Japanese experts, thus confirming the importance of technical cooperation in their implementation and operation.

It must also be added that no formal creation of an organization following the unification of North and South has been confirmed yet, because the event was so recent.

(4) Requested Facilities and Equipment

1) Results of a survey on the slopes at the Taiz Subcenter site

The problem is seen to be as follows:

① Survey of changing topography

i) Slope shoulders

The slope shoulders are paved with stones, which crack or fall as the soil underneath moves. In some areas, voids were found to have formed between settled soil and the stones.

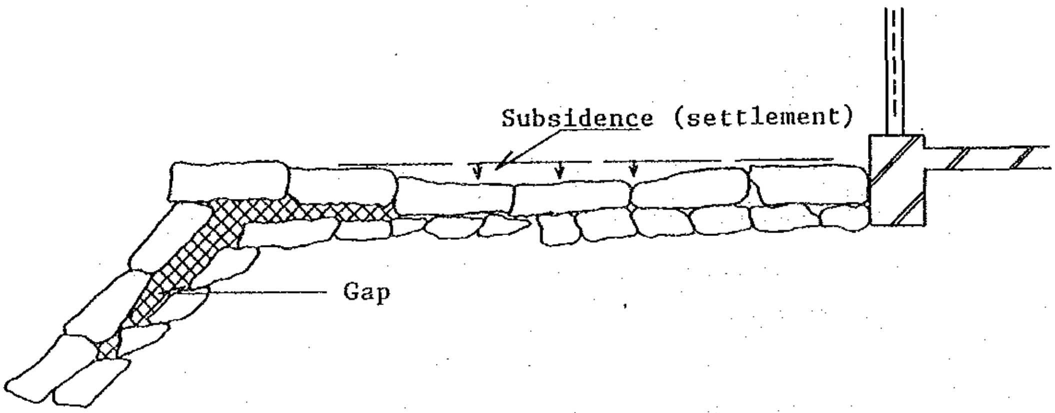


Fig. 3 Current Status of Slope Shoulders

ii) Slope

A buckling effect occurs between the stones laid along the filled slope due to decrease in adhesion between the stones and filling soil and the affect of the stones weight. This happens when rainwater penetrates into a slope with sufficiently compacted soil, which contracts upon drying out.

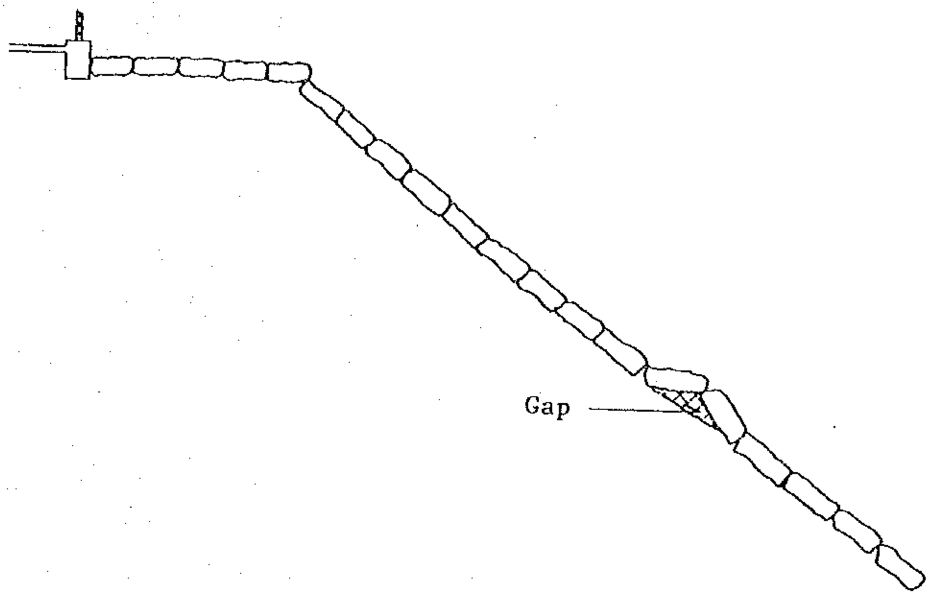


Fig. 4 Current Status of Slope

iii) Slope Ridge

The ridge remains unfinished, and is littered with debris and stones. However, nothing having an effect on the present state of collapse was found. As illustrated below however, cracks were found where the floodway meets the water channel at the bottom. This can also be assumed to be due to relative movement of the floodway, so the ground can be assumed to be of poor quality.

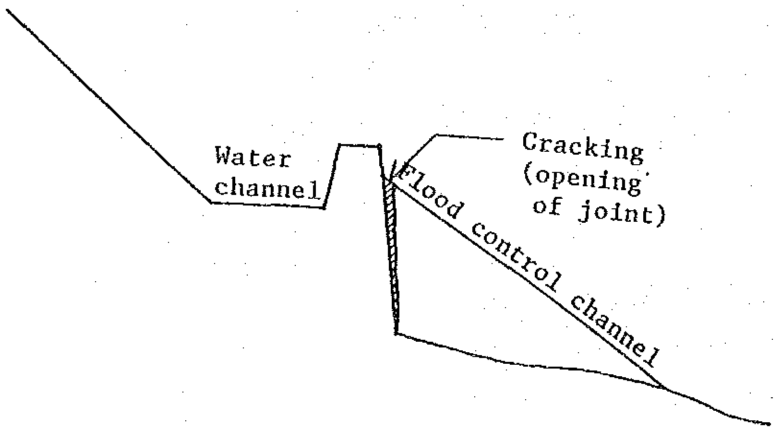


Fig. 5 Current Status of Slope Ridge

iv) Overall slope movement

The filled slope is covered with stones, and the point where the stones abut the slope shear was detected. However, this did not appear to have played a role in starting the collapse.

The stability of the slope in its existing condition is discussed in Appendix 7.

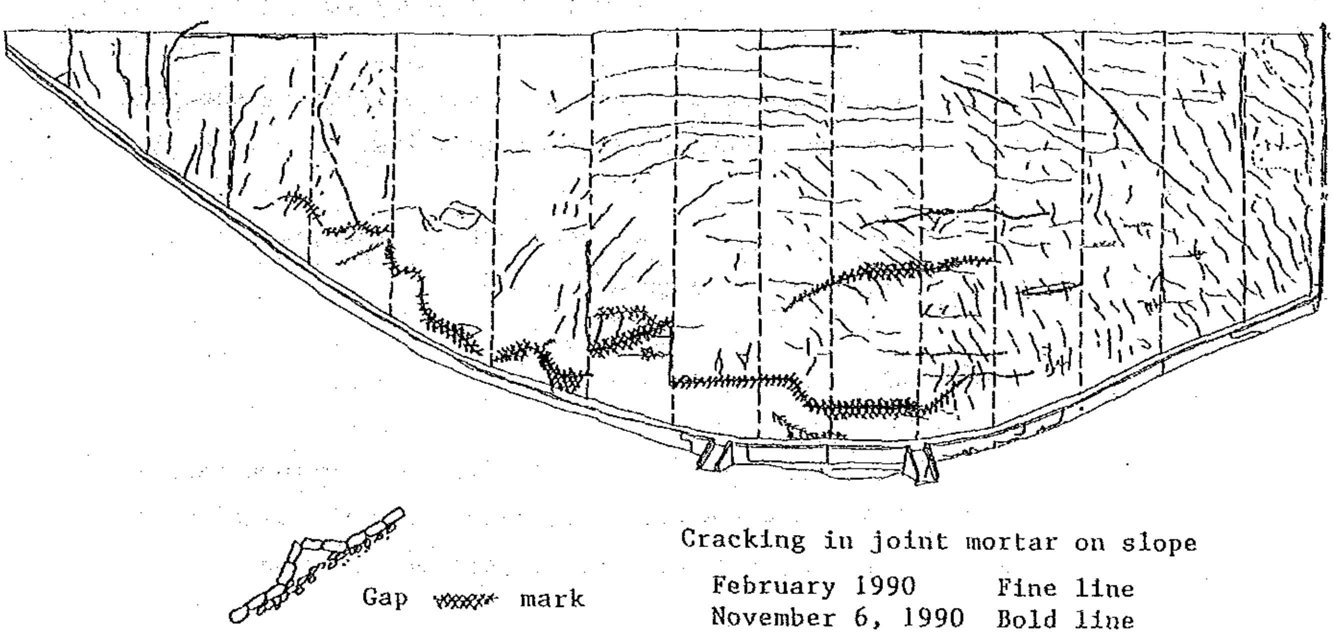


Fig. 6 Current Status of Overall Slope

② Sounding survey using the Swedish method

The rest measurements at six points within the slope are shown in the Table-6 . The relationship between the value sounded by the Swedish method (Nsw) and the N-value can be obtained from the following formula (method used by Waseda and others):

$$N = 2 + 0.067\ Nsw \text{ (gravel, sand, and sandy soil)}$$

Substituting the survey results, Nsw = 0 to 35, into this formula gives the following:

$$N = 2 + 0.067 \times (0 \text{ to } 35) = 2 \text{ to } 4$$

The survey of the building's foundations yielded Nsw = 0 to 25 at the worst settlement site, giving the following N-values:

$$N = 2 + 0.067 \times (0 \text{ to } 25) = 2 \text{ to } 4$$

All these results are N-values of 2 to 4, showing that the density is relatively low.

The details of the Swedish type sounding test are discussed in Appendix 6.

③ Site density test

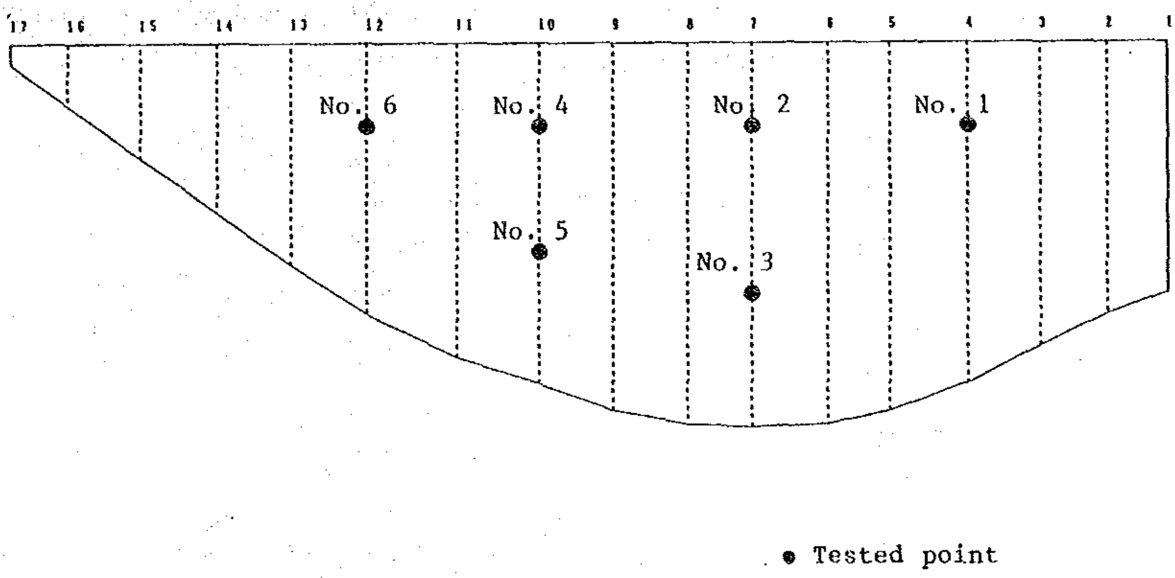
In about half the results, the unit volume weight was below 1.6 t/m^3, revealing that the density was very low and that the compaction had been insufficient.

④ Site permeability test

Tests of water permeability at the site yielded a permeability coefficient of 10^{-2} to 10^{-3} cm/sec. This is almost same as that of fine saturated sand, showing that the site has a relatively high permeability. Although visual observation indicates that the soil could contain relatively fine grains (clays), its appearance suggests otherwise, and in fact the site contains unwanted voids resulting from insufficient compaction. The grain size, as sampled in a boring survey, backs up this argument.

Table 6 Site Test Results

No.	Swedish sounding method (mean value) (mean value) Nsw	Site density test t/m³	Water permeability test cm/sec	Convert-ed N-value
1	25	1.63	1.5×10^{-2}	4
2	0 (Self-settlement)	2.02	5.8×10^{-3}	2
3	25	1.88	1.4×10^{-2}	4
4	35	1.50	4.7×10^{-3}	4
5	25	1.60	6.6×10^{-3}	4
6	0	1.80	5.5×10^{-3}	2



⑤ Settlement at the northern end of the building

Settlement was the greatest on and around the northern end of the building. Since the entire building had also suffered maximum settlement at this point, both test bores and sounding surveys were conducted in the vicinity of the building.

These surveys indicated a relatively high natural water content ratio compared to any other area. Some traces of overflow from nearby catchment facilities were also evident.

Soundings using the Swedish method resulted in values of 2 to 4. If these figures are converted into N-values, this means very poor compaction, even if the soil is sandy. Based on this investigation, the cause of the settlement can be traced to insufficient compaction of the refilled soil after temporary soil-cut work, which was done by cutting and opening previously filled soil. Rainwater has repeatedly flowed over the refilled soil. This has led to both looseness of the ground and contraction upon drying.

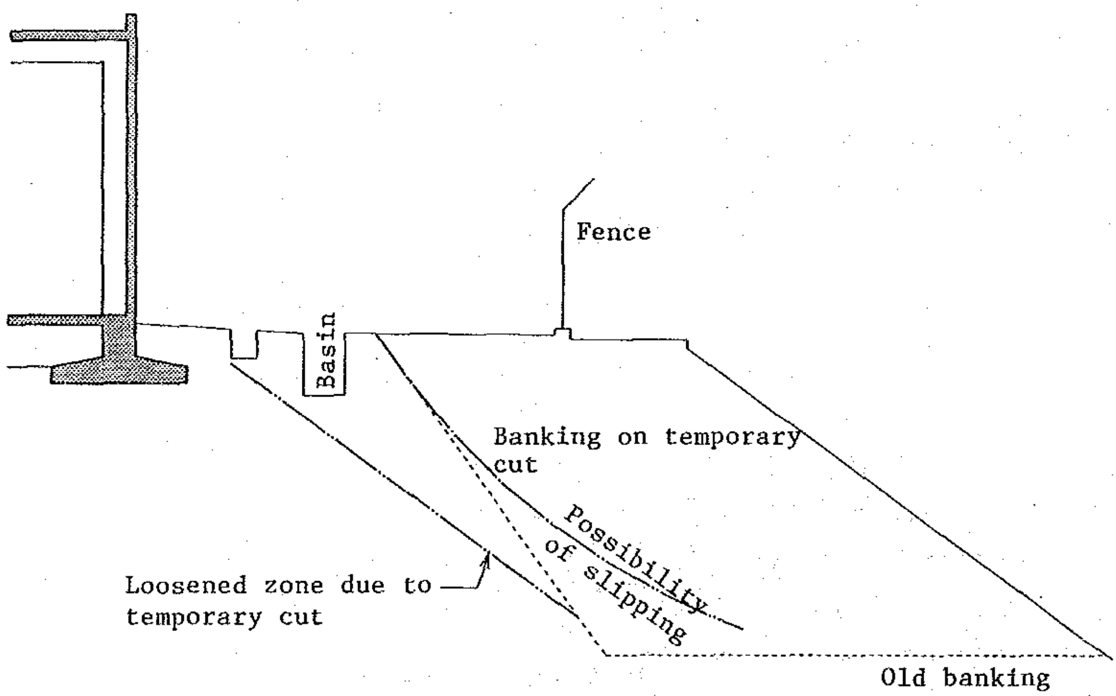


Fig. 7 Soil-Cut Range

The situation in the diagram above can be explained as follows:

. As the ground changed topographically, the catchment channel began to slide.

. Settlement caused the downstream end of the drainage piping system to clog, leading to overflow.

. Rain water overflowing the catchment system filtered into the ground, passing through the zone loosened by temporary soil-cut work and into the soil refilled in the temporary soil-cut zone, and then still further into the old soil filling. Some water infiltrated the ground under the building foundations as well.

. The building settled generating stress in the slope and forcing the ground toward the slope side. The compacted concrete on the berms slid under the influence of both the settling water catchment and this movement toward the slope side.

During the follow-up survey, it was confirmed that the erosion of the protective work over the slope on the Taiz subcenter site was not caused by overall collapse of the site, that improper slope protective work was unable to withstand erosion by rainfall during the annual rainy season, and that poor refilling soil work done after large soil-cut excavation work had a great effect. The conclusion, therefore, is that there is a possibility of the entire site collapsing if the slope is left in this condition as erosion advances.

