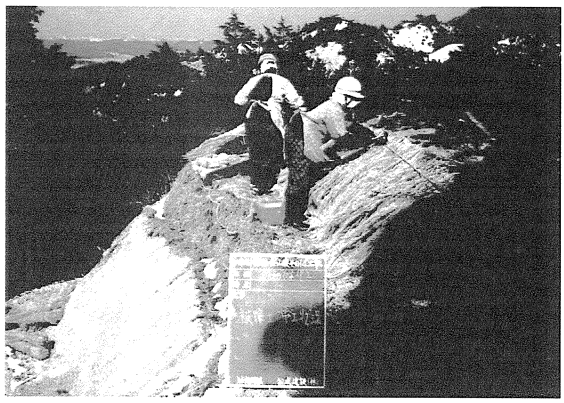
3. Selecting an effective method

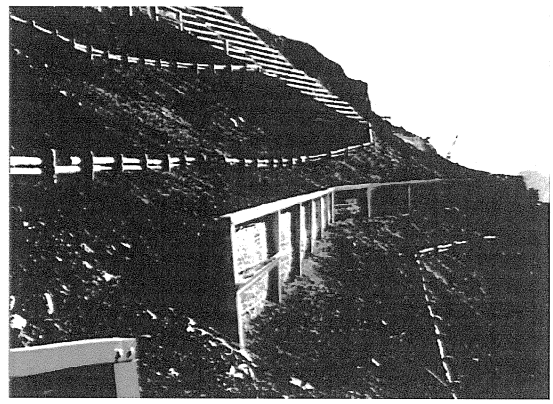
3.1 To restore greenery on hillside slopes

(14) The study is based on a work method that can guarantee flat land on terraces with a slope gradient of 10° or less.

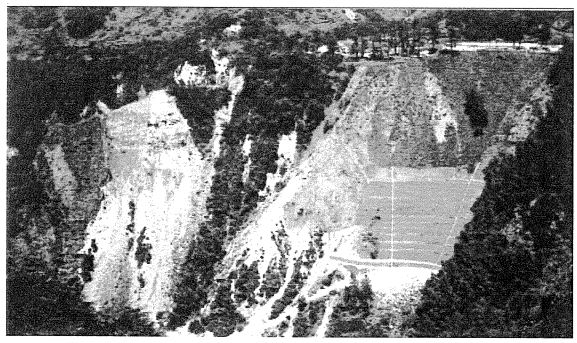
- To guarantee the foundation for the growth of vegetation, it is important to create the foundation in the form of terraces along the contour lines of the hillside foundation work to create flat surfaces with a slope gradient of 10° or less. This increases the certainty of the formation of a future forest. But if it is difficult to guarantee flat parts on the top of the slope for example, stabilizing it with net work etc. will be unavoidable, and work methods suited to circumstances are selected.



Tanakami hillside work: Initially slope surface treatment between seedling terracing work was not done, but because the seedling terracing work was buried by sediment, straw covering was done beginning in 1960. This stabilized of the slope and the trees grew normally.

