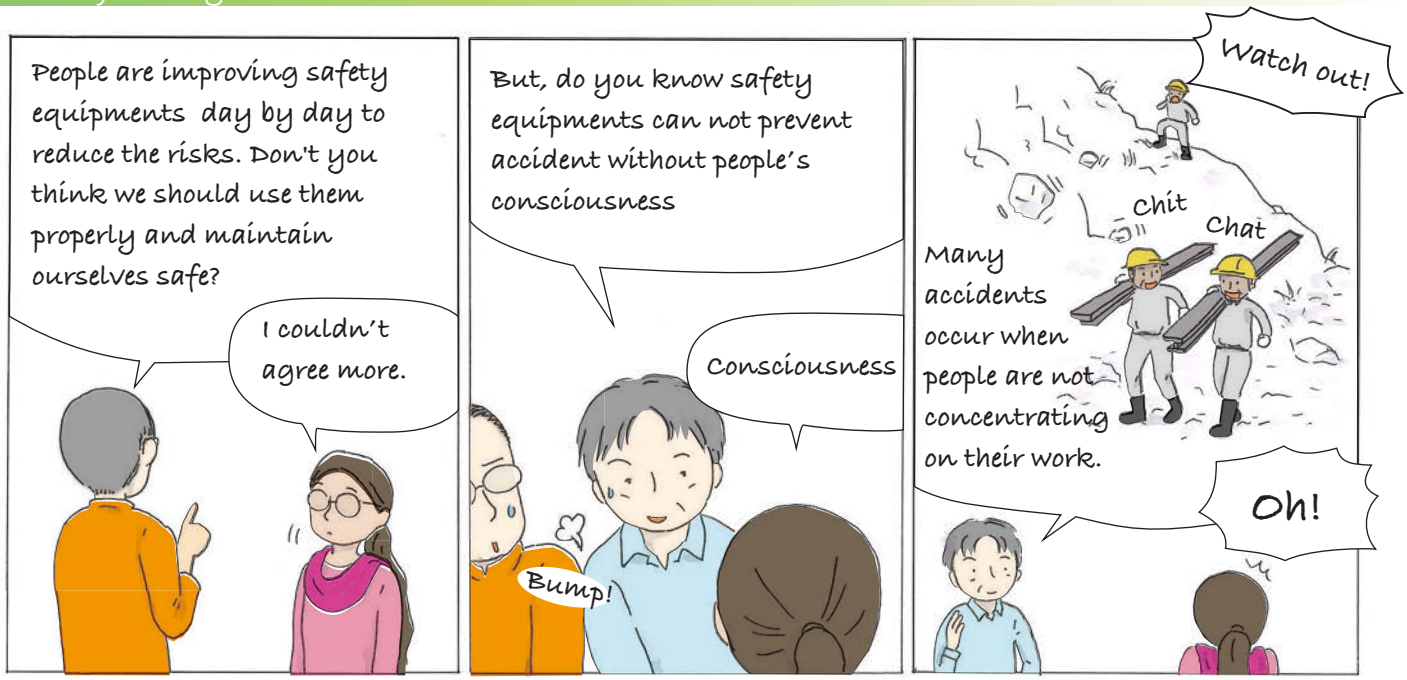
Help!!



Or, do you want to lose your life in case you lose your balance ?

Safety is more important than anything else.

Eek!!

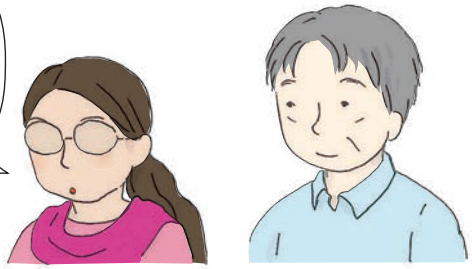


Morning meeting

It is not easy to reduce the accidents caused by carelessness.
In Japan, it is contractors' duty to place persons in charge of safety management who will hold morning meetings or share the risks of expected accidents to reduce the risks.

Adequate rest

How, are these also Contractors' duty beside the construction works?



Sorry for interrupting, but I want to add that we start safety measures before we order the construction.