To maintain the Taiz subcenter building, permanent safety of the slope must be secured. For this purpose, practical measures to stabilize the soil must be established.

2) Results of a survey of the Taiz subcenter building

The survey results are as follows:

① Test bores around the building

Because rain had fallen for some days before test boring, the water content of the soil was high on the whole. In particular, it was extreme at the northeastern corner of the building; touching the soil there made the hands wet. It was found that water was rising out of a shallow zone and that a considerable amount of water had entered through cracks in the concrete floor during rainfall. No voids were found under the foundations. The soil compaction was, however, poorer at the northeastern corner of the building, where the water content was high, than at any other point.

② Building settlement survey

As of February, 1990 the building's settlement was recorded as 7 mm at the northeastern side (emergency measures were taken in July 1988), and 9 mm at the southeastern side (as of February 1990). The cause of this is assumed to be loosening of the soil due to the infiltration of water.

③ Survey of cracks in the interior walls

The cracks were particularly conspicuous on the northeastern side of the building. Since the interior walls are made of concrete blocks, it was assumed they could not withstand the deformation caused by the subsidence of the northeastern part.

④ Water flow test in northeastern drainage piping system

By discharging water through the last catchment channel using 2 water pumping vehicles (about 4 tons per vehicle), it was found that the flow for the initial 2 or 3 tons was good, but after that it deteriorated rapidly. It is assumed that the cause was insufficient gradient in the piping system following ground settlement. Although the channel was 1.5 m deep, it can also be assumed that mud sediment was not washed out, thus reducing the cross-sectional area.

⑤ Water flow test in soil pipe

The soil pipe at the northeatern corner of the building was affected by the ground movement, but its gradient was found to have remained the same. The flow was found to be reduced, but it was determined that this did not affect its function. Water ran through other portions with no problem.

Since the foundations of the building are greatly affected, reinforcement measures are required under the foundations. This procedure should not only reinforce the foundations, but should also be a method (e.g., piling) that is likely to reduce the structural load on the slopes.

3) Supplementing the NTI facilities

The present NTI began as planned as a major center integrating the Taiz and Hodida subcenters. It forms the nucleus of the National Tuberculosis Control Program (NTP), whose role is increasing. This has resulted in a need for more space, particularly in the form of a garage for X-ray vehicles and a store for medicines and other supplies.

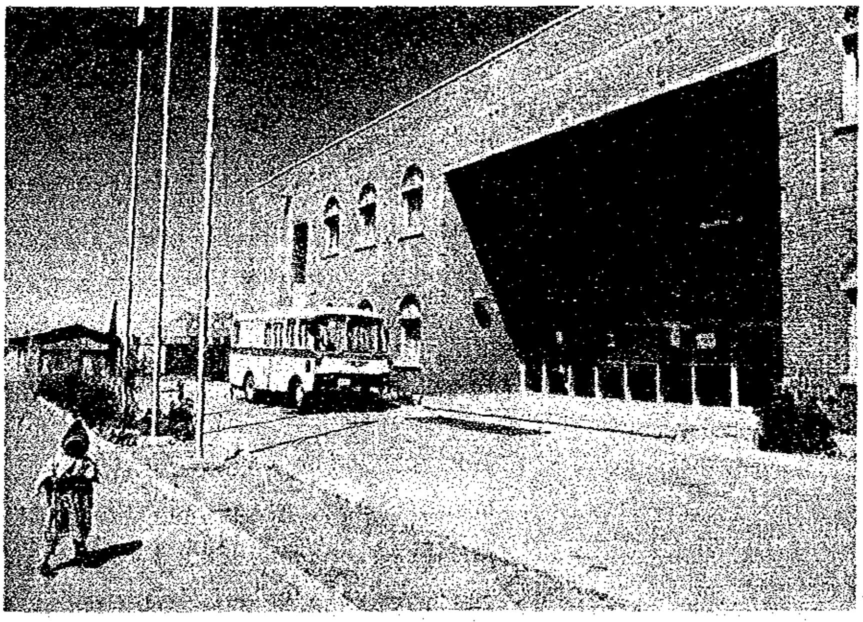


Photo 5 NTI and an X-ray vehicle

4) Equipment and materials

① Microscope for tubercule bacillus examination

The surest method of discovering tuberculosis is the sputum smear test using a microscope. The test requires neither a high-power microscope or intensive training. It is expected that if microscopes are provided for use in tuberculosis diagnosis at central health centers and the branches in all parts of the country, tuberculosis control can be improved remarkably. The health centers to be provided with microscopes are those which have, in the past, been given practical guidance by NTI or the local subcenters. Regional GTC's are responsible for maintenance of the microscopes.

② Automatic X-ray film development machine

Although three machines have been requested for NTI and the subcenters, NTI has already introduced a unit and used it with a manual developer, so a new one is regarded as unnecessary. On the other hand, it is time for the Hodeida and Taiz Subcenters, which depend fully on manual developers, to introduce automatic developers, since they are medical centers specializing in tuberculosis and thereby require the use of far more films than other health facilities. To obtain good quality printing, X-ray engineers at local health centers can be trained by making case studies at the two subcenters.

③ Instrument for bacteria test for the Hodeida subcenter

Although a request was made for replacement of the examination equipment granted under the 1987 grant aid program, due to the effects on it from high temperature, high humidity and salt, the equipment was found to have been well looked after as a whole and fully functional, so it was excluded from the grant list.

④ Resuscitator sets and first aid kits

The resuscitator is a portable case, containing an oxygen inhaler, a manual type resuscitator and a treadle-type aspirator. The fact is that the equipment has been provided not to primary health care centers such as health centers, but only to medical care centers like hospitals or dispensaries. Considering that tuberculosis control is going to be promoted through primary health care activities, the equipment should be provided at least to central health centers to give first-aid treatment for hemoptysis, respiratory difficulties, etc. First aid kits are used not only for first aid treatment but also for guidance to patient and their families, so it is effective for these purposes to provide them to the health centers which have been given practical guidance by NTI or the two subcenters.

⑤ Ambulances

Ambulances to be provided in this project are a means of emergency transportation containing a minimum of medical equipment (oxygen tanks, etc.). They will be provided to NTI, the Hodida Subcenter, Aden and Haderamout Central Health Centers, (both of which are located in the southern part of the country and function as subcenters), while the Taiz Subcenter, which has a cooperative relationship with the adjoining Revolution Hospital, is excluded from the grant list. The ambulances are used for transporting emergency and seriously-ill patients from the facility for tuberculosis treatment to a neighboring hospital.

⑥ 4WD vehicles

The 4WD vehicle is used by GTC's, appointed in each of 18 regions including 17 provinces and Sanaa City region, for the purpose of giving practical guidance to local health centers.

⑦ Administrative office equipment

As well as 4WD vehicles, administrative office equipment is especially designated for GTCs. This includes copy machines, blackboards, typewriters and facsimile machines, all of which are necessary for GTC's activities. Facsimile machines are used by GTC's to transmit the data obtained from tuberculosis training surveys in local areas to NTI in Sanaa and the subcenters. Personal computers are provided, one unit each for NTI and the PHC Bureau of the Ministry of Health, so that the network may serve to promote NTP activities.

⑧ Video cameras, VCRs, and TV sets for health education

Although video cameras and other equipment was requested as teaching materials, they are excluded from the grant aid since they are not so urgently needed.

⑨ Water softeners

Although water softeners are not included in the request, the investigation showed that the water of the country is hard and causes failures in examination equipment using water. As a result, it was decided that the supply of water softeners should be added to the project. However, they will be provided only to NTI and the two subcenters which contain a number of items of examination equipment.

⑩ Aspirators

Although they have not been requested, aspirators are included in the grant list since they are needed to remove sputum clogging the throat. They will be provided to NTI, the Taiz and Hodeida Subcenters and the central health centers in order to achieve effective tuberculosis treatment in Ibb, Aden, Haderamout.

(5) Basic Policy on Implementation of the Project

1) Facilities

① Slopes at the Taiz Subcenter site

It was found as a result of the site investigation that rainfall during the annual rainy season continues to erode the slopes and that leaving them as they are now will have an impact on the entire site. The reason for this is loading of the slope as the present gradient exceeds the natural gradient. The construction no longer plays its protective role, because of improper execution, etc. To secure the natural gradient however, would require enlarging the site, but it appears impossible to acquire ownership of adjoining land. Permanent measures must therefore be established with the current gradient, but such measures exceed the civil engineering capabilities of Yemen. The outline of the project given below will therefore, be considered on the condition that a Grant Aid Program is available from Japan.

② Medicine warehouse and X-ray vehicle garage for NTI

At present, NTI's medicines, spare parts, wheat flour and other stocks are temporarily stored using the containers which were used to transport materials and equipment during the construction period, since storage space is limited. Since this state of affairs is not desirable for medicines, X-ray films and other items which must be preserved at a fixed temperature, it is advisable to rapidly improve the situation. This is also true for X-ray vehicles, which are left in the intense sunshine when not being used for medical patrol care, since there is no garage for them at present.

In consideration of the fact that NTI, which was established under grant financial aid, and the X-ray vehicles, which were supplied through our technical assistance, have both been effectively used, it is accordingly judged right that the coming project be made in expectation of Japan's second phase of Grant Aid Program. Accordingly, the outline of the project will be studied and a basic design will be prepared for the following:

2) Equipment and materials

The national Tuberculosis Control Programme (NTP) which was formulated by former North Yemen has been continued after unification. Moreover, the NTP has been expanded throughout the country by appointing provincial Governmental Tuberculosis Coordinators (GTCs) in 18 regions, namely, 15 central health centers throughout the country, NTI, and Hodeida and Taiz Subcenters. (At NTI and the subcenters the director holds the additional post of provincial GTC.)

Now that the medical administrative organization has thus been rearranged and is playing an important part in spreading anti-tuberculosis measure across the country, it is expected that the replenishment of 4WD vehicles, office equipment and primary medical apparatus will significantly increase the effect of the NTP activities. It also corresponds to the system of Japanese Grant Aid Program. It is therefore regarded as reasonable to plan the project on the assumption that Japanese assistance will be forthcoming. For this reason, the materials and equipment plan is studied based on the following outline of the project and is basically designed accordingly.

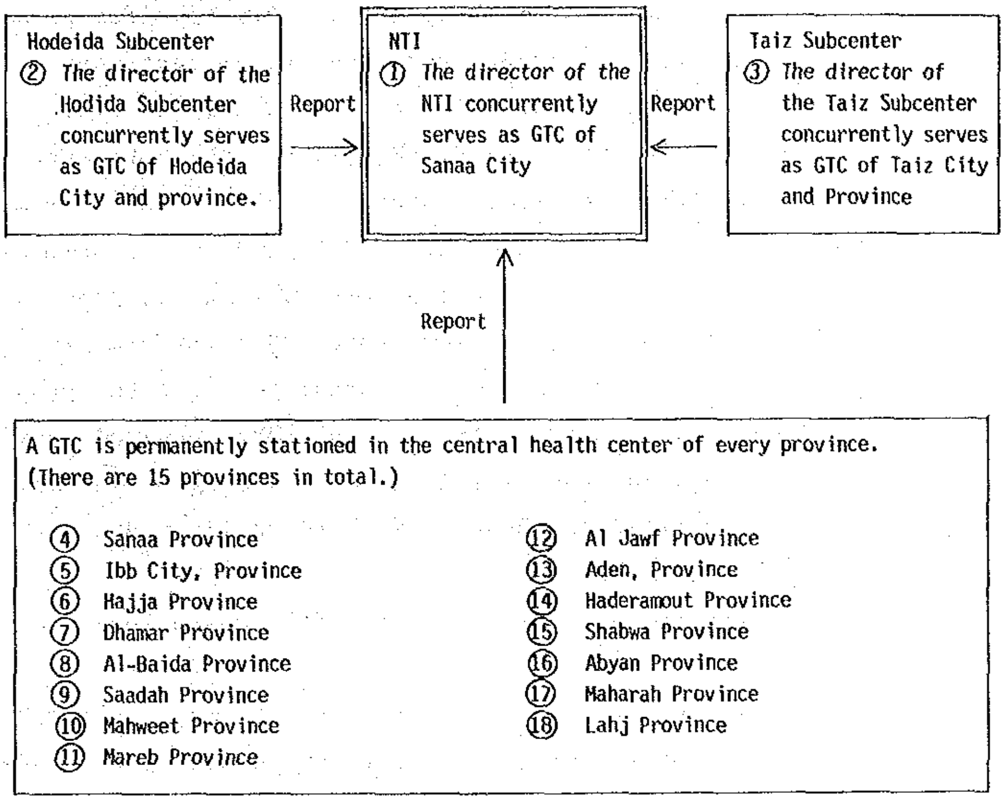
3-3 Outline of the Project

(1) Organization for Project Implementation and Project Implementation System

The organization implementing this project is Primary Health Care Bureau of the Ministry of Health (MOH). Under the implementation system, NTP section and NTI will cooperate under the instructions of the PHC bureau to give guidance to GTCs all over the country. As for tuberculosis prevention, diagnosis and medical treatment, NTI supervises these main activities and the two subcenters support NTI as sub-supervisors.

(2) Activity plan

Since north-south unification, the new Republic of Yemen had restored the function of the NTI and the Hodeida and Taiz subcenters, and expanded the system of local patrols, which gave guidance centered around the NTI and subcenters, to cover the whole country by appointing a GTC to each of the 18 areas.



In Sanaa (City), Hodeida (City; Province) and Taiz (City; Province), the GTCs also head the NTI, the Hodeida Subcenter, and the Taiz Subcenter respectively. In the other 15 areas, GTCs are permanently stationed in the central health centers.

The roles which the GTCs play in the 15 areas are as follows:

a) Guidance and supervision for Primary Health Care Units

GTCs provide technical guidance to medical assistants, nurses, and other regional medical staff on the subjects of tuberculosis prevention (BCG inoculation) for newborns and children, tuberculosis diagnosis (the sputum test), and treatment (medication, emergency treatment) for out-patients. GTCs patrol the terminal medical care facilities scattered over vast regions, including mountainous districts by 4WD vehicle to offer guidance. To support education about the sputum test, new microscopes exclusively for tubercular bacillus examination will be provided, with the number and distribution of microscopes, as in the case of medicines to be managed by the GTCs. For guidance on primary treatment, such as emergency treatment for persons tested as infected, resuscitator sets and first aid kits (emergency treatment sets) provided under the project will be utilized. GTCs instruct both medical staff and patients and their families about emergency treatment as a part of the general health and medical education.

b) Confirmation of problems in local tuberculosis control

GTCs confirm, and report to the NTI, any problems in local tuberculosis control which result from geographical and social conditions (tribal relations, lifestyles, etc.) which differ by region. The need to provide ambulances and aspirators has been recognized in some of the 18 regions; and the need to replace workers and material installations will be checked and reported to the NTI by GTCs in the future.

c) Collection of statistical data on tuberculosis

The GTCs have a duty to collect tuberculosis-related data in the field of primary health care activities. Data collection focuses on central health centers, health centers, and health care units, although data from medical care activities at local hospitals and dispensaries are also used. The data comprise registrations of tubercular patients, follow-up surveys of those dropping out of medical care, and test of resistance for patients after prescription of anti-tubercular drugs.

The GTCs file and record the data in the privacy of their offices located in the central health center in each region, and send updates to the NTI by facsimile every week. The equipment necessary for this data collection and recording activity includes typewriters, blackboards, and copiers in addition to the facsimile machines.

d) Maintenance of medicines

Each region's GTC is responsible for distributing BCG, anti-tubercular drugs and other medicines provided by the NTI to health centers and health care units. A periodic report is made to the NTI describing their distribution and usage.

The aim of this project is to step up these activities by the NTI, the Hodeida and Taiz Subcenters, and the GTCs by the following procedures.

① Replenishment of medical equipment now lacking at the NTI and the Hodeida and Taiz Subcenters.

② Construction of a medical supplies store, an X-ray vehicle garage, and other necessary facilities at the NTI.

③ Permanent reinforcement of site slopes at the Taiz Subcenter.

④ Installation of medical equipment exclusively for tuberculosis control in the central health center of each area.

⑤ Installation of the office equipment needed by GTCs to process data.

⑥ Provision of communication equipment for the GTC network.

⑦ Provision of ambulances to central health centers in urban areas with no hospitals to transport emergency or critically ill patients to hospital.

Exemplified by Sanaa (NTI), Ibb, Aden, and Haderamont (central health centers).

⑧ Provision of 4WD vehicles to allow GTCs to patrol remote areas.