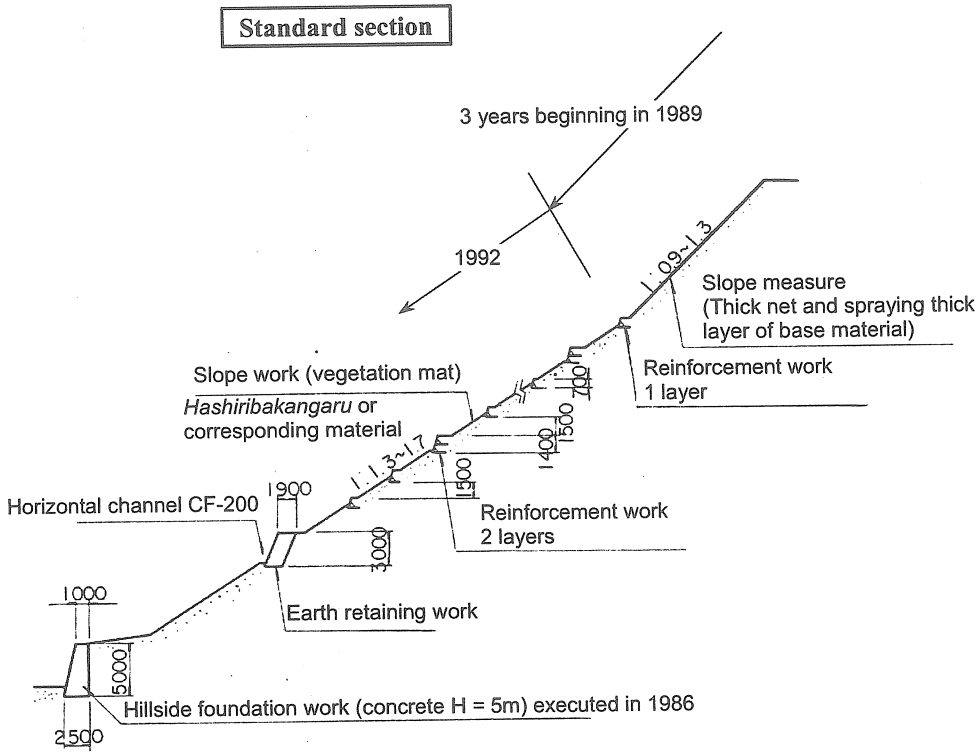


Onagi hillside work: on the earth retaining work,scoria that is easily moved by the wind etc. was firmly solidified.



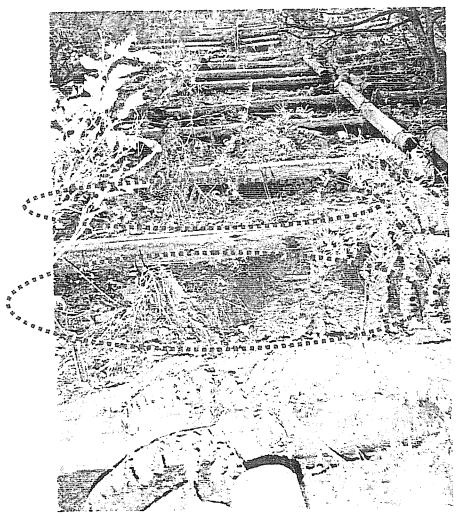
Mizutani hillside work: hillside foundation works are selected according to the slope gradient.
Gentle slope: earth returning work + vegetation mat
Steep slope: net work + spraying a thick layer of base material

Standard section

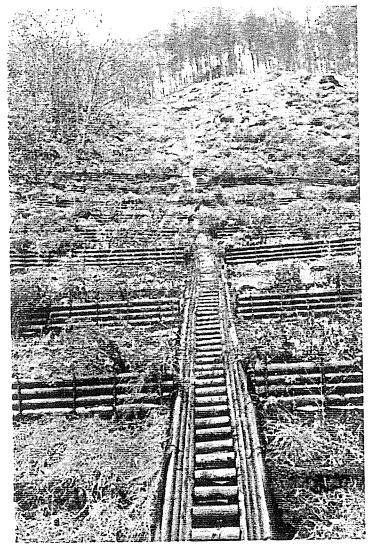


(15) The topography is accurately assessed to perform dependable treatment of the surface water and the underground flow on the slope.

- In order to more firmly establish the greenery, it is important to accurately assess the topography to treat the surface water and the underground flow on the slope.



Tsuchiyabara hillside work: The surface flow on the slope scours the ground under the thinned material so that is above the ground, allowing the sediment to move. This delays the recovery of the vegetation.
*** Countermeasures are now completed.**



Nomugi Pass hillside work: As in the case of the Tsuchiyabara hillside work, thinned material is used to make the foundation work, but the surface and underground water flows are appropriately performed so that no scouring can be seen.

(16) This a soil dressing work method with extremely good vegetation growth base improvement effects.

- If the soil particle diameter on the site of the base for the vegetation is too coarse or dense, the water content falls, encouraging the fall of voids, creating a shortage of water or air needed for the growth of vegetation. Soil dressing is an improvement method that restores the appropriate particle diameter constituency, and the more soil dressing provided, the more effective it is. But it is necessary to consider the importance of the land and the cost of using the method to decide to use it.