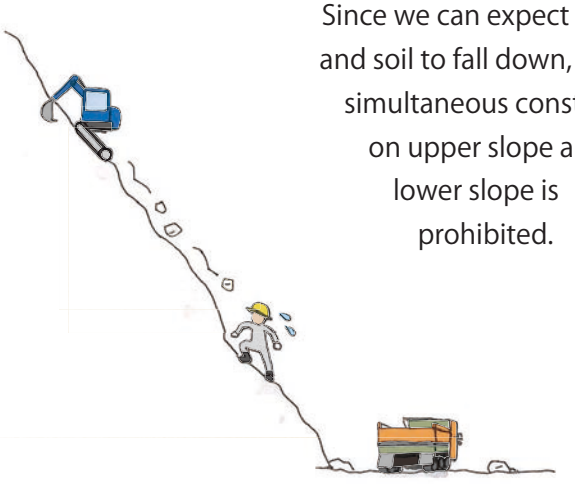
Settlement of information board

Before we order? What does it mean?

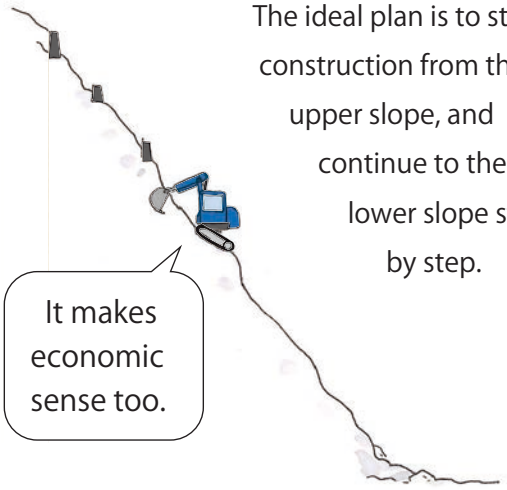
As Osam san explained earlier, erosion control works are carried out on collapsed land or on weak ground, and accidents are expected to occur more frequently here than at other construction sites. If we can foresee accidents and make plans to prevent or reduce the accidents, it is helpful for contractors.

When you make these plans?

Yes.
For example...

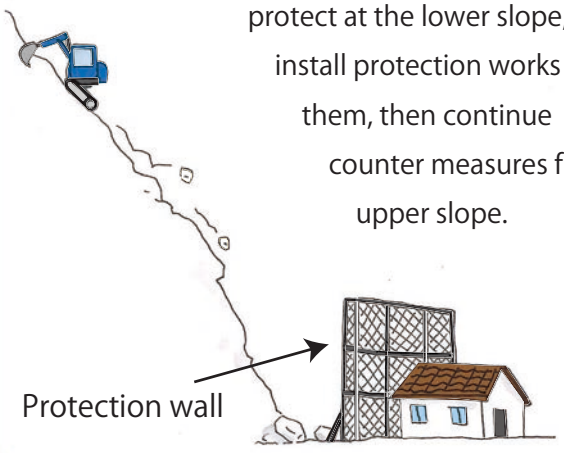


Since we can expect rocks and soil to fall down, simultaneous construction on upper slope and lower slope is prohibited.



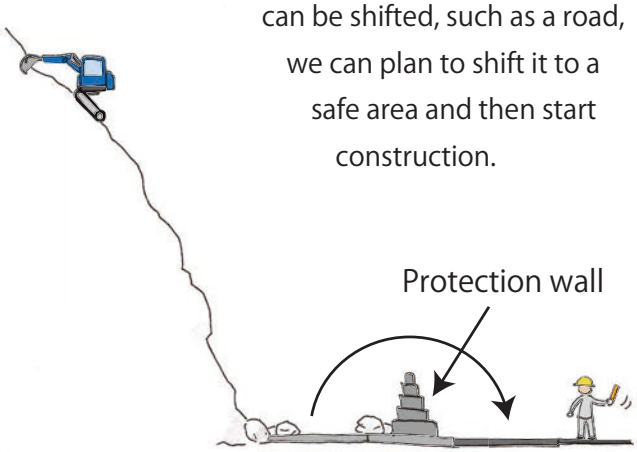
The ideal plan is to start construction from the upper slope, and continue to the lower slope step by step.

It makes economic sense too.



If there is something to protect at the lower slope, we install protection works for them, then continue counter measures from upper slope.