(3) Location and Circumstances of the Project Site

1) NTI

Sanaa, where the NTI is situated, is the capital city of the Republic of Yemen. It is on a plateau (2,300 m above sea level) called the Central Highland. The population is about 430,000 (1986), and there is a remarkable flow of population into the urban areas of the country as is the case in other countries. Except for the great difference in temperature between the night and day, the weather is generally warm and there are two rainy seasons per year (March - April and July - August). The annual precipitation is about 150 to 250 mm.

The NTI is situated near Taiz road, an urban trunk route connecting the cities of Sanaa and Taiz, about 7 km south of the central area of the city, and the entrance is about 900-1,000 m east of the road. At present, the access path from the road is not paved. Ownership of the land around the site is held by the government of the Republic of Yemen.

The site area is about 44,000 m^2. Around the site, the land gently slopes down toward Taiz road, and the site is covered with solid ballast gravel. There is a scarcity of vegetation nearby, and the noon sun is very strong. With the vegetation which was planted by NTI, the site has become distinguishable from its neighbors. Since it is currently idle, there are no environmental problems such as noise or air pollution and it can be considered a good natural landscape.

As for the infrastructure, access paths are as yet incomplete. Since electricity and telephone services reach a village about 500 m away however, the site is supplied via an extension from there. A stable water supply system has been established after well excavations.

Based on data from well excavations in Sanaa province, the geology appears to consist of top soil about 4 m deep and layers of lapilli and sand from 4 m down to 31 m deep. The geology of the NTI site was found to be almost the same.

2) Hodeida Subcenter

Hodeida stands by the Red Sea on a coastal plain called Tihamah. The plain is covered with sand dunes which extend to a width of 50-70 km along the Red Sea. Because of its situation, the city is the most important harbor in the Republic of Yemen, and the majority of imports and exports for the country pass through it. The population is about 100,000. The area has a subtropical climate of high temperatures and humidity under the influence of the

Red Sea, and the relative humidity is 70% on average. The temperature averages 30°C (the daytime temperature in summer may exceed 40°C) or higher throughout the year, while precipitation is very low.

The Hodeida Subcenter stands in the grounds of the Republic Hospital in the southern part of the city. The hospital has a vast amount of land, so it can be expected to expand further in the future. Urban planning calls for this zone to become a central medical facility of the city. Good access is provided by trunk roads nearby. There are no facilities likely to disturb the site provided. The land now belongs to the Republican Hospital, but no problems are foreseen in the administrative procedure to transfer title to the center.

The site is about 6,500 m^2 in area, a rectangle 100 m x 65 m. There are almost no variations in level, the land being mostly flat sand. This site sees a lot of sunshine, and the seasonal winds from the Red Sea always blow from the west. Environmental problems such as traffic noise, air pollution, etc. are next to none at present, because the site is situated at the southern extremity of the city.

The infrastructural facilities are already complete within the hospital, so there are no particular problems in drawing them onto this site. (Neither a sewerage system nor city gas is yet available on the urban level as in Sanaa however.) According to data from well excavations in Hodeida province, the geology consists of a fine sand layer 3 m deep, under which there is an ordinary sand layer reaching down to 18 m. The geology of this site can be considered similar.

3) Taiz Subcenter

Taiz is situated at the southern end of the central highlands, at an elevation of about 1,300 m above sea level. It is thus lower than the 2,300 m elevation of Sanaa, but it is all the same a mountain city at the foot of sharp mountains comprising the central highlands. Since it is in a valley, the temperature becomes relatively low during the winter period from September to February, but the minimum temperature seldom reaches 0°C. The average temperature is about 18°C in winter and 25°C in other seasons so it can be called a warm climate in general. There are two rainy seasons per year (March-April and August-September) as in Sanaa, and the precipitation is relatively high, with monthly precipitation sometimes exceeding 100 mm.

The Taiz subcenter is situated to the east of the Revolution Hospital in the northern part of the city. The area was initially scheduled for development as a central medical area, and a site was provided for the center as one link in the plan. The site is almost rectangular, about 6,000 - 7,000 m^2, and is flat land stretching northward along the boundary with the Revolution Hospital. This topography results from the fact that this is a vast area of filled soil. For this reason, a level change of 16 - 17 meters occurs at the northeastern side of the site where it meets the natural geology of the valley.

A variety of problems, both natural and caused by the soil filling, are described in para. 2.4 "Details of the Request" in the preceding chapter.

The existing infrastructure is relatively complete, as the neighboring Revolution Hospital is modern and well-prepared infrastructurally.

(4) Outline of the Facilities and Equipment

1) Facilities

The facilities in this project comprise those for completing the NTI and those related to permanent measures for the slopes at the Taiz Subcenter.

① Completing the NTI's facilities

The NTI is now short of space for the storage of medicines, spare parts, and food-stuffs such as wheat flour, etc. (to be used to improve the nutritional diet of outpatients). Currently containers used to bring in equipment and materials during construction have to be used for this purpose, thus causing administrative problems. The addition of storage space is seen to be a necessity. The present NTI garage (42 m^2) is already partly used as storage space, so making use of this garage for storage is preferable from the viewpoints of convenience of location and efficiency.

The NTI is also now arranging for some X-ray vehicles for periodical examinations through technical cooperation with JICA. However, they are left in the strong sunshine when not used for medical patrol care, so a new garage for them is now required. It is recommended that a garage (54 m^2) be constructed in an easily accessible location. A site should be chosen so as not to obstruct NTI's front entrance and to ensure the best possible traffic planning.

2 Measures for the slopes at the Taiz Subcenter

Various problems connected with the slopes are detailed in para. 2.4 "Details of the Request" in the preceding chapter. Measures are needed for permanent reinforcement of the slope, reinforcement under the building foundations and the repair of cracks in the building and window frames affected by the problem. Reinforcement under the foundations has to not only reinforce the foundations, but also reduce the structural load on the slopes. Repairs to the walls of the building will require repainting after filling requiring materials in the cracks, since the cracks cause anxiety among the staff who are accustomed to stone-made structures. These are not structural walls, so there is no real problem in terms of facility maintenance and management.

2) Equipment and materials

The equipment and materials involved in this project and the area where they are to be provided, is outlines as follows

① Microscopes
② Automatic X-ray film development machines
③ Water softeners
④ First aid kits
⑤ Resuscitator sets
⑥ Ambulances
⑦ 4WD vehicles
⑧ Personal computers
⑨ Copiers
⑩ Blackboards
⑪ Typewriters
⑫ Facsimile machines
⑬ Aspirators

(5) Maintenance and Management Plan

Maintenance and management has been performed by the Ministry of Health (MOH) of the Republic of Yemen, as was done in the period of the former North Yemen, since the completion of the NTI in Sanaa and the Taiz and Hodeida Subcenters. The Facility Bureau within the MOH runs the Sanaa NTI, while the Taiz and Hodida subcenters are run by the facility division of the Health Bureau in each province.

The maintenance, management, and repair of facilities, equipment, and medical equipment in the Sanaa NTI, and a system to maintain and manage personnel and technical matters, spare parts, etc. is better organized through links with workshops attached to local hospitals and Central Laboratories (through which medical facilities with no workshop receive repair service for medical equipment and so on.) Furthermore, since there are many repair workshops related to the mechanical, electrical and other equipment in Sanaa, it does not take long to find the skills and materials required for repairs. In the case of the Hodeida Subcenter too, since it is located next to the Republic Hospital and the port city has good material distribution, maintenance, management, and repairs are easy. In addition, there are many branch workshops in Hodeida, facilitating maintenance and management of the facilities.

Since the Taiz Subcenter is also located next to the Revolution Hospital, the situation is the same as at the Hodeida Subcenter. Because Taiz itself is in a narrow valley, and the majority of inhabitants are engaged in farming, neither commerce nor material distribution channels have developed as well as in the other two cities. It is therefore, more necessary than is the case with Hodeida or Sanaa, to consider stocks of materials and spare parts for the maintenance, management, and repair of facilities and equipment.

Maintenance and management costs for facilities and equipment are estimated as follows:

① Daily preservation cost

Considered are the costs for parts required, cleanser, oil, etc., excluding test medicines, consumables and the personnel cost for preservers. From the Japanese side's experience, it is estimated that the costs are fully covered by around 1% of the equipment cost. In the project, approximately YR80,000/year will be required as preservation costs.

② Breakdown repair cost

In this project, repair cost is estimated at 3% of equipment cost and around YR240,000/year.

Permanent measures for the slopes and reinforcement of the building foundations, as described in para. 2.4 "Details of the Request," are beyond the capabilities of the Yemeni side. Since no maintenance and management can be expected even after the measures have been taken, methods that do not require maintenance and management (maintenance-free) should be adopted wherever possible in the plan for the site slopes. Consequently maintenance and management costs will not be included.

3-4 Technical Cooperation

JICA's technical cooperation on this project commenced in 1983, and has been extended until 1992.

The purpose and details of the cooperation cover examination and research to (1) improve organizational aspects and foster skills to implement the National Tuberculosis Control Program (NTP), (2) develop preventive, diagnostic, and therapeutic technology both in the NTI and at the subcenters, and (3) improve the Tuberculosis Control Programmes.

Since the commencement of the project, Japan has accepted trainees and dispatched Japanese experts to the project area, while recording methods have been unified; a system for registering patients has also been established; X-ray skills have been improved and the medicinal treatment methods have become more effective. The technical supervision at the NTI and the two subcenters has thus gained a good reputation.

In order to extend these activities nationwide however, there are limits to the periodical supervisory visits to the local HCUs from these centers, as they are being conducted now. Action should be taken by each provincial GTC, appointed anew after unification, to encourage local HCUs to positively participate in measures against tuberculosis, and to periodically give them guidance from each center.

For this reason, it is necessary to provide a minimum level of equipment and materials to the central health center in every region to allow them to perform their role effectively.

The role of this project can be said to have been significant in building up the systems now in place on a national level.

CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Basic Design Policy

(1) Natural Conditions

1) Geographic conditions

The Republic of Yemen (formerly North and South Yemen) is situated at the southern tip of the Arabian Peninsula. It borders Saudi Arabia to the north, faces the Indian Ocean to the south, and lies across the Red Sea from the coast of Africa to the west. Topographically, the nation consists of a plain in the western half of the country along the Red Sea coast, a mountain range stretching from north to south down the center, and a gently falling plain extending eastwards from the central mountains. It can be classified into 5 topographical regions.

① The narrow Tihamah plain facing the Red Sea

There are many flat areas 40-100 km wide and 200 m or less above sea level (the Hodeida subcenter is located in this area).

② A hilly zone 200-2,000 m above sea level surrounded by the Tihamah plains and the central mountain range

This zone is topographically precipitous, where great level differences exist. Many dry rivers called "wadi" fill with water during the rainy season. (The Taiz Subcenter is located in this area.)

③ The central highland zone is scenic and picturesque with mountains rising up to 3,720 m above sea level.

The highest mountain is Nabi Shueib. (The NTI is located in this area 2,300 m).

④ Southern Yemen on the Indian Ocean

As mentioned earlier, the topography of the Republic of Yemen forces a fair number of geographic restrictions on construction work depending on the region. Domestic transportation is often difficult, for example. For this reason, the basic policy will be to establish a work execution plan based on materials and equipment procurement using transport as infrequently as possible, and making optimum use of the work execution skills and practices of each area.

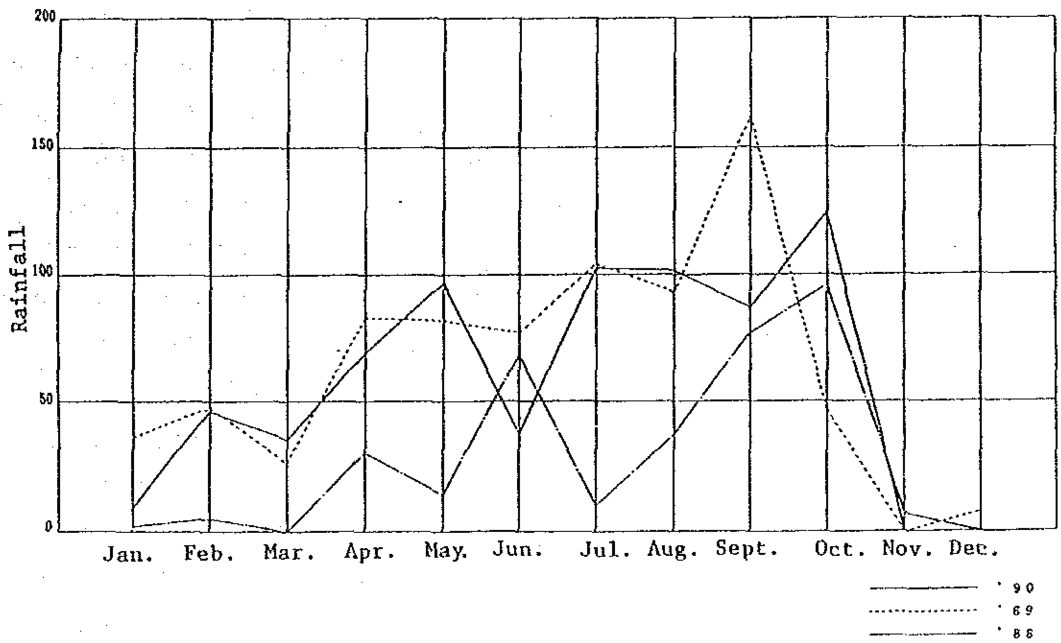
2) Weather conditions

The Republic of Yemen's climate is closely related to the topography. Since the height above sea level ranges from zero to nearly 3,800 meters, climatically it ranges from temperate to tropical.

The country has the highest precipitation of the Arabian Peninsula. Part of the Tihamah plain and a zone along the Red Sea is a desert with tropical climate, and the annual average temperature is about 30°C, but the annual temperature difference is high, ranging from 2°C to 50°C. The annual average precipitation is about 100 mm or less. The hilly zone, on the other hand, has a tropical or subtropical climate, where the annual average temperature is about 25°C and the annual average precipitation varies greatly from 300 mm up to 1,000 mm. The central highland zone is temperate climate, and has the most comfortable climate of the Arabian Peninsula. It is not unduly cold in winter, and summer is also moderate.

The Taiz area, located between the Tihamah plain and the central mountains, has particularly high precipitation, and data for a period of 3 years (1988-1990) is shown in Table 8 below. This chart shows that the period from November to March is a dry time when the precipitation is low every year. However, the years 1989-1990 are characterized by high precipitation. In implementing measures for the site slopes at the Taiz subcenter, therefore, the basic policy should be to do sufficient examinations of the work execution process to enable slope protection work to be completed during the dry season. For foundation work not affected by the rainy season, the policy should be to be thoroughly ready for any precipitation after the measures are taken.

Table 8 Patterns of Precipitation at Taiz



(2) Social Conditions

North and South Yemen were unified in 1990. Before unification, the North Yemen strongly resembled a tribal nation, while the South Yemen had a separate history with an open policy based on socialist concepts rather than tribal and religious traditions. In the new Ministry of Health formed after unification, many of the policy-making initiatives are often left in the hands of former North Yemen's Ministry of Health. In many of the activities related to countermeasures against tuberculosis, the ratio of management posts occupied by personnel of former South Yemen's Ministry of Health is very high because of their knowledge of modern practices. In promoting this project, therefore, all decisions should be thoroughly disseminated away from central government and down to each local autonomous area on the province level.

(3) Situation in the Local Construction Industry

In the newly unified Republic of Yemen there are substantial differences in procedures and the decision-making process among the various communities, although the permit and approval systems associated with doing business, the relevant laws and regulations, etc., do comply with central government standards. When procuring equipment and materials, all imports still pass through the port of Hodeida. Work execution systems are also independent in Sanaa, Hodeida and Taiz. It is, therefore, also necessary to determine a realistic means of securing a labor force and procuring local equipment and materials based on the characteristics of each area.

(4) Use of Local Businesses and Locally Available Equipment

Construction activity is generally falling off compared with its level at the time the NTI was constructed in 1986. In 1986 for example, there were many European-based joint-venture constructions companies, but they have all withdrawn, because the market is so depressed, and now there is only one foreign-capitalized construction company (Chinese). The basic policy should, therefore, adopt methods which allow work associated with the slope measures in the project to be handled by workers with only basic skills. Any work exceeding that level of skill should be executed with technology introduced from Japan (i.e. reinforcement of building foundations).

Local procurement of equipment and materials will be the aim as far as possible, while any items not available locally should be clarified in advance.

