SUMMARY

It is undisputed that the existence of roads is an imperative requirement for smooth development of rural areas. Unfortunately, roads have very often a rather destructive impact on the environment of adjoining areas and therefore, a bad reputation among experts conscious of the natural environment. Road builders should and can do a lot to improve this unpleasant situation by giving top priority to environment protective measures. Such measures should be an integral part of all activities from survey to design, construction and through the whole life span of the road. A precondition to success in this regard is the active cooperation of all concerned people (politicians, government officials, engineers, labourers, and farmers) who should be or become aware of the problems.

What were the main difficulties we had to overcome in the LJRP, not only in terms of environmental protection, but also in general?

- The cooperation between Nepal and Switzerland is based on the so called "Counterpart System" which is without doubt a good system with many advantages (e.g. possibility of know-how transfer, identification of DOR with project) but it also requires from both the individual counterparts a lot of goodwill, the readiness to listen and to understand the socio-cultural situation of the other, mutual confidence and respect, taking one's share of responsibility, etc. This is quite a difficult task if the not always uniform interests of the individual partners is considered. If the partners do not succeed in their cooperation the project as a whole might suffer.

- Another problem was the compulsion to apply the HMG/N administration's rules and regulations for project implementation. Here too, such a project concept has enormous advantages (HMG/N's identification with the project, strengthening of HMG/N's administrative bodies, etc.) but serious disadvantages, too, like being dependent on an administration which is rather slow and inflexible, creating huge delays in the construction programme and therefore, considerable cost increases (inflation, running fixed cost). This problem could be lessened considerably by the introduction of some special regulations for the 2nd project phase. It is clear, that such alterations can only be considered as curative measures. Real improvement of the administrative system must aim at its roots (e.g. delegation of authority).

- Without the timely payment of land compensation to the concerned farmers along the road, the local population will not cooperate with the project. A precondition for the identification of the local people with the project and the basis for successful implementation in the long run is the cooperation of the local population. Again, the 2nd project phase gave the opportunity to solve the problem (funding of land compensation by the SG).

- The awarding of piece-contracts to local petty contractors is a lengthy and arduous procedure which can cause serious delays in the construction programme. The issues here are understandably complex and, as in all countries, many factors other than simply work efficiency affect the choice of contractors and labour. Naturally the project prefers contractors who guarantee good work quality and timely execution, and would wish to make this the only criterion. The situation could be improved by introducing a procedure which allows a preselection of 150% of the needed number of contractors, purely on grounds of ex-

perience and efficiency with the final selection then taking into account the judgement of local leaders

- A technical problem of comprehensive implications is the achieving of a smooth and controlled surface water run-off. The solving of this problem is the key not only to minimize maintenance cost but also the overall investment in the long run. Besides that, it is a substantial contribution to efforts aiming at avoiding environmental damage. The most important measures in short are:

- Proper drainage of water-saturated slopes and spring run-off,

- Sealing of side drains against water penetration into the underground along slide endangered sections,

- Side drains should be discharged only into natural brooks, rivulets, and rivers,

- Steep gullies carrying an increased water volume due to road water discharge should be protected by check-dams as far down as necessary to avoid depth and side erosion of the riverbed.

- Another far reaching issue is the quality of construction material and work execution especially in regard to long term cost savings. Only rigid site supervision combined with hard punishment for the contractor in case of bad quality can be the right solution. The execution of quality tests is a complementary method to force the contractor to do a good job. Our big problem was the lack of sufficient Swiss supervisory staff to guarantee consistently good work quality. Therefore, we had to adapt certain construction techniques to tackle the problem (side drains, blacktop).

- The problem of the selection of an appropriate binder for the blacktop layer could be solved quite easily after tests had given encouraging results in favour of bitumen emulsion. We could, therefore, avoid using a binder (bitumen) which has to be heated up with firewood for its application. A cost comparison of the two techniques shows a difference in favour of bitumen application if only the market price of firewood is considered. This difference becomes invalid if the cost of regrowth of firewood (reforestation) and the existence of the new bitumen emulsifying plant at Hetauda is taken into account. It is, therefore, strongly recommended to use bitumen emulsion as binder for hillroad construction and maintenance if labour intensive methods are applied, to save valuable energy resources in favour of the local population who is completely dependent on it.

- The World Food Programme support for the project had mixed results. On the one hand it helped to stabilise the local market situation, but on the other hand, the problems created by the mostly unreliable distribution of food were quite serious at certain times when no food was available over long periods. The labourers ran away from the site and the work came to a standstill. We were not able to improve this unhealthy state as we had no say in the matter. For future, similar arrangements HMG/N should leave the responsibility for the transportation and distribution of food to the project itself to guarantee proper coordination between WFP and the construction programme.