Protection wall



If the object to be protected can be shifted, such as a road, we can plan to shift it to a safe area and then start construction.

Protection wall

This way, we have to consider what to protect, how to proceed the works, and how to manage the material etc. If this is not done, the construction will stop in the middle because the contractor cannot carry on the work safely.

Yeah. To start the construction safely, we have to consider the safety measures from the beginning of the planning.

Yes. We, designers prepare execution plan along with design drawings considering safety measures.
This is the execution drawing of a Project's model site.

It is a site where the upper slope is very fragile, isn't it?

1 To secure the safe passage of the road;
① Current road will be shifted toward the river side.
② A protection wall will be installed to protect new road.

3 To prevent the rocks from falling down on workers, a protection fence will be installed temporarily.

2 To transport material toward the upper slope safely, a monorail will be installed temporarily.

In addition to that, we also planned to close the road at certain period during the construction, and position staff to guide passengers, since we cannot assure that no stone will fall down.

Do we have to do so much?

It is a matter of course.
We cannot order construction that cannot be proceeded safely.
The execution plan includes all these costs, so that bidders can estimate the cost that includes appropriate safety measures.

This is the execution drawing.
Contractor should carry out the works according to this.

No chance to cut in..

It is not a mandate for contractors to follow the execution plan that we prepare. It is sometimes modified according to their techniques, judgment, and experience.

For example, for the protection fence that I mentioned, some of them use net, but others may use a wire net or other material.

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Sometimes, their safety measures are more strict and efficient than our ideas.

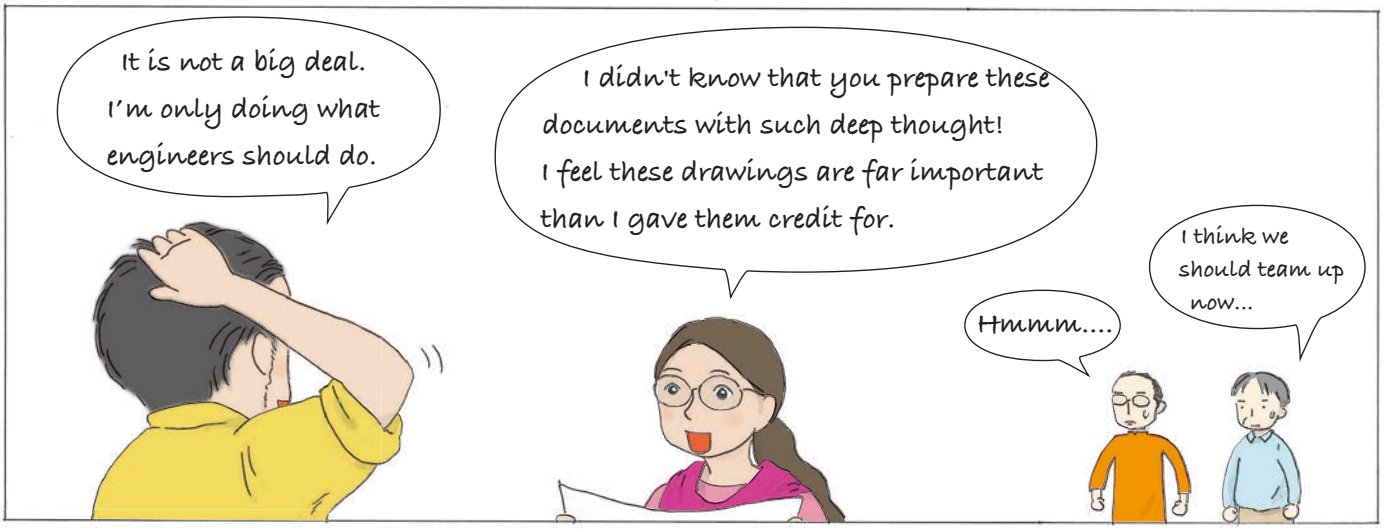
But it seems this may cost a lot.

It is true.
It requires cost and effort.
But safety and human lives should have priority above all else.

to estimate the cost,
and to prepare the execution plan so that the contractors can carry out safety measures within the adequate budget.