(5) Ability of Project Implementation Organization to Maintain and Manage the Facilities and Equipment

Project-type technical cooperation since 1983 has resulted in steady achievements by the NTP of former North Yemen. Even since north/south unification, the NTP's organizational systems can be said to have been filled with the acceptable skills from the south, too. It is expected, moreover, that the GTCs to be appointed around the country will greatly contribute to the nationwide promotion of the NTP. The present facilities (particularly the central health centers), equipment, and materials, however, cannot be regarded as sufficient to cope with the organization's expansion in activity after unification. Looking at the equipment and materials owned by NTI, and the Taiz and Hodeida Subcenters, maintenance and management is good. The proposed equipment and materials include nothing with high maintenance costs so there will be no problems with the cost of maintenance and management either.

Basic maintenance and management at NTI and the two subcenters is performed well, including cleaning. Maintenance of more technical matters as in the problems of the site slopes in Taiz, however, is presently nonexistent. This project must therefore, be designed to require no maintenance at all after the work is completed on the slopes, etc., while the equipment and materials employed will be those which can be fully handled with the present available skills.

(6) Basic Policy on the Range and Sophistication of the Facilities and Equipment

Planning for the facilities should cover the following:

① Addition of a garage for X-ray vehicles and storage for medicines at the NTI.

② Permanent slope measures for the Taiz subcenter.

③ Reinforcement of the damaged building foundations and repairs to cracks on the interior walls and sash frameworks.

Except for the building foundation reinforcement and sash replacement, all the foregoing should adopt a work method available locally, and must take into consideration the lack of maintenance after work is done.

The equipment and materials will have to be replenished to cope with the expansion of countermeasures against tuberculosis after north/south unification, as follows:

① Replenish the equipment and materials in the NTI and in both the Taiz and Hodeida Subcenters;

② Replenish the equipment and materials in the central health centers (under the GTCs) under the guidance of the NTI and both the Taiz and Hodeida Subcenters.

Equipment and materials for this project should be selected in accordance with the following policies:

① Focus on efficient, sturdy, and manual designs, avoiding fully-automated equipment requiring a high level of technical expertise in the case of breakdown.

② Easy maintenance and management procedures, and for which spare parts will be available over a long period.

③ Equipment incorporated with voltage stabilizers, in order to cope with unstable supplies.

④ Proved and tested for reliability overseas.

⑤ The equipment and materials must not duplicate those granted under the technical cooperation.

Transportation and installation of the equipment should also take into consideration the following matters:

① High quality export packing since temperatures in the hold may rise to 70°C during shipping.

② Vacuum-packed precision equipment.

③ Special preparation such as coating of the lenses for items of particular precision, such as microscopes, etc.

④ Protect equipment from dust and similar problems (openings must be sealed).

⑤ Give a minimum of training for operation of the equipment, the instruction manuals for all equipment are in English.

(7) Basic Policy on the Term of Project

The project will focus on the reparation of the slope at the Taiz subcenter.

The measures will consist of slope work and building foundation reinforcement work. The work most directly affecting the term of the project is the slope work associated with the rainy season in Taiz. Work to reinforce the building foundations should therefore take precedence in establishing the work procedure so that the slope work may be done outside the rainy season.

4-2 Examination of Design Conditions

(1) Taiz Subcenter

1) Results of soil tests

The results of an analysis of soil samples collected during the site investigation are as follows.

① The soil consists mainly of coarse grains of mixed gravel and sand, but the soil distribution is good, indicating that the bearing strength will be adequate under dry conditions.

② The distribution of grain size of the ground indicates an extreme reaction to moisture, and the higher the water content, the lower the bearing strength. The soil tends, therefore, to be affected by rainfall, particularly in Taiz where the annual precipitation is high.

③ Because slope compaction is inadequate, the damage increases every rainy season due to an increase in the water content.

2) Current stability of the slopes

The examination of slope stability can be summarized by classifying the problems into directly and indirectly related issues, as follows.

① Issues directly related to the stability of the slope as a whole.

. The slope gradient is steep (1:1.5)

. The filled soil is fairly loose (degree of compaction ≈ 86%).

. The ground is loose as a result of temporary soil excavation.

. The slope contains many stones left after stone-laying work was repeated, causing looseness of the slope.

② Issues indirectly related to the stability of the slope as a whole.

. The slope is long and is not terraced.

. The stones laid down with the filled soil is badly fitted (the loose soil means that the stones do not adhere tightly to the soil).

. There has been an infiltration of rainwater into the filled soil (overflow from the catchment works).

. Cracks have formed in the joints of stone work, so that infiltration of rainwater is not prevented during rainfall.

These problem points and countermeasures against them are indicated in Table-9.

Table 9 Problems and Countermeasures for the Slope

No.	Problem	Countermeasure
1.	Steep gradient (1:1:5)	Reduce the slope gradient and strengthen the ground (drive in piles with anchors, or similar, by adding chemical solution).
2.	Loose filled soil	Replace the filled soil and strengthen the ground.
3.	Looseness of ground due to temporary soil excavation.	Replace the filled soil and strengthen the ground.
4.	Long slope without terracing (water easily infiltrates).	Add small terraces and install a drainage system.
5.	Fitting of the heavy stones to the filled soil is poor.	Replace the slope soil with a soft type.
6.	Leakage of rainwater into the filled soil.	Complete the drainage system.
7.	Cracks in the stonework joints, allowing the infiltration of rainwater.	Add small terraces to drain the rainwater.

3) Results of boring surveys

The data collected through the boring survey conducted in August, 1990 by the Yemeni side are attached at the end of this document. The following is an outline of the survey results:

Geological Results per Boring Hole:

No. 1: The upper portion consists of loose sandy clay mixed with cobblestones (N-value = 50) under which there is fine sand (N-value = 70). There are traces of what used to be a wadi.

No. 2: The upper portion consists of sandy clay mixed with cobblestones (N-value = 25) under which there is wet sandy clay mixed with cobblestones. Bedrock exists at GL-10.0 m. (Of the six holes, only this one had a high water content, thus requiring an investigation of the relationship with leakage from the septic tanks.)

No. 3: The upper portion consists of loose fine sand mixed with waste (N-value = 15), under which there is compacted fine sand. Bedrock exists at GL-15.0 M.

No. 4: The upper portion consists of slightly compacted fine sand, under which there is dense silt. Bedrock exists at GL-12.0 M.

No. 5: Loose clay mixed with cobblestones or sand mixed with silt from the top. Bedrock exists at GL-7.0 M.

No. 6: Compacted clayey sand mixed with cobblestones at the top, under which there is slightly compacted sandy clay. Bedrock exists at GL-6.0 M.

In outline, the stratification consists of sandy silt mixed with gravel between 6 and 15 meters below the surface, with N-values of 50, 70, 25 and 15 as measured with the standard penetration test, but this scatter in values can be attributed to the fact that the ground is filled soil (mixed with large stones or the like). Boring was carried out at 6 points, and measurements were standard penetration, water content, grain size, soil grain specific gravity, liquid-phase, and plasticity tests.

4) Countermeasures for building foundations

The causes of damage to the building foundations are described in para. 2.4 "Details and Contents of the Request" in Chapter 2.

It is necessary to reinforce the building foundations, and the following effects of reinforcement can be expected:

① The structural load on the slopes will be reduced.

② The lower structural load on the slopes broadens the choice of countermeasures against slope damage.

③ The improved foundations will prevent the formation of cracks on interior walls and others places, which are related to building settlement.

(2) NTI

Facilities to be examined in the NTI are the addition of a garage for X-ray vehicles, granted under the technical cooperation from the government of Japan, and storage for medicines.

The NTI side also proposed that a garage (for three vehicles) within the NTI building be examined, and whether space to store medicine can be found within the NTI building. The location, near the medical treatment department and administrative department, is suitable as regards to architectural unity with those departments. The following should, therefore, be adopted as design conditions:

① Turn the existing garage (42 m^2) into a storage room for medicines.

② Construct a garage for X-ray vehicles in a location near the building and ensure that traffic flows do not obstruct NTI's front entrance.

4-3 Basic plans

(1) Site/Location Plan

1) Measures for stabilizing the site slope at the Taiz Subcenter

The slopes should be stabilized according to the characteristics of the filling soil, and the gradient should reflect the depth of filled soil as shown in Table 10.

Table 10: Filling Soil and Standard Slope Gradient

Material	Depth	Gradient	Remarks
Sand of adequate grain size, gravel, and gravel mixed with fine grains	5 m or below	1:1.5 - 1:1.8	Applied to filling soil on ground with sufficient strength and with no water infiltration.
	5-15 m	1:1.8 - 1:2.0	
Poor grain size	10 m or below	1:1.8 - 1:2.0	
Rock (including muck)	10 m or below	1:1.5 - 1:1.8	
	10-20 m	1:1.8 - 1:2.0	
Sandy soil, hard clayey soil and hard clay (hard diluvial clayey soil, clay, etc.)	5 m or below	1:1.5 - 1:1.8	
	5-10 m	1:1.8 - 1:2.0	
Volcanic ash-type viscous soil	5 m or below	1:1.8 - 1:2.0	

Note: The depth of filled soil means the difference in level between the top and bottom of the slope.

Applying this to the slopes at the Taiz subcenter yields a gradient of about 1:18-1:20 (in fact steep at 1:15) according to their scale.

Since calculations of slope stability have revealed that the existing slope is not very stable, it is necessary to examine the following plans for maintaining the slope in a stable condition.

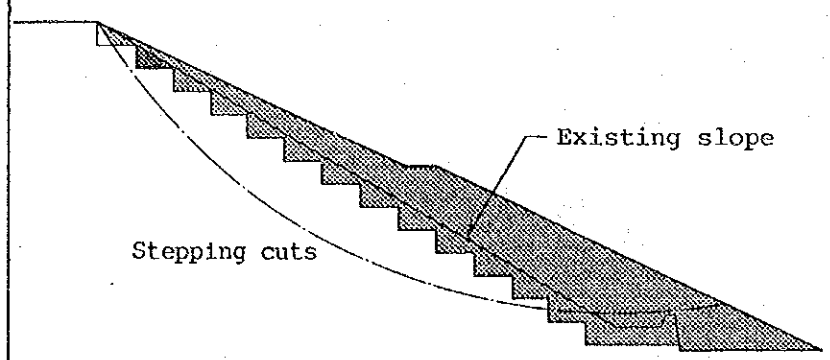
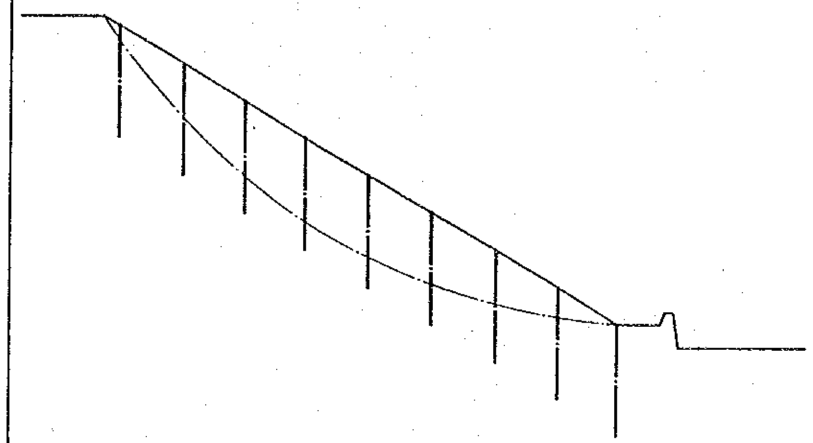
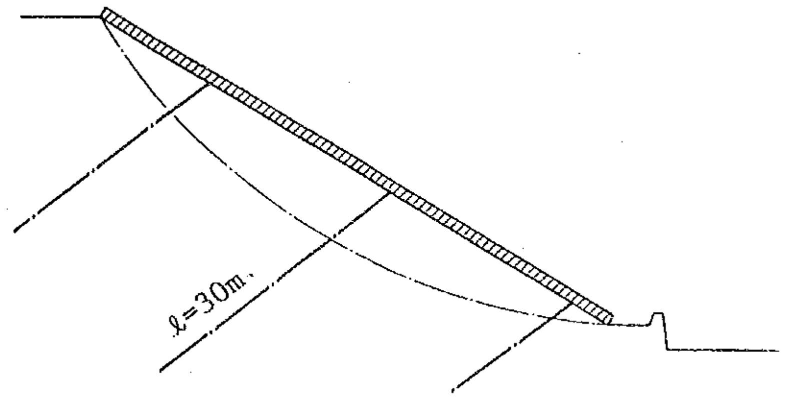
① Plan for filling soil (to reduce and stabilize the slope gradient)

② Plan for restraint work (driving in reinforced mortar piles to increase the shear resistance)

③ Plan for restraint work (to increase the shear resistance with ground anchors).

Examining these work plans from the viewpoint of site conditions, the construction situations, work execution capability, maintenance-free service, etc. results in the details given in Table 11. This examination shows Plan ① to be the most suitable method.

Table 11 Examination of Methods for Working the Slope

	① Plan for filling soil	② Plan for deterrent soil (reinforced mortar piling)	③ Plan for deterrent soil (grounding anchors piling)
Summary of Work Execution	Plan for filling soi (gradient change) Plan for filling soil (gradient change) 	Deterrent soil (reinforced mortar piling) Deterrent soil (reinforcing mortar piling) 	Deterrent soil (grounding anchors piling) Deterrent soil (grounding anchors piling) 
Features	To make the slope gradient a stable gradient of 1:2.0, through which the stability of the entire slope is to be protected. It is necessary to take measures for rain water on the surface and to execute the underground drainage work, both adequately. The work may be rather large scale, but controlling the work execution is easy, as it is a general working method.	To drive many reinforcing piles into the current slope to increase the strength of the entire slope. Both the equipment and materials for this purpose need to be brought in from foreign countries. This method is efficient, but it requires a long time. Also, since a lot of water will be used under this working method, there are slight problems with safety.	To apply the site piling framework into the slope surface in order to execute the grounding anchors work. This method requires removal of laid-down stones in advance. Since the soil is loose, it is necessary to reduce the bearing force per anchor (but increase the number of anchors).
Effects	This working method is of the most trouble-free in terms of slope stability (superior in long-term safety too) out of these three plans. It is preferable to make surface water drainage system flexible to follow the compaction or more or less deformation of filled soil.	Pouring mortar into around the reinforcing piles has also an infiltration and pouring, even though it is a little, and as a whole, the strength of the ground increases exactly. Long-term stability can also be expected.	Since this working method intends to increase shear resistance by pressing the ground, the ground may deform substantially, unless many anchors are piled to lower the tension on each anchor, as the ground is loose.
Site Condition	○	△ (Work execution highly difficult)	× The work becomes large scale, affecting the building
Construction Situation	○ (Locally procurable)	△ (Procure work execution equipment from Japan)	× (Procure work execution equipment and ground anchors from Japan)
Degree of Difficulty of Work Execution	○	△	△
Maintenance	○ (Possible locally)	△ (Difficult locally)	△ (Difficult locally)

2) Determining the cross-sectional geometry

The plan for filling soil, as adopted in the preceding paragraph, requires the acquisition of land 15 meters beyond the boundary line. Discussions by the Yemeni side indicated, however, that no land could be acquired. As a result measures for stabilizing the slopes must fall within the site boundary, and so some new aspects are introduced into the plan for filling soil.

a) Design of the standard cross section

① Small terraces

Since the slope is nearly 30 m long, small terraces will be formed at the middle of the slope. These terraces will assume the dual role of stabilization and preventing erosion of the slope surface by shortening the flows of rainwater during rainfall.

② Top and bottom of the slope

In order to reduce the gradient of the slope as a whole, it is necessary to force the top of the slope backward (toward the building) and to install a gravity-supported retaining wall at the bottom of the slope.

③ Slope gradient

The gradient will be 1:1.75 (average gradient including terraces = 1:1.84).

b) Choice of slope protection work (rainwater drainage work)

Reducing the gradient is important for stabilization of the entire slope, but it results in longer flows for rainwater drainage and a larger water collection area, both of which are undesirable. For this reason, the terracing in the middle of the slope was planned, but there is a high possibility of gully erosion (gulleys caused by flows during heavy rain), piping, etc., as water flows down the slope. Since these problems, if allowed to continue, could lead to a catastrophe, adequate measures need to be taken.

The problems with the slope can be summed up by the following items:

① Rainfall

As described in subpara. 4-1-(1) above, Taiz has a basically dry climate, but with some heavy rain. It is sometimes hit by concentrated rainfall, during heavy rain, over a short time (rainfall per day = 40-60 mm). On 3 October, 1990, for example, 67 mm of rain fell in 45 minutes. When rainwater erodes a bare slope without vegetation, the following phenomena are observed:

. Erosion by rain drops

The erosion begins with loosening of soil and sand on the surface by the impact force, or kinetic energy, of the water droplets. Further, the rainwater picks up this splashed material which then blocks the voids in the surface, thereby reducing the overall infiltration capacity and increasing erosion due to surface flows at weak points.