(17) Considering the years of service until the vegetation is firmly established and the strength of the hillside foundation work materials.

- When thinned wood and bags of soil are used to execute hillside work, their service life until the vegetation is firmly established is considered.

Nomugi Pass hillside work: example of the use of wood obtained by thinning trees

Tsuchiyabara hillside work: Use of bags of soil Professor Ote studied the use of soil cement as material to fill soil bags in the Kyoto University Forest.

(18) Basically fertilizer is not used.

- While fertilizer does speed maturation, it creates vegetation with low resistance, and other damage is caused by the stress on the vegetation when fertilization is stopped.
- If fertilizer is used, the following points should be considered.
  - It should be organic material such as straw that provides gradual and gentle effects.
  - To guarantee voids in the soil (improving the physical properties of the soil) the use of bark fertilizer (wood chips) or other material with effects other than fertilization should be considered.

(19) Hill side revegetation work is done considering the growing period.

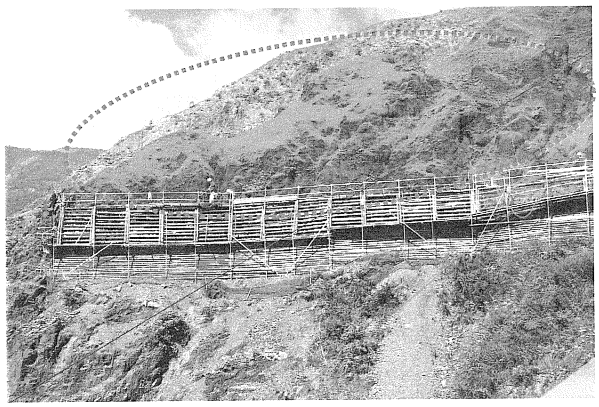
- Revegetation work should be done considering the period when newly introduced species grow (the two normal growing periods of vegetation are spring (March to June) and autumn (September to October)).

(20) Planting (seeding) must be performed in three stages, collecting → storing → sowing based on a thorough knowledge of the individual properties of the seeds themselves.

- Planting (seeding) must be performed in three stages, collecting → storing → sowing based on a thorough knowledge of the individual properties of the seeds themselves. Simple collection and simple seeding can be done for all kinds of seeds, but to perform simple seed collection, the maturating period of the seeds is clarified, and to perform simple seeding, the basic steps are removing the raw humus from the ground surface, sowing the seeds, and placing enough soil to cover the surfaces of the seeds.

(21) Basically revegetation of rock ground is not done.

- Basically this is not done, because it often creates unnatural scenery and there are few cases where it is necessary to carry out emergency measures to control sediment runoff.



Matsuki hillside work: example of rock revegetation
Rock revegetation is done as a measure to prevent surface erosion of weathered rock under harsh climatic conditions such as freezing and cold wind damage during the winter.
As a measure to prevent falling rocks during the work on the lower slope, net work is often done on exposed rock near the top of the slope, but simple revegetation is avoided whenever possible.

3.2 To encourage the transition to the target forest

(22) Problems such as delayed transition of species by vegetation with excessive fecundity.

- The following are conditions for the early introduction species when the first priority is early

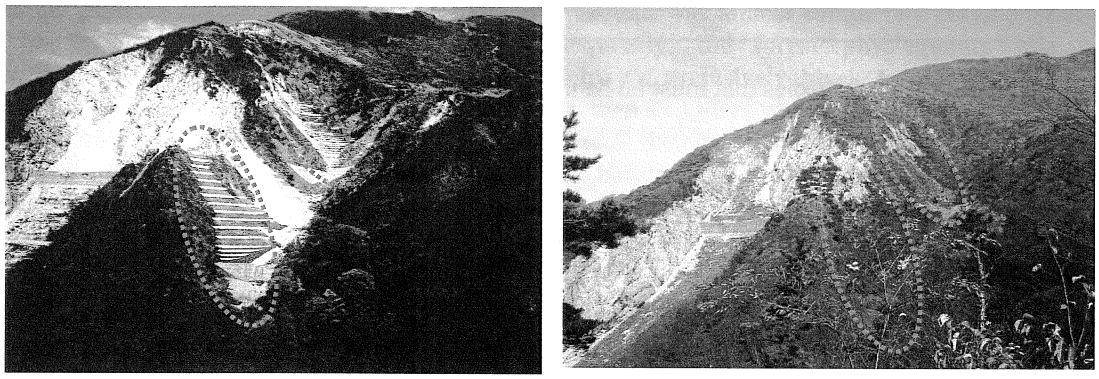
revegetation.