For this reason, it is our responsibility to prepare drawings that are based on accurate surveys,

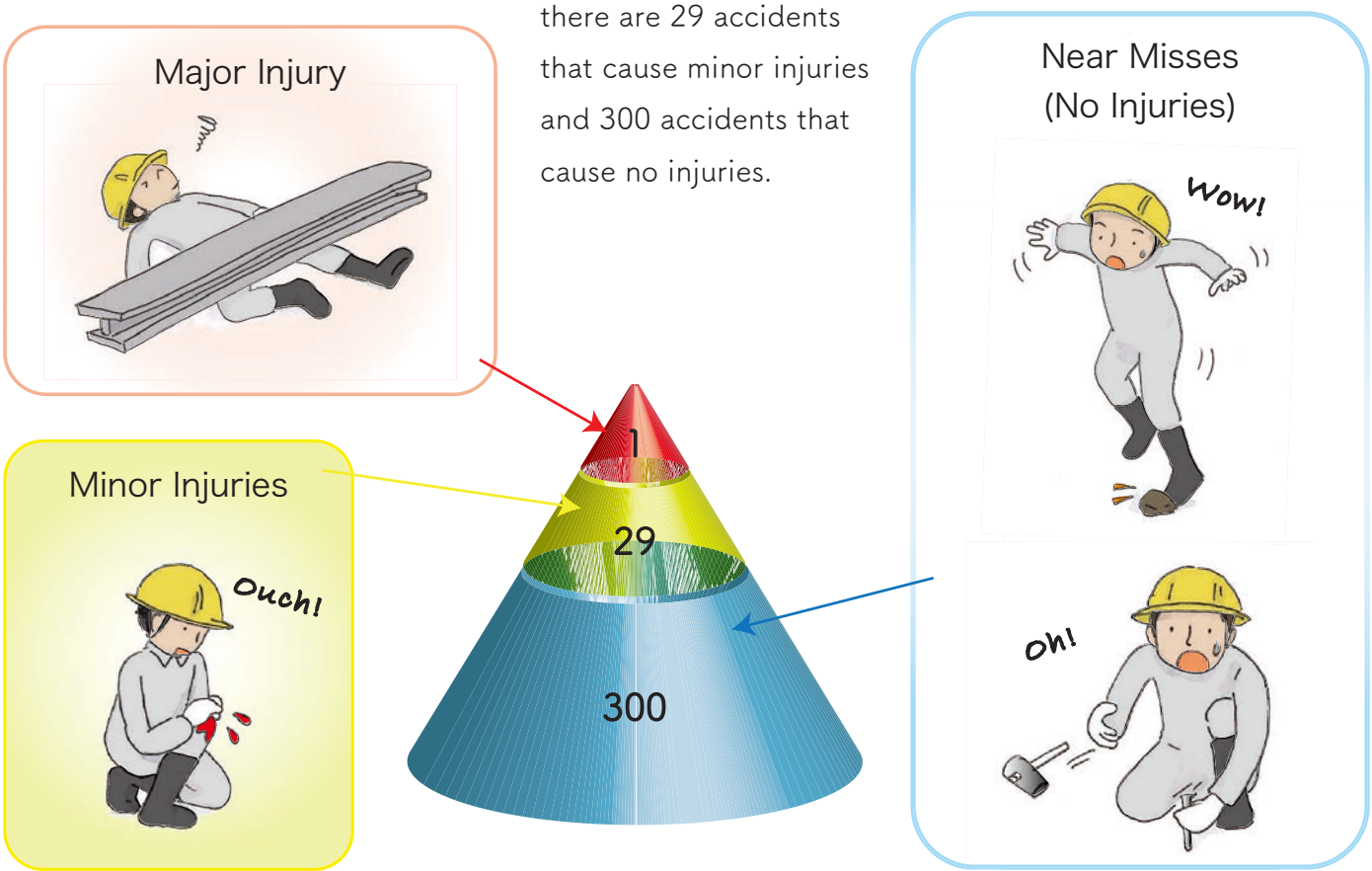
No chance to put in a word..



Heinrich's Law

There are 300 near-misses and 29 minor injuries behind a single major injury.

Heinrich's law was an empirical finding mentioned in the book that Herbert William Heinrich (1886-1962) published in 1931. He was an officer of an insurance company and examined more than five thousand accident cases. He found that before every accident that causes a major injury, there are 29 accidents that cause minor injuries and 300 accidents that cause no injuries.