. Sheet erosion

This is a phenomenon in which a thin surface flow of almost uniform thickness erodes the surface soil almost uniformly. It is initial stages of a new slope's erosion before developing into rill erosion.

. Rill erosion

This is the condition in which the flowing water gathers in rills. If the slope is short, neighboring rills merge to form a much larger rill, greatly enhancing erosion. Parallel ditches on a bare, cut slope are indicative of this phenomenon. If the slope is long enough, such as a mountainside, a gradual convergence of the rills as the water flows down develops into a large gully.

. Gully erosion

Converging rills on a slope increase the flowrate, and the scouring force increases leading to the formation of a gully.

② Nature of the soil

The soil constituting this slope generally has a good grain size distribution (large ratio of fine grains). Since the soil is not well compacted as a whole, it is very susceptible to erosion by rainwater as discussed above.

③ Unsuitable for vegetation

The climate is dry with long periods of no rain, so covering the slope with vegetation throughout the year is not feasible. Thus this method of slope protection may not be practical.

④ Maintenance and management ideas

It is necessary to ensure that no repairs or reinforcement work is necessary after completion of work on the slopes. Since children pass the area on their way to and from their school, strong measures should be taken.

⑤ Material acquisition

The materials used in measures to stabilize the slope should be that available locally if possible. Avoiding the use of special materials as much as possible will result in better utilization of local workers' skills. This means a smoother flow of work and allows immediate measures to be taken in the case of an incident.

⑥ Appearance

The current slope and buildings reflect the local stone culture very well, and are in harmony with the surroundings. It is undesirable to introduce anything of unusual shape or material in this work. It is necessary to clearly understand this point.

A study of these conditions led to the plans shown in Table 12. It was concluded that Plan A would be the most appropriate.

c) Treatment of the surface

Considering the conditions above and comparing and examining the slope surface treatment procedures gave rise to Table 13. The stone laying method (together with mat work) of Plan 1 was determined to be superior in terms of long-term safety, workability, and economy, and this working method also harmonizes well with the surrounding environment. Furthermore, most of the materials needed are available locally, and optimum use of local workers' skills can be made.

The use of mats is common in riverbank protection and in preparing slopes for parks and other landscaped areas.

Table 12 Examination of the Slope Appearance (Slope Surface)

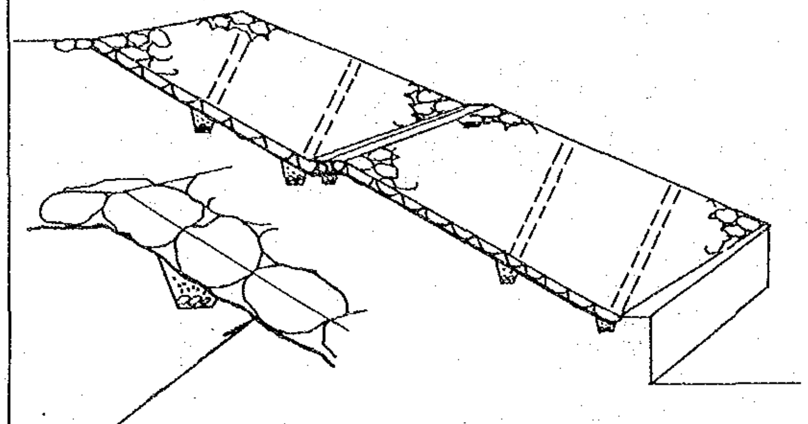
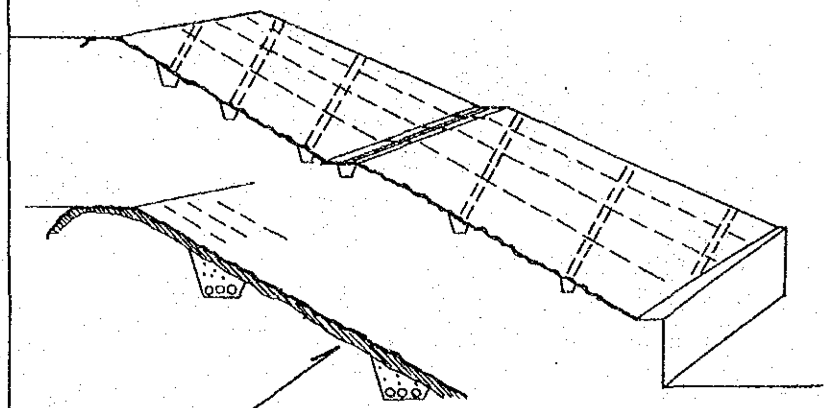
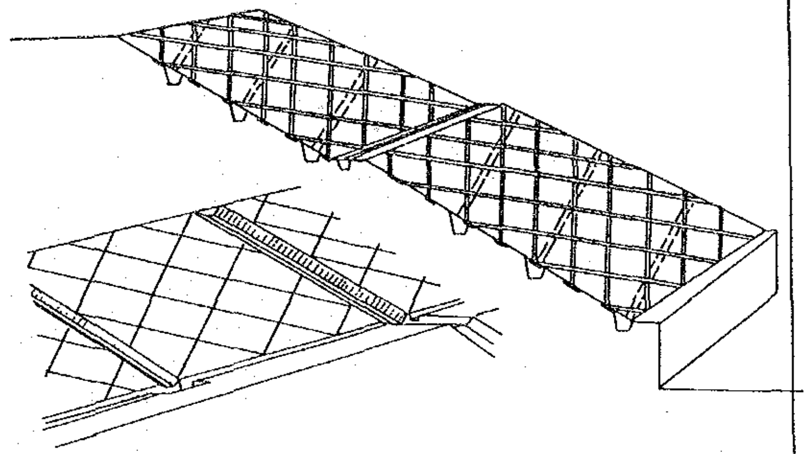
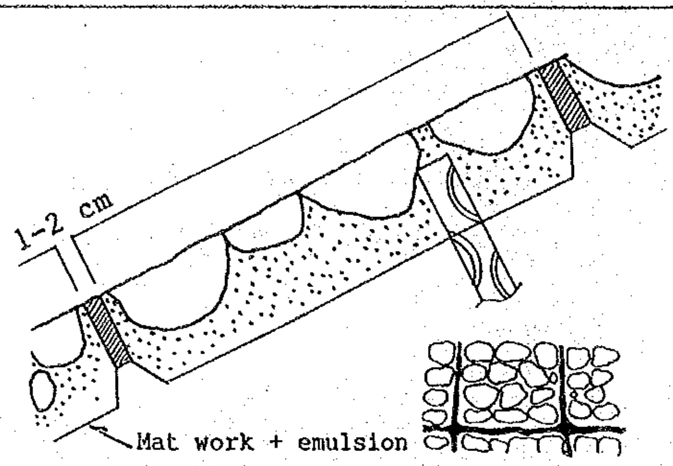
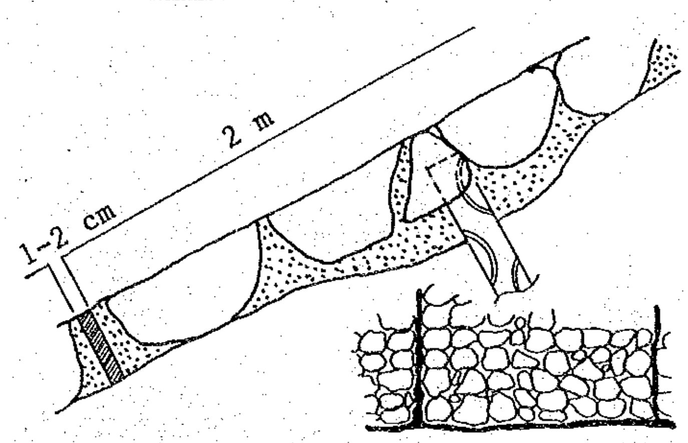
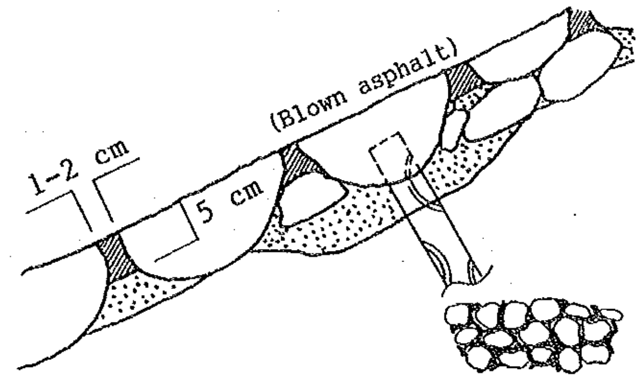
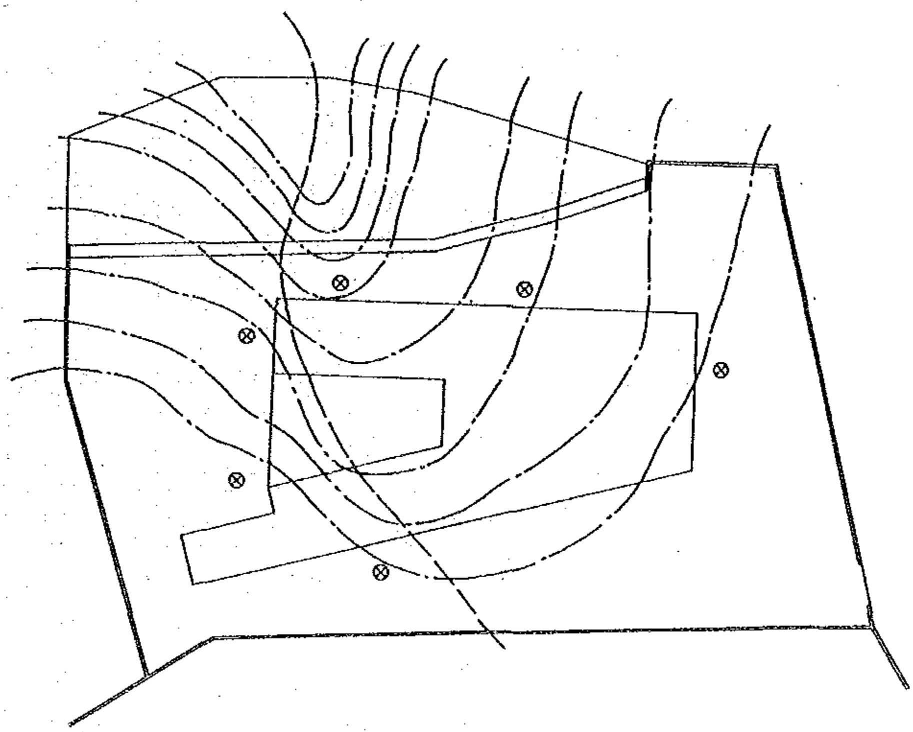
	Plan A	Plan B	Plan C
Schematic Sketch	 Mat work (Spray asphalt emulsion)	 (Spray asphalt emulsion)	
Features	Mats for preventing any rain water from infiltrating or being sucked out are placed over the slope surface. Asphalt emulsion is spray around the mats to minimize the infiltration of rain water, as well as to increase their endurance. A subdrainage system is to be laid out on the back of the mats to collect the water from the surface.	Asphalt emulsion with high permeability is sprayed over the slope surface, upon which mats are then laid down. These mats are weather resistant and of strong material, over which asphalt emulsion is sprayed to increase their weather resistance. resistance.	Grid frames are worked out onto the slope surface. Within these frames, a longitudinal drainage system is laid down densely, as well as asphalt emulsion being sprayed around to prevent any rain water from infiltrating the filled soil, thereby collecting the rain water flowing down through these frames.
Effects	To have sufficient resistance against erosion by rain water. Even if cracks form among the stones laid down after compacting the filled soil, the mats so worked can prevent large volume of rainwater from infiltrating. The filled soil is well familiarized with the stones laid down to follow the compaction of soil as well. There are no problems in maintenance and management. This finished slope looks good and is also in harmony with the surrounding environment.	To have sufficient resistance against erosion by rain water. To follow the compaction of filled soil as well. Superior in workability because are light materials. Since there is no actual record of permanent measures on weather resistance, this slope is slightly inferior. Dark black in color and as such is not in harmony with the surrounding environment. As the slope surface is easily released, problems remain in maintenance and management.	This method is inferior in the countermeasure against erosion by rain water to Plan A and Plan B. Good workability because materials are light. Applicability not good after compaction of filled soil. Dark black in color and as such is not in harmony with the surrounding environment. Either deforming the grid frames or eroding the filled surface soil raises questions in terms of maintenance and management.
Total Evaluation	○	△	X

Table 13 Examination of How to Treat the Slope Surface (Countermeasure Against Rain Water)

Working Method	Plan 1	Plan 2	Plan 3
Summary of Work Execution			
Features	Sand mats are laid down over the filled soil surface, over which asphalt emulsion is sprayed. On the top, stones are laid. The sand mats are sprayed with emulsion to reduce their permeability and prevent any rain water from infiltrating into the filled soil. Even if settling down of filled soil causes cracks in the concrete, the finished slope is safe against infiltration and erosion by rain water, because the sand mats follow the movement of the filled soil. Reinforcing the slope with reinforced concrete needs to be worked out in order to prevent any stones laid down from becoming loose or collapsing.	Stone are laid directly onto the formed, filled soil surface. Joints are made every 2 m in a crossing form, over which asphalt is blown (t = 1-2 cm). Spaces between stones are joined with concrete so that joints still remain closed, even if compacting of the filled soil produces cracks. The jointing material should be of a stable material even under high temperature. Concrete also should be of sufficient thickness to ensure no cracks among the joints. For safety's sake of all the laid-down stones, anchoring them with reinforced concrete is required (2 anchors per block). This is a method to supplement the defects (time and manpower consuming and incomplete pouring) of Plan 1, but if any crack is generated at any other than the joints, a water path tends to be formed between the concrete and the filled surface. For this reason, it is necessary to work out a sufficient subdrainage system.	spaces between stones are joined with concrete so that joints still remain closed, even if any crack is caused by compacting of the filled soil. The joining material should be of a stable material even under high temperature. For safety's sake of all the laid-down stone, anchoring them with reinfoced concrete is required (one anchor per 5-10 m^2). In addition to being time and manpower consuming, pouring tends to become incomplete, as the shape of stones is not uniform. Since pouring at normal temperature flow out due to pouring on the slope, a heating-up and pouring method is called for (very difficult to control temperature).
	Mats can prevent any fine grains of soil from being sucked out, even if water seeps out of the underground, as well as any rain water from infiltrating the filled surface soil. The mat can also make stones well familiarized with the fill soil. Although there is doubt about the life of mats, laying them down underground and spraying asphalt emulsion over them, allows them to last for a long time. Even if settling of filled soil happens to cause any voids, settlement due to flowout of fine grains canbe prevented, because mats prevent any fine grains of soil from being sucked out, too.	This is a method to supplement the defects (time and manpower consuming and incomplete pouring) of Plan 1, and has a certain extent of followability to the filled soil. Since it can also be assumed that cracks may partly form within blocks, densely reinforcing them with reinforced concrete may be required for subdrainage. Binding the movement of each block requires reinforcing it with reinforced concrete of about 2 anchors/m^2 per block. To prevent cracks from forming within any block, backup concrete needs to be placed thickly, but it is not advisable for stabilizing the slope. Since voids and water paths tend to be produced on the back of the stones laid down, the subdrainage needs to be worked out in a certain density.	The work execution requires a long time, and pouring also requires thorough control, but applicability to the filled soil is high. To reduce the work of reinforcing the slope with reinforced concrete, backup concrete needs to be placed thickly as in Plan 2, but it is not advisable for stabilizing the slope (no applicability to setting down and the filled soil, by which voids can form on the back of the stones laid down).
Total Evaluation	○	△	×

d) Building foundation reinforcement

The bearing strata at the site, based on the results of boring tests, are shown in Fig. 8 below.