- From the start of its growth, it is highly adaptable to direct sunlight, drying, freezing and other climatic conditions and to the soil texture.
- There are many seeds from stock trees and they are widely available.
- It grows quickly.

But carrying out improvements looking ahead to the formation of the target forest must be done carefully, because the high fecundity (competitiveness) of the early introduction species may cause problems such as delayed transition.

- Coniferous trees such as pine and Japanese red cedar are often used because of their high fecundity, but their needles do not decompose easily so that soil does not form for a long time. And the needles that are not decomposed cover the ground, preventing the invasion of other species, also delaying the transition.

Tanakamiyama hillside work: A clear cutting experiment was done to simulate a case where all pines dried up leaving the land almost bare, but because there were no stock trees, vegetation did not invade even though the light conditions were good. Later broad-leaved trees were planted at the same location, but they did not grow. It is hypothesized that this failure occurred because the pine needles were deposited in a lower layer without decomposing, so that soil is not formed.



Otomikawa hillside work: Example of the impact of early introduction planting work over a long period
A long period of time passed without any transition from the transplanted trees that were introduced early. Then 50 years after the execution, the originally planted trees had declined and completely disappeared, allowing a low forest to form by natural invasion.

(23) To introduce early introduction species, it is necessary to give careful thought to the constituent species when the transition to the target forest has been completed.

- The early introduction species should be selected by giving careful thought to the constituent species when the transition to the target forest has been completed.
  - From the start of the execution, the pioneer vegetation and the next generation vegetation should be mixed.
  - The initial introduction species are selected according to local conditions with reference to nearby transition processes without necessarily being limited to the normal vegetation transition process (annual grasses → perennial grasses → low trees → high trees).
  - Native species (if possible, locally produced species) should be used whenever possible.

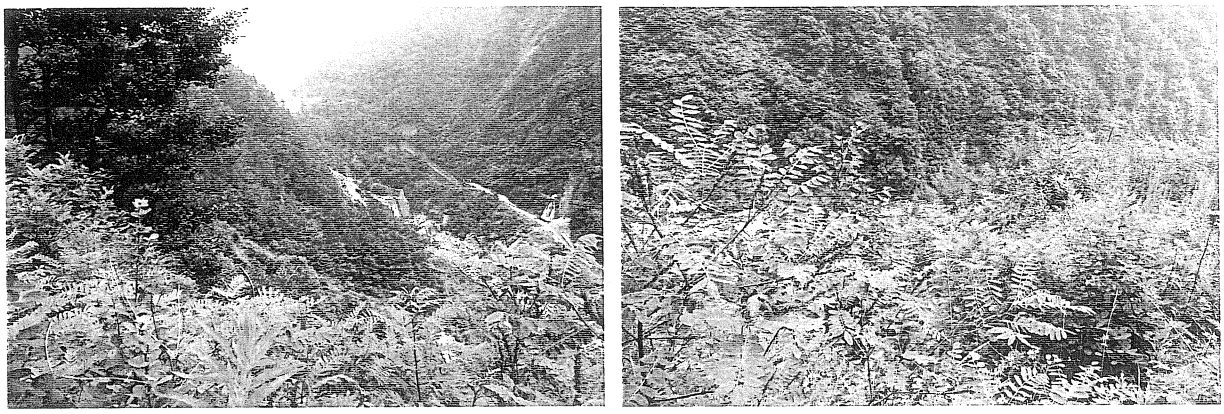
(24) Japanese alder (*Alnus japonica (thunb.) steud*) or firma alder (*alnus firma*) that have nitrogen fixing bacteria that help the growth of vegetation are selected as early introduction species.