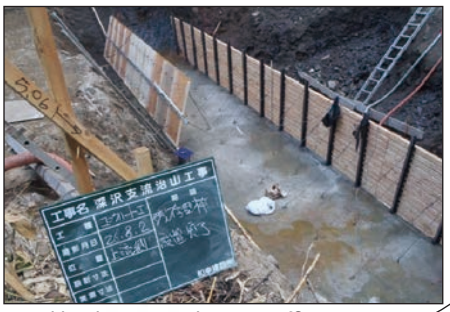
Although Heinrich's law is not an absolute one that predicts that 300 accidents occur before a major injury takes place nor that a major injury will occur after 29 minor injuries, it gives us a caution that there are more risks of major injury at the place where minor injuries or near-misses often take place. The key to reduce the risk is to note near-misses that happen daily and eliminate these causes from both employees and employers side.

8. Supervision and inspection

Points for attention in completing construction as specified in the plan.


It's been 3 months since the construction started. It seems that everything is going well without any accident.
Thanks god for that. However, I cannot say everything is all right...
Oops...
Ring Ring Ring
Hello,
Oh.. Well... That figures. We should find out the counter measure quickly... OK...OK...
I think he received a similar call few days ago too.
Construction schedule will fall behind, but we have no choice. Yeah...
Next day
As per our telephonic conservation, I changed the design to this..
Hmm.. Can you change the design to excavate a little bit deeper?
If you think the depth is not sufficient, OK, I will modify it.
Sorry for making you hurry, but
Let's finalize the modification and start the construction by tomorrow.
No problem, I'll finish immediately.
Was there some problem?
Although we don't have any serious problems or accident, minor troubles occur frequently. For example, we found the base rock is much deeper than we had expected when we started the excavation. Or,
the amount of groundwater was far more than our estimation... Every time we come across such challenges, we need to modify the design and send the changes to the contractor.

Once construction starts, supervisors are actively involved even if there is no trouble. For example, when the contractor completes installing the molding, they have to check whether it follows the design. Also...



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... the supervisor must closely check with the contractor, if the mixture of concrete is the same as one specified in design, if the concrete is poured into molds properly, etc.

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Supervisors keep records all these work and pictures, and they handle troubles that unexpectedly happen like this time.

In this Project, Indian engineers are working as supervisors, but Japanese Experts give them advise or support whenever they need. These issues come to me finally.

trouble Hmm.. Opinion Hmm...

Since I need to reply and give proper opinions to them promptly, I' m busy. I must do this till the end of the construction.

It sounds tough...

Now, I understood why he is less chatty these days...

2 months later...

Ah, you are here ! Garima san, are you doing some urgent work at present?

It is not so urgent, I think. But why?

Because I'm going to the site for inspection. Why don't you come with us and see it?

All items to be inspected are already listed up.

Can I see?

The items are far more than I had imagined.

It has to be. After all, we are here to check if the construction was carried out exactly as specified in our design. And, at the same time, it is an evaluation of our supervisor too.

In case concrete is used for the site, we check the strength of the concrete with the "Schmidt Hammer"

We directly measure the items and check if the size of the items are same as specified in design. Could you measure the angle of the slope with "Slant" ?

OK. It is 45 degrees, as stated in the design.

Measuring from the designated point with "Transit" or other instruments, we check the size and arrangement of objects to check if they are correct.

In case the inspection gives a poor report, the contractor will have to do the construction all over again, and the supervisors will be questioned about their responsibility. Moreover, the payment for the contractor will not be approved.

This is all very strict.

Supervisors understand it well and they supervise the construction with daily checks and minor inspections. All these efforts are done to ensure the works is completed properly by the date of contract. I was relieved to see that this site was well supervised.

Anyway, I'm hungry after walking a lot. Let's eat a talhi meal. My treat.

Wow! You are so kind! I'm actually starving!

When I worked on this Project for the past years, I noticed that [redacted]on engineer, supervisors and [redacted]

[redacted] involved in a single construction work.

Yes. And, we can not leave this site completely even after the construction is done.

I think you saw the name plate installed on the check dam. It shows our responsibility to the site in future too.