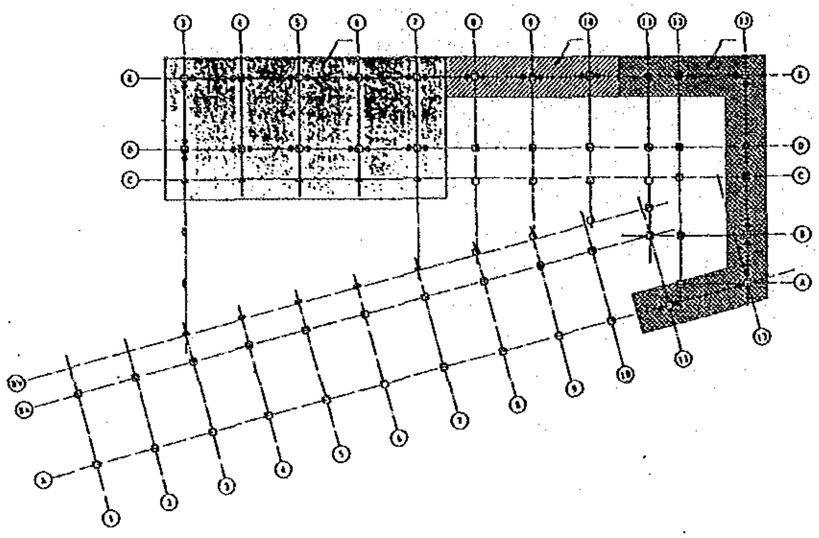
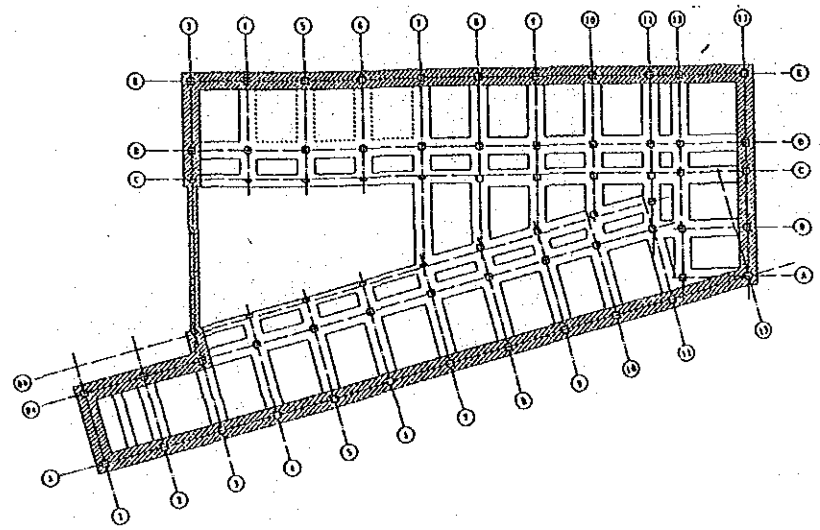
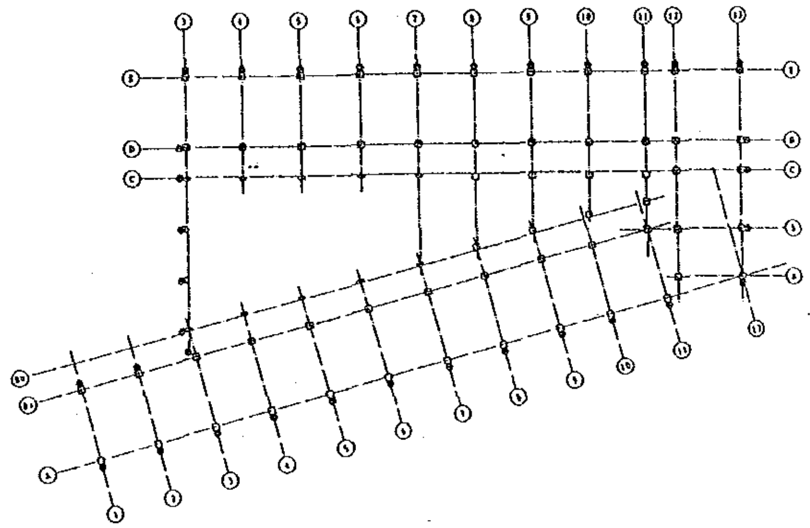


Levels of bearing strata

Fig. 8 Bearing Strata at the Site

An examination of forced piling, driven piling, ground improvement, and other methods of reinforcing the foundations from such viewpoints as economy, effectiveness, and local skills gave rise to Table 14 below. Plan A was selected as most suitable after an overall evaluation.

Table 14 Examination of Measures for Reinforcing the Building Foundation

	Plan A	Plan B	Plan C
Methods			
	This is a method of excavating under the foundations, into where jacks are put and steel pipe piles are forced, using two piles per column.	This is a method of improving the ground by pouring a chemical solution under the foundations around the outside of the building.	This is a method of boring holes (ø450) around the outside of the building with a well digging machine.
Features	This is a method of putting jacks under the existing foundations, 1.0 m long steel pipes (dia. = 300ømm) to each other at a time by welding and then to force them thereinto. There is neither vibration nor noise during work execution. Term of work: 10 months (1 group)	This is a method of excavating under the foundations with a boring machine, and then pouring chemical solution into the space to solidify the ground. Term of work: 10 months	This can be performed with a well digging machine Because of its excavation capabilities, it can reach the bearing layer. Term of work: 3 months
	○	○	◎
Effectiveness	The use of two piles per column can give sufficient bearing force. As piles are to be hammered in to meet the column cores, no eccentricity is produced. Piling can be performed inside the building.	This method can increase the interceptability, as well as the ground bearing force, under the foundations around the outside of the building. An increase in the ground bearing force of the entire building can be expected.	This method can obtain more ground bearing force than any other method. This method has the pile's bearing force transmitted to the building via the beams to be newly installed.
Affect on medical activities	Slight	Slight	There are vibrations
Ability to execute	High degree of skill is required.	High chemical solution cost. Inferior in terms of bearing force.	The impossible work by approaching the building increses a pile's eccentric distance to 1.0 m. Solving this eccentric distance results in a large scale of reinforcement with beams.
Relation with slope	To reduce the structural load on the slope.	To reduce the structural load on the slope is impossible.	To reduce the structural load on the slope.
Total evaluation	◎	△	○

(2) Facility Plan

1) NTI storage for medicines

The existing garage (42 m^2) at the NTI will be turned into a storage area for medicines. Locating the storage here offers such advantages as ease of control and a minimization of the work, as shown in Fig. 9 below. It will cause no problems for the 4WD vehicles that were kept in the garage, because these vehicles are often left in the parking lot around the building rather than in the garage for the sake of convenience.

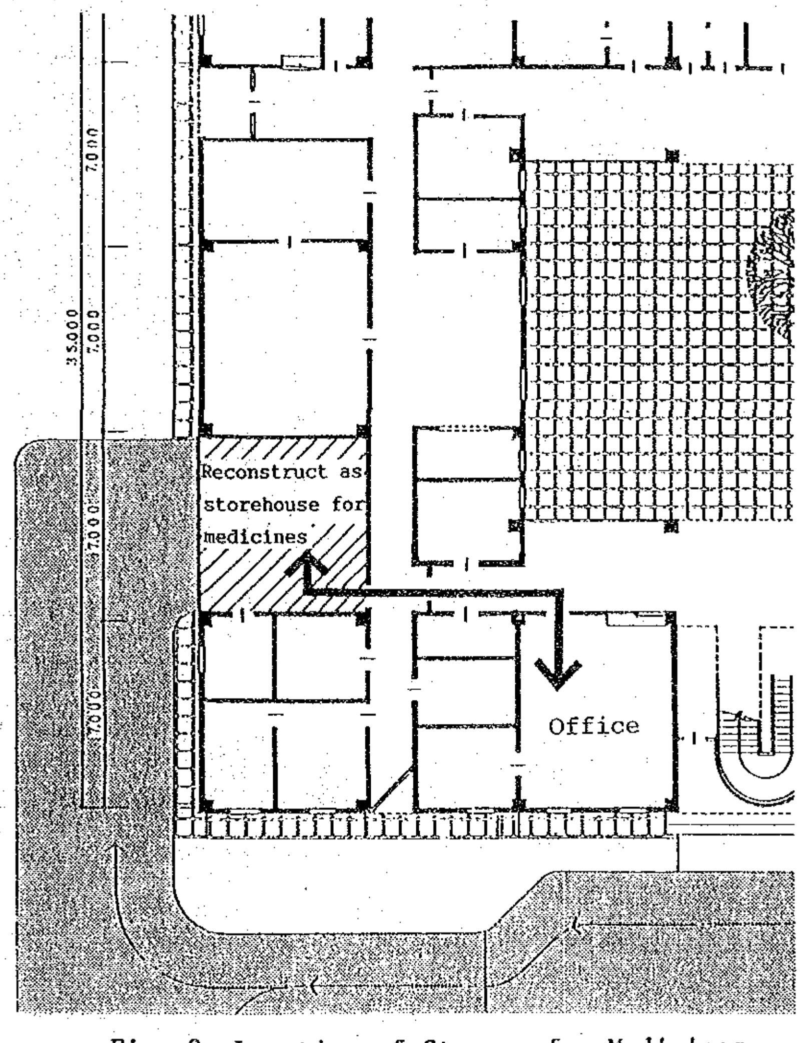


Fig. 9 Location of Storage for Medicines

2) Garage for X-ray vehicles

The garage for X-ray vehicles must be over 3.7 m high because of the vehicle's height. For this reason, it is desirable to choose a location that does not impair the appearance of the NTI building. The location best able to meet this condition is shown in Fig. 10 below. An area of about 6 m x 9 m = 54 m^2 is required.

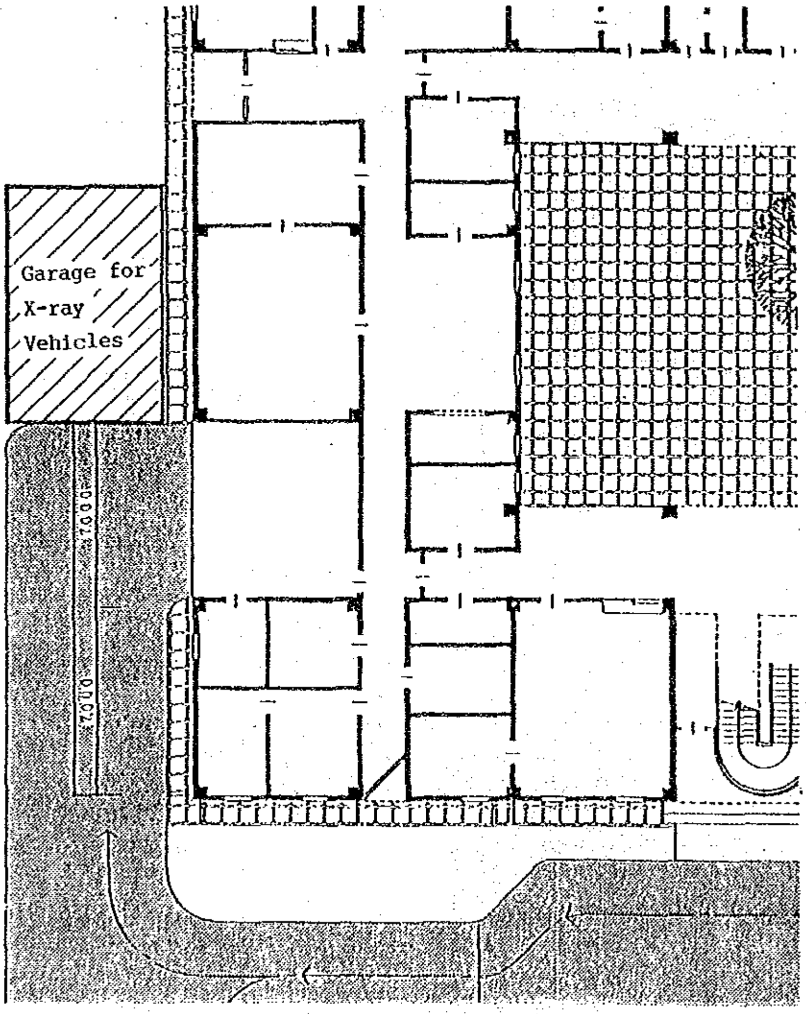


Fig. 10 Location of Garage for Roentgen Vehicles

(3) Equipment Plan

Each area, including the NTI (Sanaa City region), the Hodeida Subcenter (Hodeida Province) and the Taiz Subcenter (Taiz Province) is divided into 18 blocks consisting of Sanaa and other provincial areas.

In developing the countermeasures against tuberculosis, previously carried out by the former North Yemen's three centers centered on the NTI, to the national level after unification, the new Republic of Yemen has appointed and stationed GTCs at the central health centers in 18 areas throughout the country to improve local tuberculosis control. It is necessary for each HCU in these areas to play a role by undertaking its work with a minimum of equipment and materials, rather than by the system of direct patrol supervision which exists today. With this objective in mind, distribution of equipment and materials has been planned based on the scale and level of the HCU in each area. The results are as shown in Table 15.

Table-15 Equipment Distribution Plan

Primary medical care	Microscopes	Distributed to health centers which have received patrol guidance by local central health centers, NTI and the two subcenters under the administration of GTCs.
	First-aid kits	
Office equipment	Copiers, blackboards, typewriters, facsimiles	Distributed to support GTC's activities
	4WD vehicles	
Relatively advanced medical equipment	Automatic X-ray developing machines	Hodeida and Taiz subcenters only
	Water softeners	NTI, Hodeida, and Taiz sub-centers only.
	Aspirators	NTI, Hodeida, and Taiz sub-centers, and central health centers which are capable of proper use of aspirators.
—	Resuscitator sets	NTI, Hodeida, and Taiz sub-centers, and every local central health center. (Two places at Aden).
Personal computers		Provided to NTI and the Ministry of Health's anti-T.B. section for information link-up.
Ambulances		NTI, Hodeida Subcenter, and central health centers at Aden and Haderamout (Note)

Note: Since it was discovered during the survey that a hospital adjoining the Taiz Subcenter has a transportation system, it will also be used in the project. Equipment will be distributed as shown in Table 16. The distribution quantity of equipment will be determined based on the acuteness of demand for equipment. The equipment is intended to be distributed to health centers which have received patrol guidance by NTI and the two subcenters which have attained advanced medical level to fully utilize the equipment.

Table 16 List of Distributing Equipment and Materials per Area

Equipment / Area	Microscope	Automatic X-ray film developing machine	Water softener	First-Aid box	Emergency aspiration bag set	Ambulance	4WD vehicle	Personal computer	Copier		Blackboard	Typewriter		Facsimile	Aspirator
									S	M		Electric	Manual		
Sana'a	9		1	12	2	1	2	2		2	2	2		2	2
Taiz	10	1	1	12	1		1			1	1	1		1	2
Ibb	5			7	1		1		1		1		1	1	1
Hodeidah	6	1	1	8	1	1	1			1	1	1		1	2
Hajja	7			8	1		1		1		1		1	1	
Dhamar	11			4	1		1		1		1		1	1	
Al-Baida	3			3	1		1		1		1		1	1	
Saadah	7			5	1		1		1		1		1	1	
Mahweet	6			3	1		1		1		1		1	1	
Mareb	3			3	1		1		1		1		1	1	
Al-Jawf	2			3	1		1		1		1		1	1	
Aden	10			12	2	1	1			1	1	1		1	2
Haderamout	10			8	1	1	1		1		1		1	1	1
Shabwa	3			3	1		1		1		1		1	1	
Abyan	3			3	1		1		1		1		1	1	
Maharah	3			3	1		1		1		1		1	1	
Lahj	8			5	1		1		1		1		1	1	
Total	106	2	3	102	19	4	18	2	13	5	18	5	13	18	10