Fortunately, our project agreement allowed us to take advantage of lessons we were taught during the project implementation by nature or the prevailing circumstances. Several times we had to reconsider whether and how our proceedings should be improved. The following represents the most important changes in our course of action:

- Initially, we designed the road to be cut completely into the slope in order to have it secure enough if slides should happen later on. This philosophy proved to be completely wrong as our experience showed during the monsoon. A maximum of surplus material from the road profile excavation had to be deposited as closely as possible (no access for mechanised transport yet), but safe places were mostly not available leaving only the possibility of throwing it down over

the road edge. These loose soil masses started to slide down as soon as the monsoon began. But the upper road slopes which were much steepened in the course of road profile excavation failed too. The disaster along the first 6 kms was complete as this section is characterised by a winding upwards of the road with several hairpin bends in a narrow corridor (Cover Plate). Thereafter, we designed the road in order to reach a mass balance in the cross section if possible and over short sections in the long section to minimise surplus material. It is evident that this proceeding results in higher earthwork cost as vs retaining walls become necessary.

- In the course of this philosophy, the sequence of earthwork activities had to be changed to respond to environmental protection aspects. The following is the ideal sequence:

- Collection of topsoil for re-use (bioengineering measures) above the road profile,

- Construction of vs retaining walls, if any,

- Excavation of road profile and backfilling of vs walls,

- Drainage of ms roadslope, if necessary,

- Construction of ms toewalls, if any,

- Construction of temporary side drains,

- Bioengineering treatment of road slopes.

Rock material gained from the excavation has to be collected for re-use (construction of walls, side drains, stone soling, etc).

- It happens again and again that traffic forecasts are inadequate. This was also the case for the LJR where traffic censuses reach already 200% of the estimated number of trucks in the first year after the completion of construction. This fact forced us to execute a blacktop reinforcement programme on the first 60 kms. But not only was the number of trucks underestimated, but the amount of overloading too, especially where the mine transport from Kharidhunga to Lamosangu was concerned. Our calculation was based on an overloading rate of 50%. In reality, we had trucks with 75% overload!

- Comparisons between gravel and blacktopped roads show that the long term investment (construction and maintenance cost) is lower for blacktopped roads if their gradients exceed a certain limit. In the case of the LJR this result is enhanced by the fact that the occurrence of suitable gravel material along the road is too limited to maintain a gravel road during its assumed life span. It was, therefore, decided to revise the initial concept and build a blacktop road surface.

- In the sequence of road construction activities the critical stage is reached when the earthwork is completed. Normally, earthwork construction lasts a full construction season and the watermanagement works can only start at the beginning of the following season. Therefore, the monsoon hits a structure which is not yet armed accordingly and serious damage will be the consequence if preventive measures are not taken in advance. Again, we have been taught accordingly on the first 6 kms. These preventive measures consist of two things:

- Construction of a temporary water management system consisting of dry masonry side drains and river crossings (causeways),

- Bioengineering measures on the adjoining road slopes.

These measures have to be executed before the monsoon starts.

- Finally, a side effect of our road base construction was the finding that the stone soling layer could be a solution for an improved gravel road surface of much better durability than the water bound gravel surface has. It is therefore recommended to have as the first layer a normal gravel layer, followed by a thin sand layer (5 cm), before the stone soling is added as the surface layer.

Given the present situation of road construction in the hills, we were struck by the fact that quite often well known basic rules about engineering are not followed. Let me mention a few:

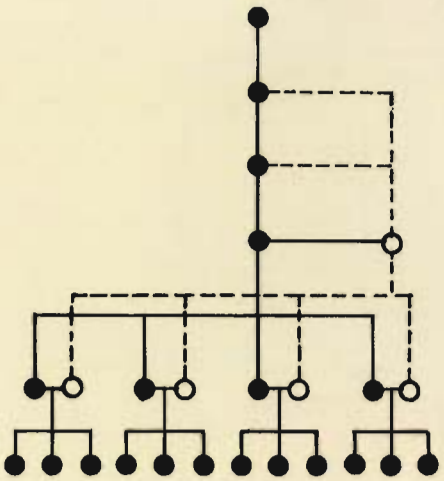
- Survey and design should be given enough priority in the course of road construction. In normal cases, these activities swallow only about 10% of the total construction cost. This is almost negligible vis-a-vis the 90% construction cost. It should, therefore, be executed very carefully and thoroughly to guarantee the best possible alignment selection. Therefore, only very experienced experts in the fields of geology, road, and structure engineering are good enough for this task. Sloppily executed survey and design may easily result in a doubling of construction and maintenance cost as well as enormous environmental damage.