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I see.
Our work and responsibility will continue until the site is covered with greenery and returns to becoming a forest in the future, when people settled downstream can live without been threatened with landslides.

Yesss !!

Exactly!! I' m now absolutely confident that you learned the spirit of erosion control work! I have dome my work!
Also, I could talk from the beginning to the end this time for the first time!

Now I can return to Japan without any regrets!

Thank you everyone ! Take care !

Yow!

Thump!

Chief! You must be in a hurry to check the designs of the next site! The project will go on as long as there are landslides!!

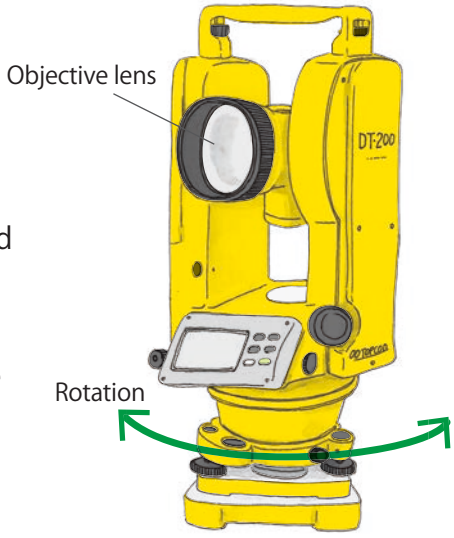
We are still on the way to continuing erosion control works

Chisan tools
Tools for Inspection

Many kinds of instruments are used for inspection for erosion control works. Most times, these are used not only for inspection but are also used by supervisors during their routine work when construction work is being carried out. Supervisors and inspectors have to be able to use these instruments correctly and record correct results.

【Theodolite (Transit)】

Theodolite (Transit) is a survey equipment that measures bearings. After settling the base of the equipment on level ground, you aim objective lens rotating on the upper part of the instrument and read the scales or figures. The vertical angle can be measured by changing the angle of the objective lens.
In Japan, using models that have an additional function to measure the distance with light waves are becoming increasingly popular.



【Schmidt hammer】

Schmidt hammer is a device that measures compressive strength of concrete or other solid materials. It measures the rebound value after beating the object with its spring force. This method is non-destructive and estimates the strength of objects without changing their current shape. Because the data might have discrepancies, it is recommended that the average value from more than 20 times of readings on a single object be obtained.

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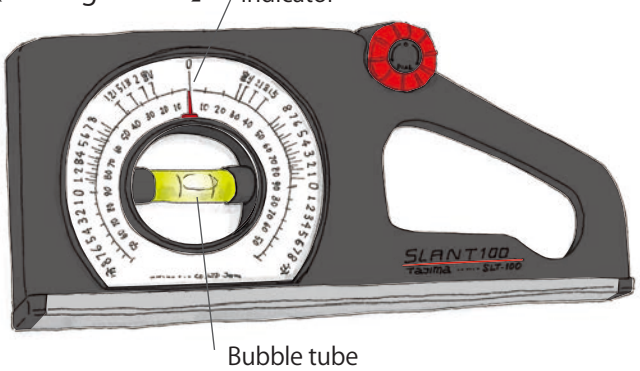
20~25 of rebound number is taken at each point of testing and an average value of the readings is taken as rebound index.

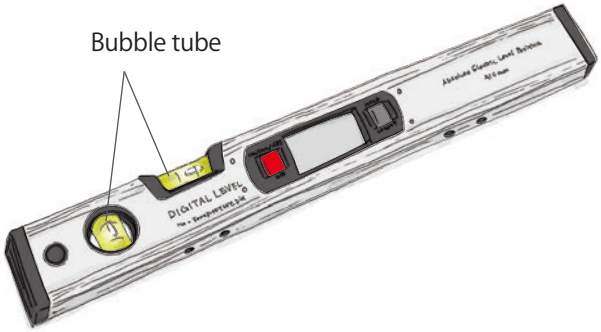
【Inclinometer】

Inclinometer is used to measure the angle of slopes or surface of objects using bubble tube or circular protractor. In Japan, it is common to use analog inclinometer where inclination is visible, whereas, the digital inclinometer is common in India. While measuring angles, you place the inclinometer directly on the slope that you need to measure, and read the scales or figures.

【Analog model】



【Digital model】



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