(4) Basic Design Drawings

1. NTI X-Ray Vehicle Garage

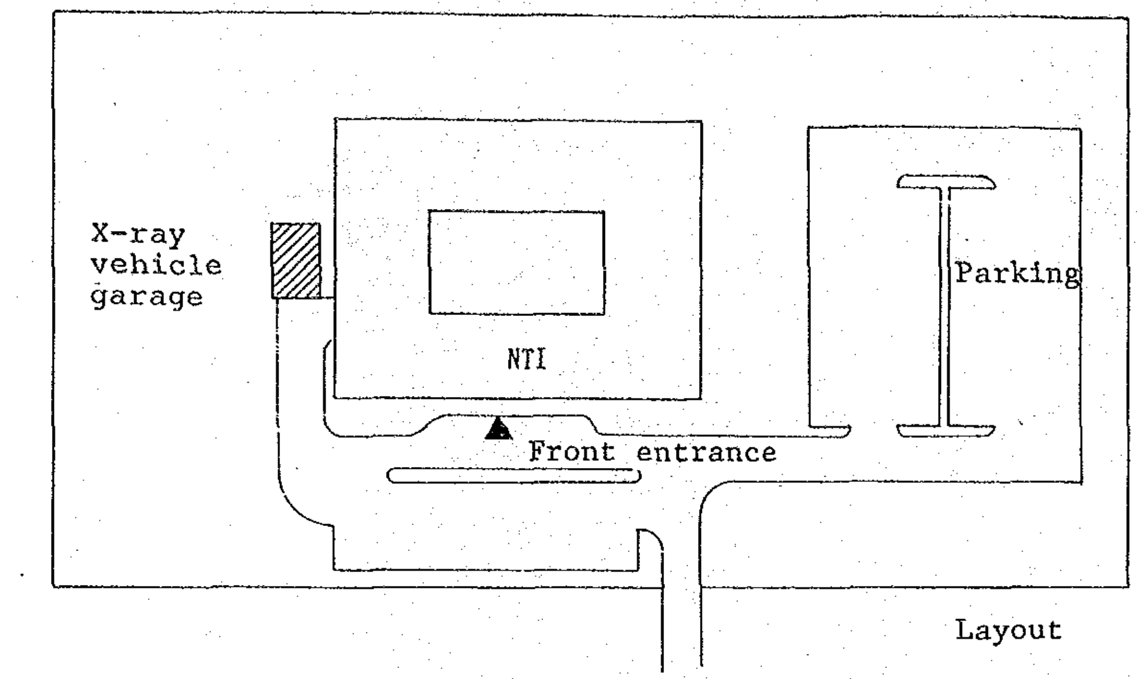
2. NTI Medical Supplies Store

3. Plan of Slope on Taiz Subcenter Site

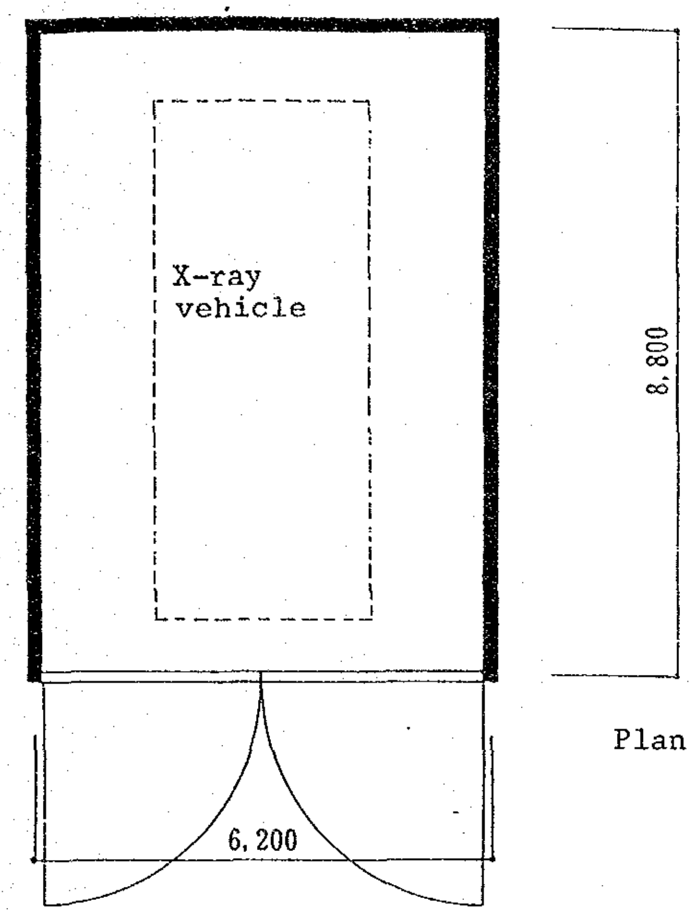
4. Section through Slope on Taiz Subcenter Site

5. Layout of Pressure-Driven Piles for Taiz Subcenter

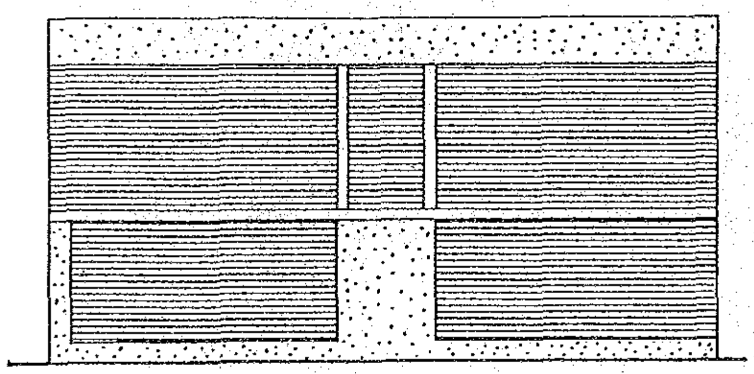
6. Outline Drawing of Pressure-Driven Piles for Taiz Subcenter