- Erosion protection may often seem to be a foreign word and is not taken seriously enough. Compared to other road construction components it is rather cheap but has far reaching consequences in regard to environment stability and financial savings (maintenance). It is a continuous task from the construction stage throughout the road's life span.

- The same is valid for maintenance. So far, maintenance is neglected badly in Nepal. This fact shortens the life span of a road enormously, with serious financial consequences and may even double the volume of investment for a given road network in a certain period. Maintenance, too, should start just after construction completion (preventive concept) and is a continuous task throughout the road's life span.

- Considering the low priority given to maintenance, it would be justified to invest a bit more during the construction phase to minimise future maintenance cost. The overall investment (construction plus maintenance cost) will become smaller.

FIG. I COUNTERPART SYSTEM (JOINT DECISION TAKING)



(Source, Lit. 3)

FIG. 2 PROJECT ORGANISATION CHART IST PHASE

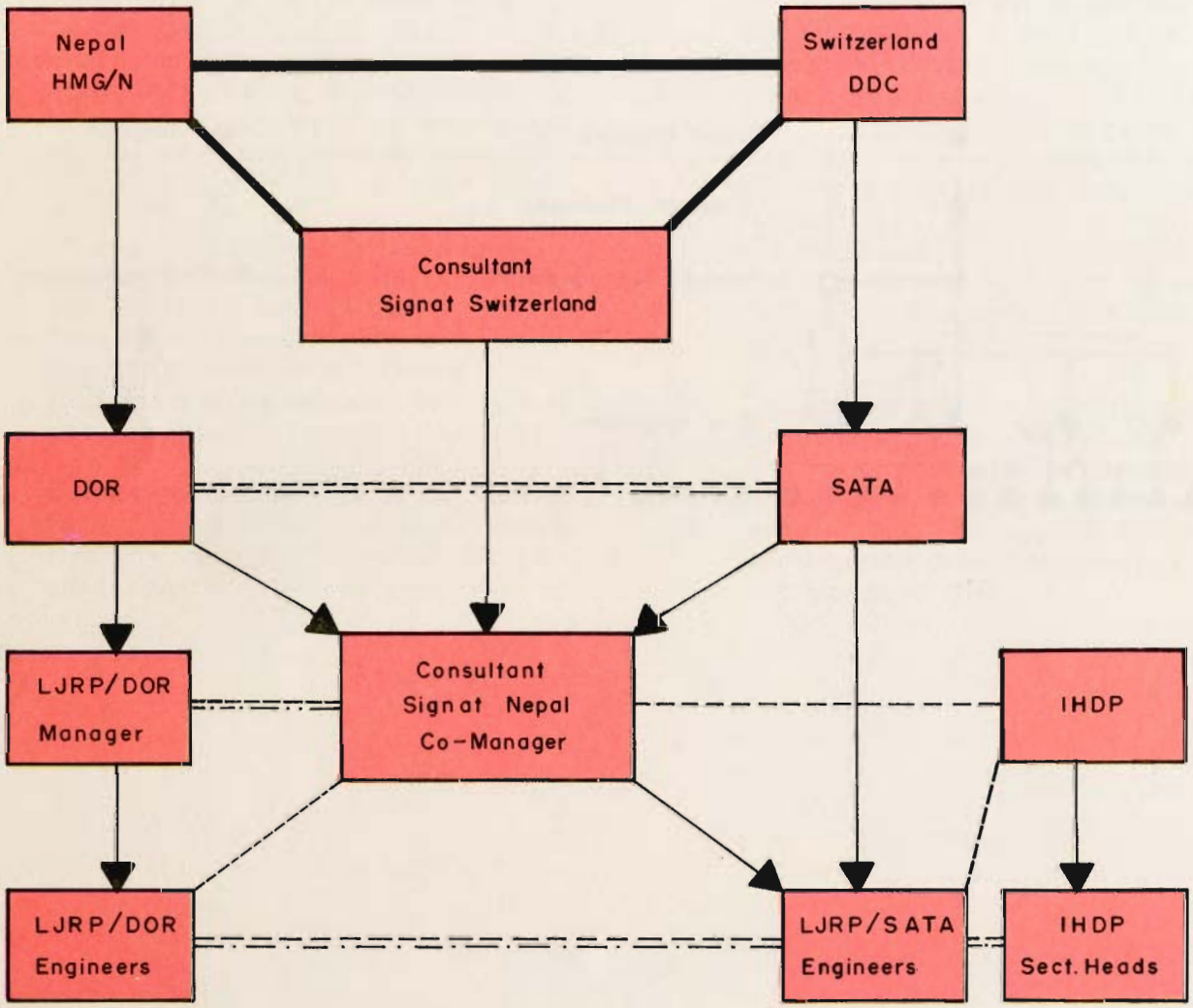


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FIG. 3 PROJECT ORGANISATION CHART 2ND PHASE