- Selecting species with nitrogen fixing bacteria effectively establishes vegetation. Until now, legume vegetation that includes black locust (*Robinia pseudo-acacia*) and false indigo (*Amorpha fruticosa*) has been widely used. However, considering later vegetation transition, these should be avoided as much as possible, and at the same time Japanese alder (*Alnus japonica (thunb.) steud*) or firma alder (*alnus firma*) that have nitrogen fixing bacterial may be selected.

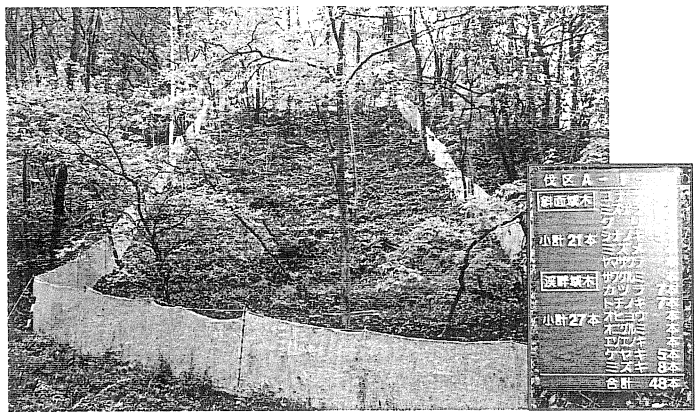
(25) Species that must be handled carefully are legume vegetation that include false indigo (*Amorpha fruticosa*) and black locust (*Robinia pseudo-acacia*), and exotic gramineous vegetation typified by Kentucky 31 fescue.

- The followng are species that must be handled carefully when they are introduced.
  - If too many seeds of *Lespedeza* vegetation such as false indigo (*Amorpha fruticosa*) are sowed, their roots are thickly concentrated near the surface, delaying the transition by preventing the invasion of other vegetation.
  - Because *Lespedeza* vegetation such as false indigo (*Amorpha fruticosa*) have nitrogen fixing bacteria, if too much is spread, the soil acquires excessive nitrogen. This results in the ground being dominated by gramineous vegetation or bamboo grass that thrive on nitrogen, delaying the transition by preventing the invasion of other vegetation.
  - The fecundity of black locust (*Robinia pseudo-acacia*) is extremely high, delaying transition by preventing the invasion of other vegetation. And because its roots are shallow so that it is easily toppled, it should not be selected because it is not suitable for slope stabilization.
  - Exotic grass vegetation typified by Kentucky 31 fescue requires a large quantity of fertilizer, and when the fertilizer is exhausted, it dries up. Another reason it should not be selected is that

because its color is unnaturally blue when it is flourishing, it often seems in disharmony with the surrounding scenery.



Upper slope of the Mizutani hillside work: overall luxuriant growths of Chinese lespedeza (*Lespedeza juncea*), bush clover (*Lespedeza bicolor*), and false indigo (*Amorpha fruticosa*) introduced as early introduction species have appeared more than 10 years after execution, but no conspicuous transition can be seen.



Ushibushi hillside work: Case of problems caused by black locust (Robinia pseudo-acacia)
Initially, red pine, himeyashabushi alder (Alnus pendula matsumura), and black locust (Robinia pseudo-acacia) were planted, but later the ground was almost completely taken over by black locust (Robinia pseudo-acacia). Consequently, the forest physiognomy was transformed in order to prevent disasters caused by an exclusively black locust (Robinia pseudo-acacia) forest and resolve ecological problems, then measures were taken to encourage a native species forest consisting mainly of the exotic species, konara (Quercus serrata Thunb. ex. Murray), oak (Quercus crispula Blume), Japanese chestnut (Castanea crenata), Japanese linden (Tilia japonica), sawagurumi (Pterocarya rhoifolia), and Japanese katsura tree (Cercidiphyllum japonicum).