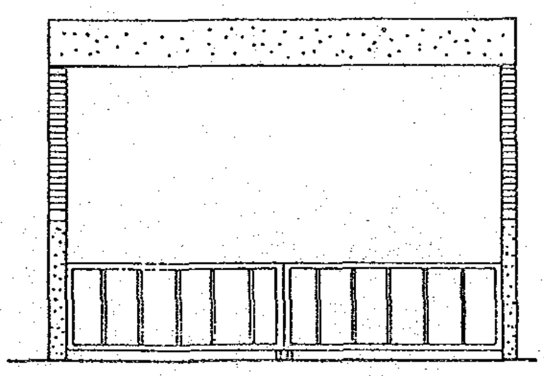
Layout



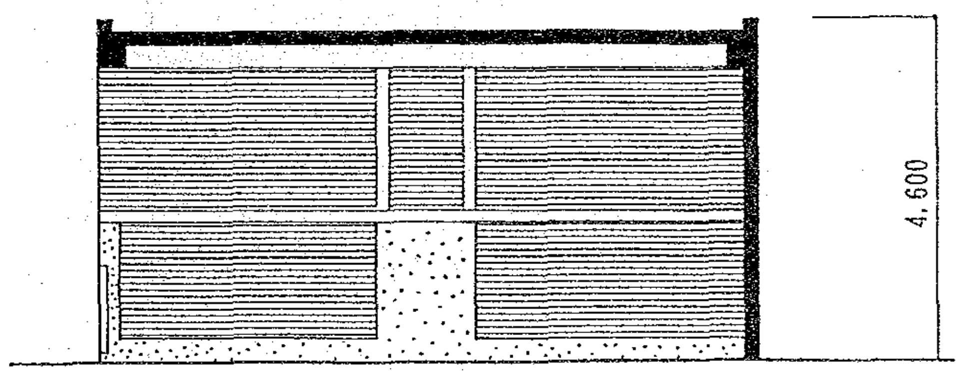
Plan



Elevation



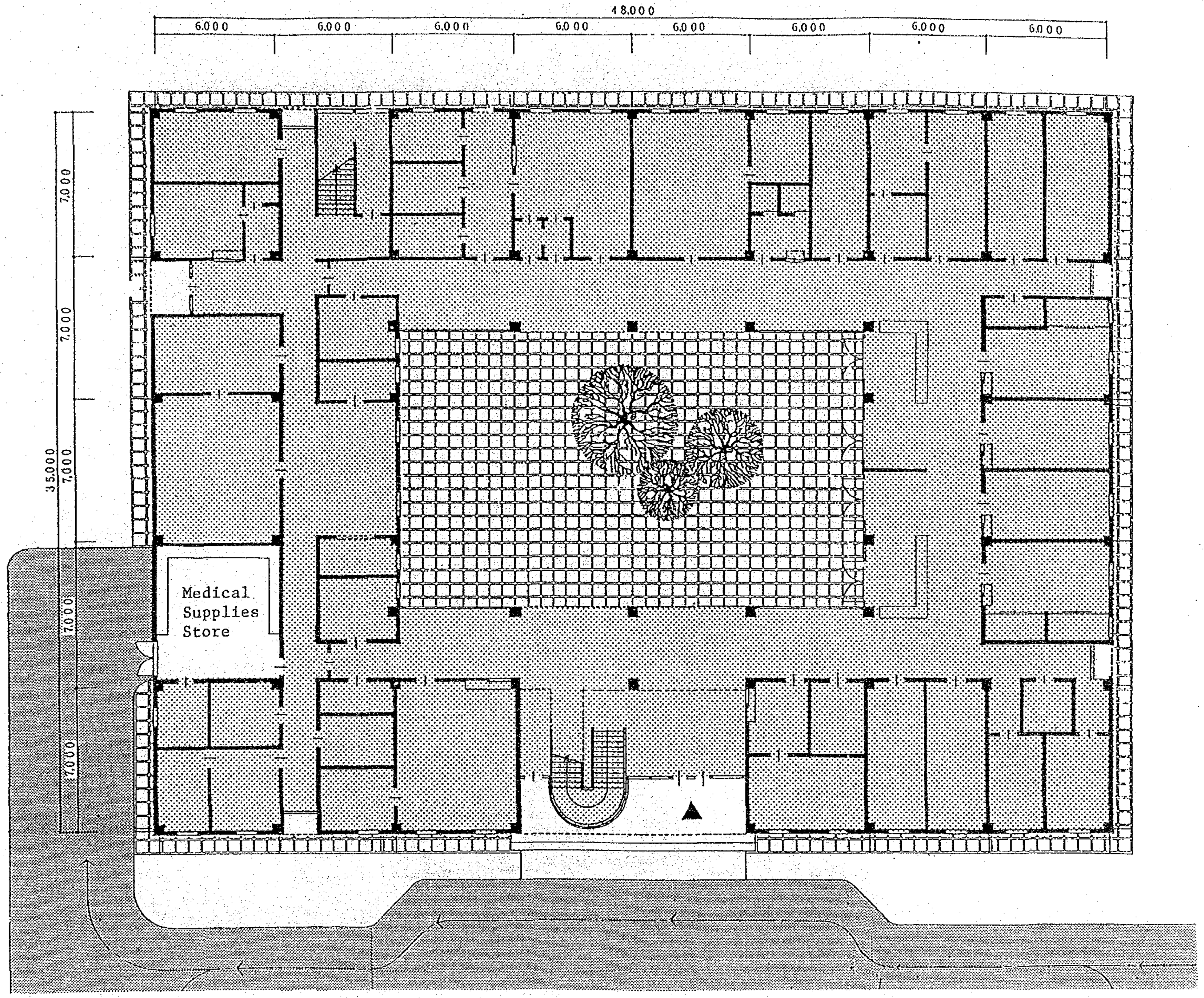
Elevation



Section

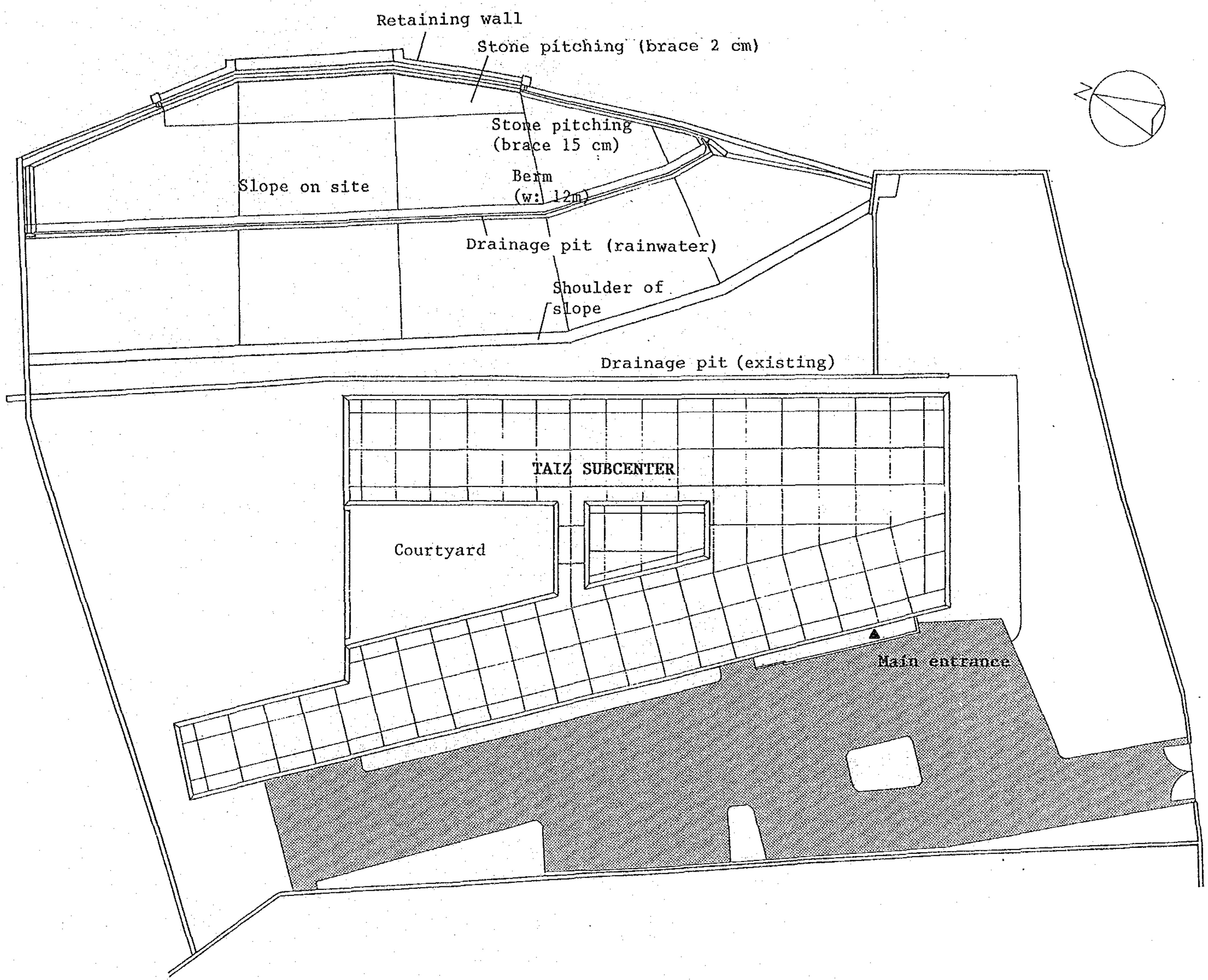
(4) Basic Design Drawing

NTI X-ray Vehicle Garage 1:100 | 1



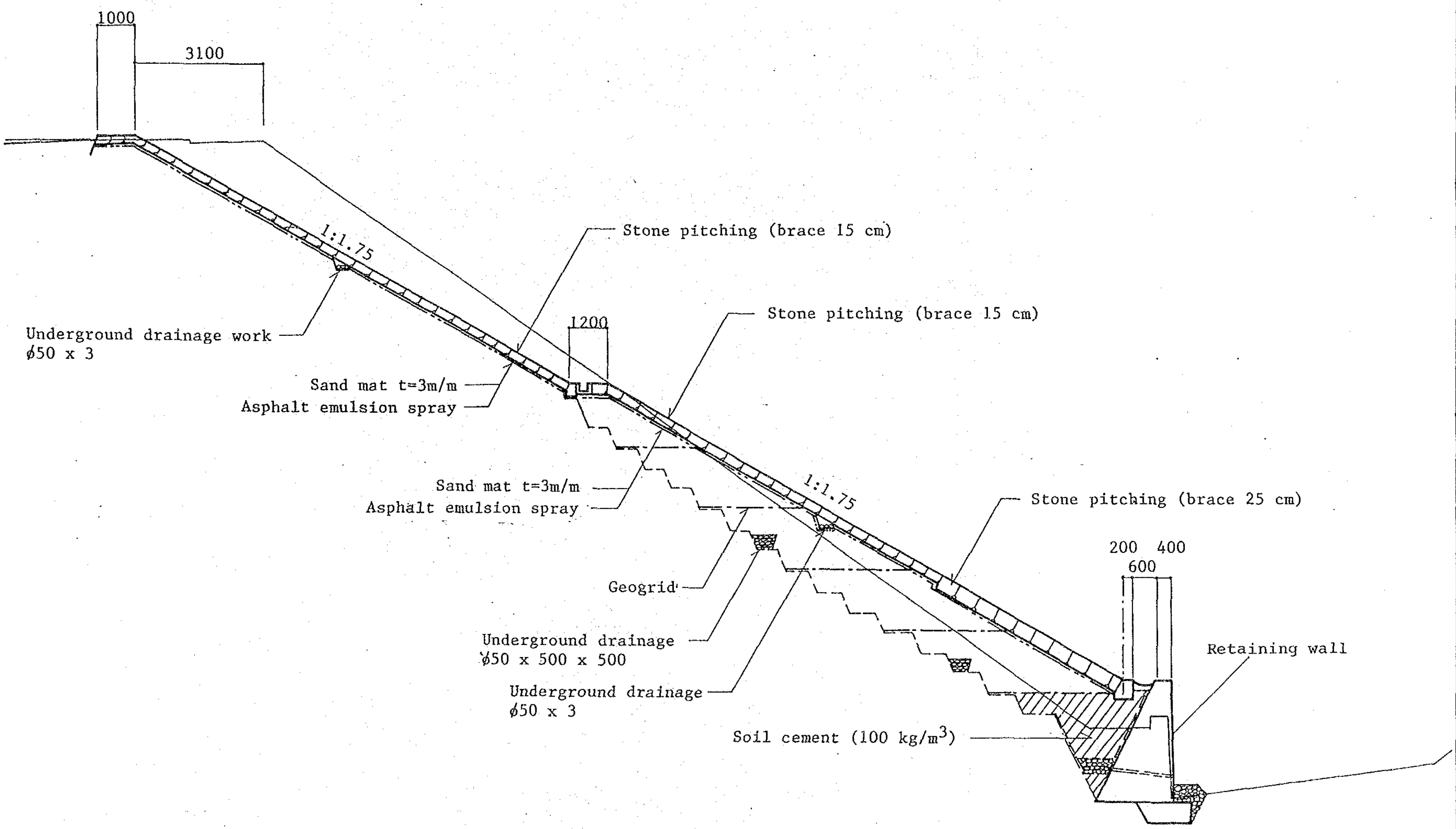
(4) Basic Design Drawing

NTI Medical Supplies Store 1:200 2



(4) Basic Design Drawing

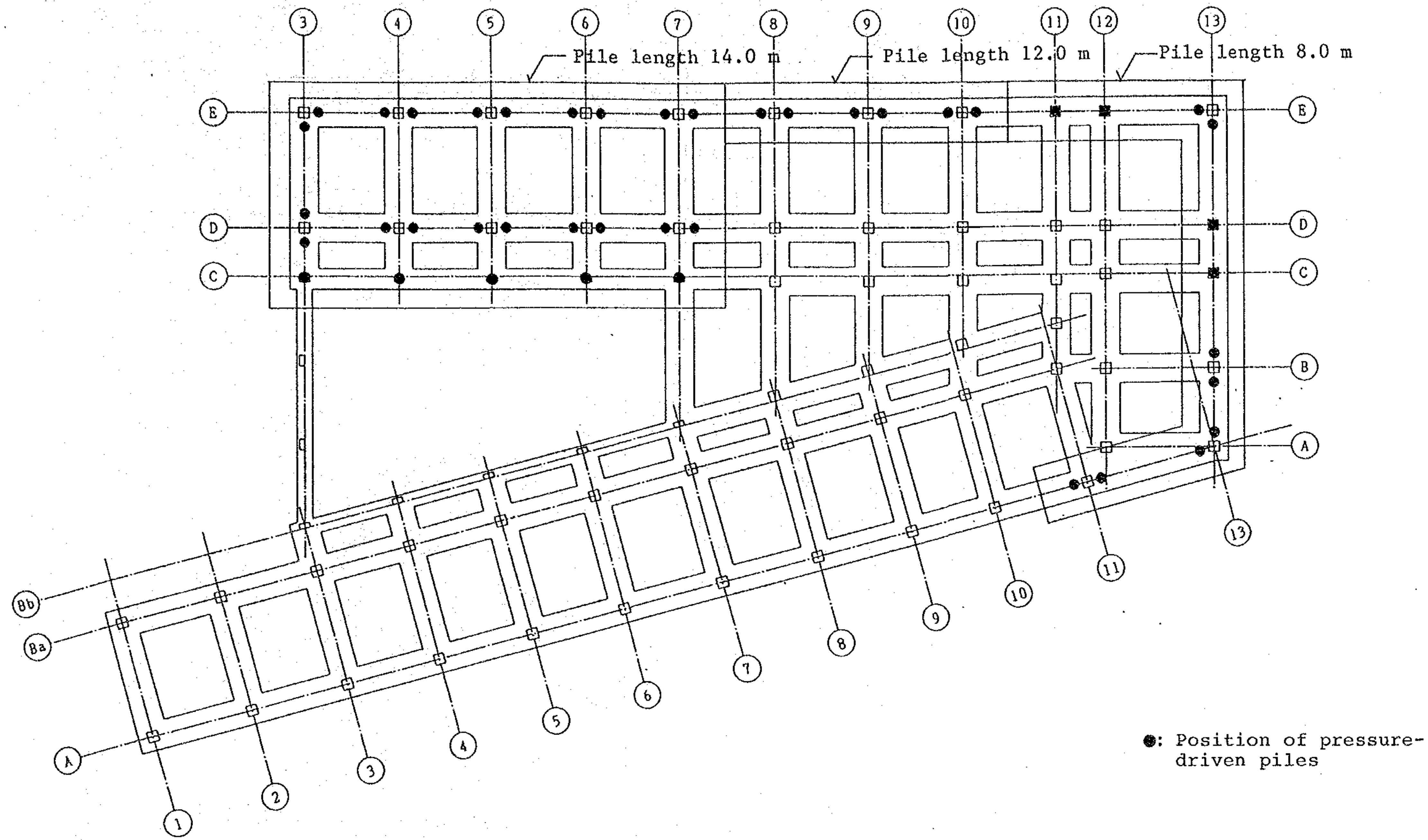
Plan of Slope on Taiz Subcenter Site 1:400 | 3



(4) Basic Design Drawing

Section of Slope on Taiz Subcenter 1:100

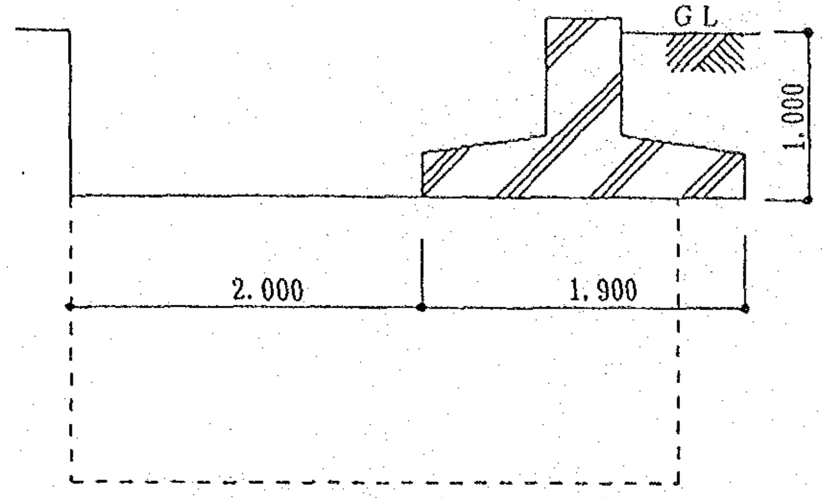
4



(4) Basic Design Drawing

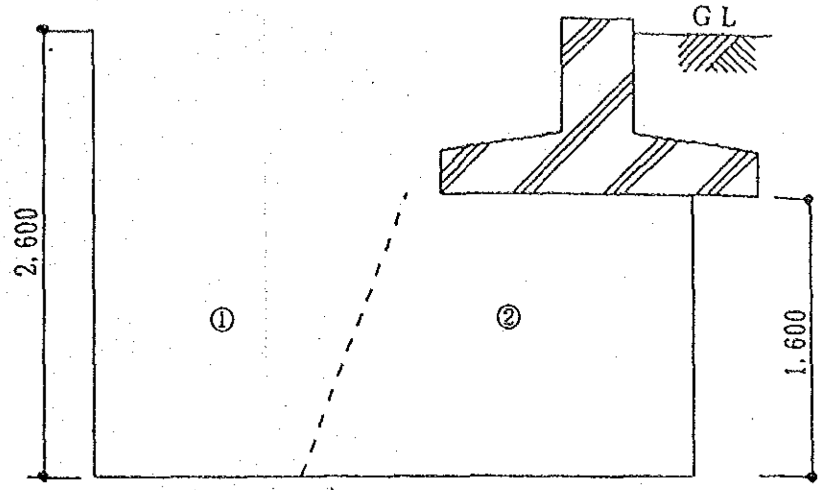
Layout of Pressure-driven Piles at Taiz Subcenter 1:300

5



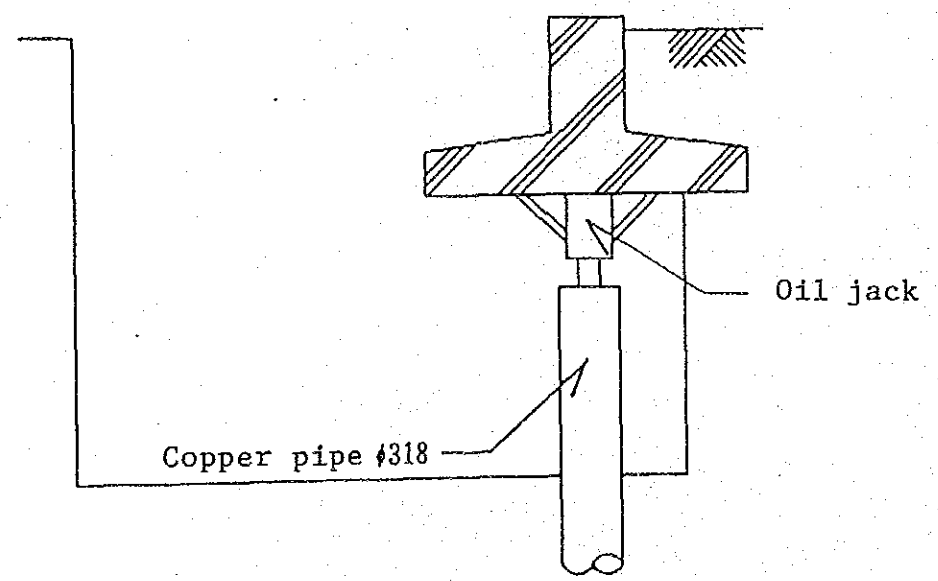
Peripheral excavation H=1.0m W=2.0m

External excavation | 1

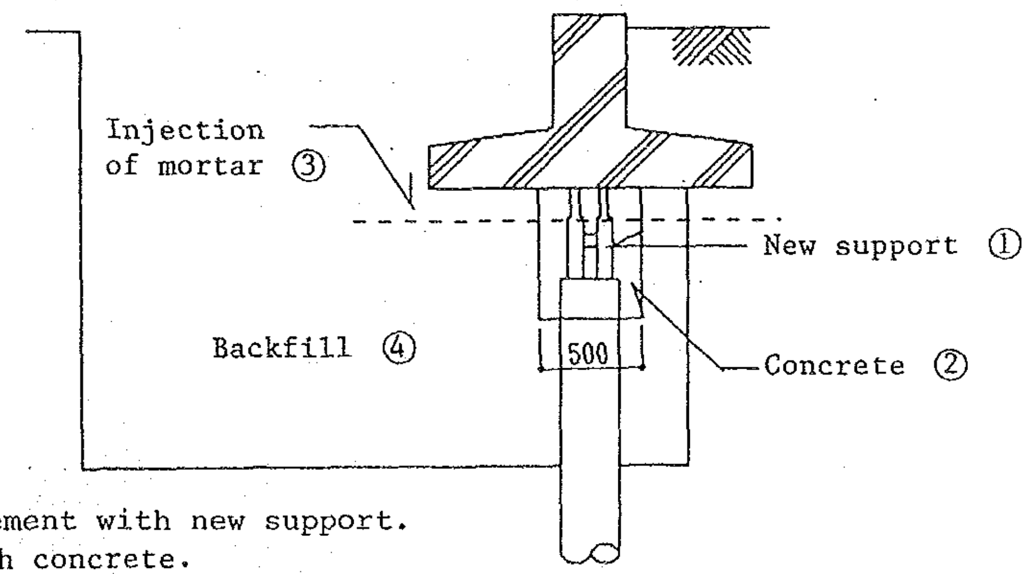


Constructed in sequence of ①, ② in width 1.0m and depth 1.6m

Excavation under foundations | 2



Steel pipe pressure-driven pile | 3



① Reinforcement with new support.
② Fixed with concrete.
③ Backfill and injected mortar about 20 cm in thickness under foundations.
④ Backfill periphery.

Anchoring and backfill | 4

(4) Basic Design Drawing

Outline Drawing of Pressure-driven Piles at Taiz Subcenter | 6

4-4 Execution Plan

(1) Execution Policy

The plans for executing the NTI storage area for medicines and the garage for X-ray vehicles should all be made such that they can be handled using locally available skills. On the other hand, measures for the slopes at the Taiz subcenter will be supervised by Japanese engineers who are to stay at the site since stabilizing the slope is directly related to stabilization of the entire site and because reinforcing the building foundations also includes tasks beyond the capabilities of locally available skills. The roles of the Yemeni and Japanese sides, respectively, are shown in Fig. 11 below.

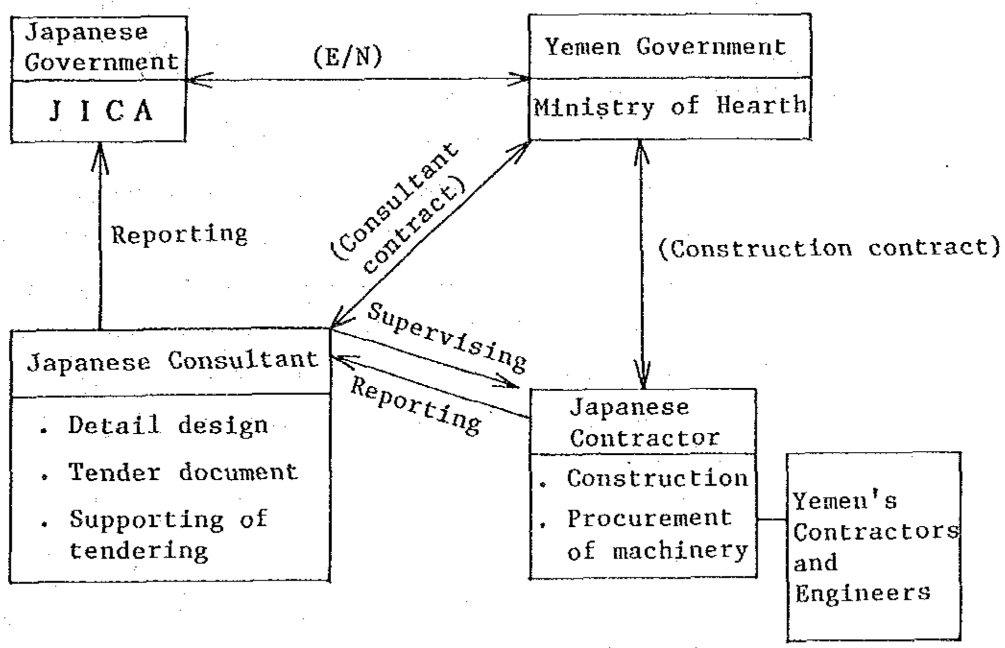


Fig. 11 Roles

(2) The Local Construction Industry and Points to Note in Executing the Project

Procurement of materials and manpower within the Republic of Yemen is basically possible. It may, however, be deemed necessary to dispatch engineers from Japan for work requiring a high degree of technical accuracy, such as reinforcement of the building foundations at the Taiz subcenter.

Since almost none of the medical equipment is being locally manufactured, this means it must be procured from Japan. It is necessary to select manufacturers whose maintenance systems are well established so that no problem occur with maintenance, management or repair of such equipment.

The Japanese contractors will be in charge of execution and supervision, while the locally contracted laborers should handle physical work.

(3) Execution and Supervision Plan

In the execution and supervision of this project, it is important to match the local procurement of materials with the schedule, to secure their quality and accuracy, and to make adequate plans to transport the equipment and materials procured from Japan. Construction supervisors should be dispatched from Japan when starting and completing each operation.

1) Management activities to be performed in Japan:

. Comprehensive process management and checks of the reporting process.

. Approving execution programmes submitted by constructors, site engineers, materials and equipment, manufacturers, and subcontractors.

. Inspection of such domestic products as equipment, materials, and supplies, to be delivered to the site.

. Reporting activities to the Japanese authorities.

2) Supervisory activities to be performed on site by the supervisors:

. Joint attendance at, supervision of, and technical instruction in various tests.

. Inspection of such products as equipment and materials which are manufactured locally.

. Site instructions for solving problems and other matters concerning the execution of work.

. Checking and approving the drawings for execution of work.

. Reporting activities to the Employer and activities concerning the matters approved by the Employer.

. Inspection of each process.