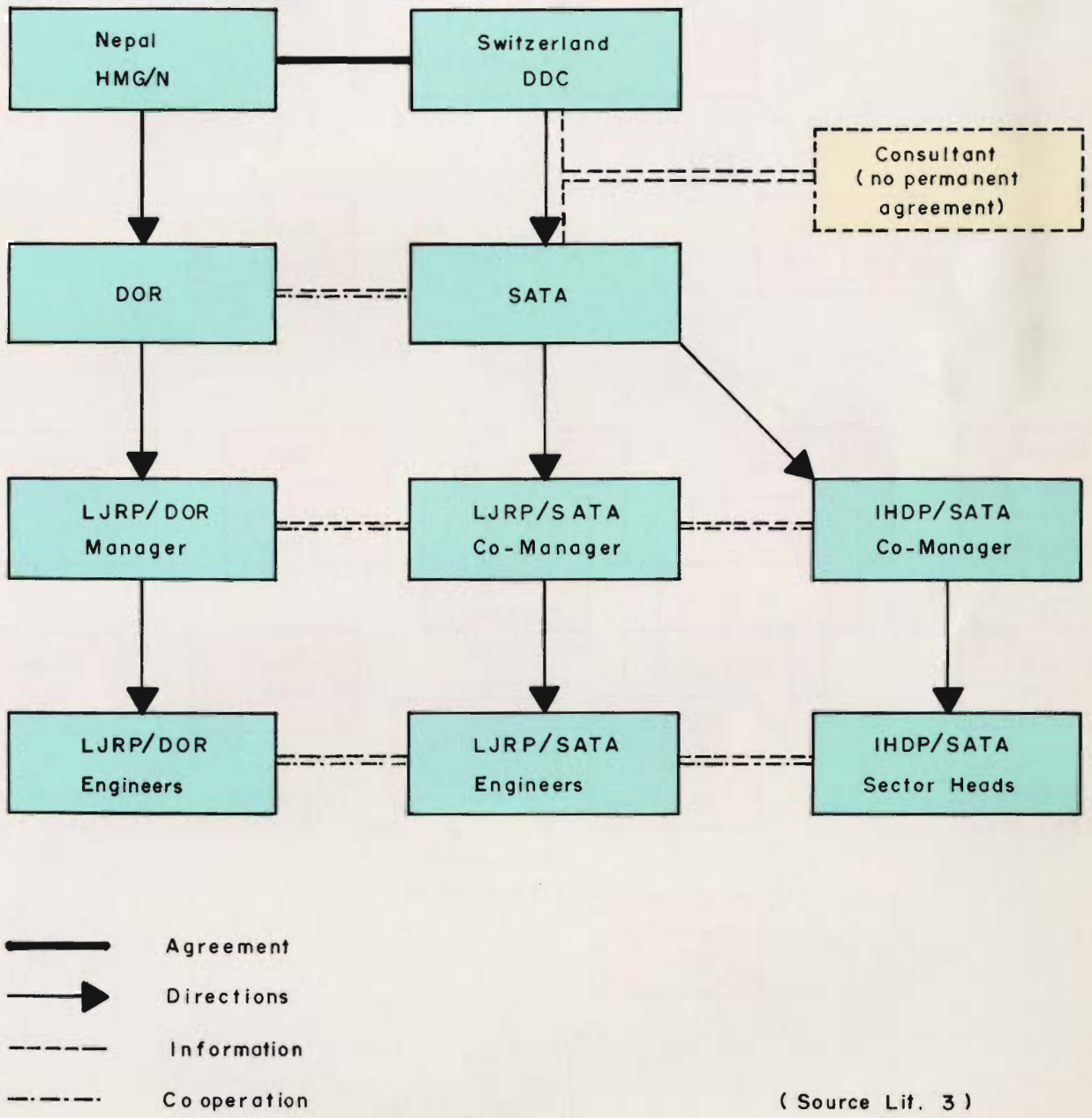

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FIG. 4 ORGANISATIONAL STRUCTURE OF PROJECT

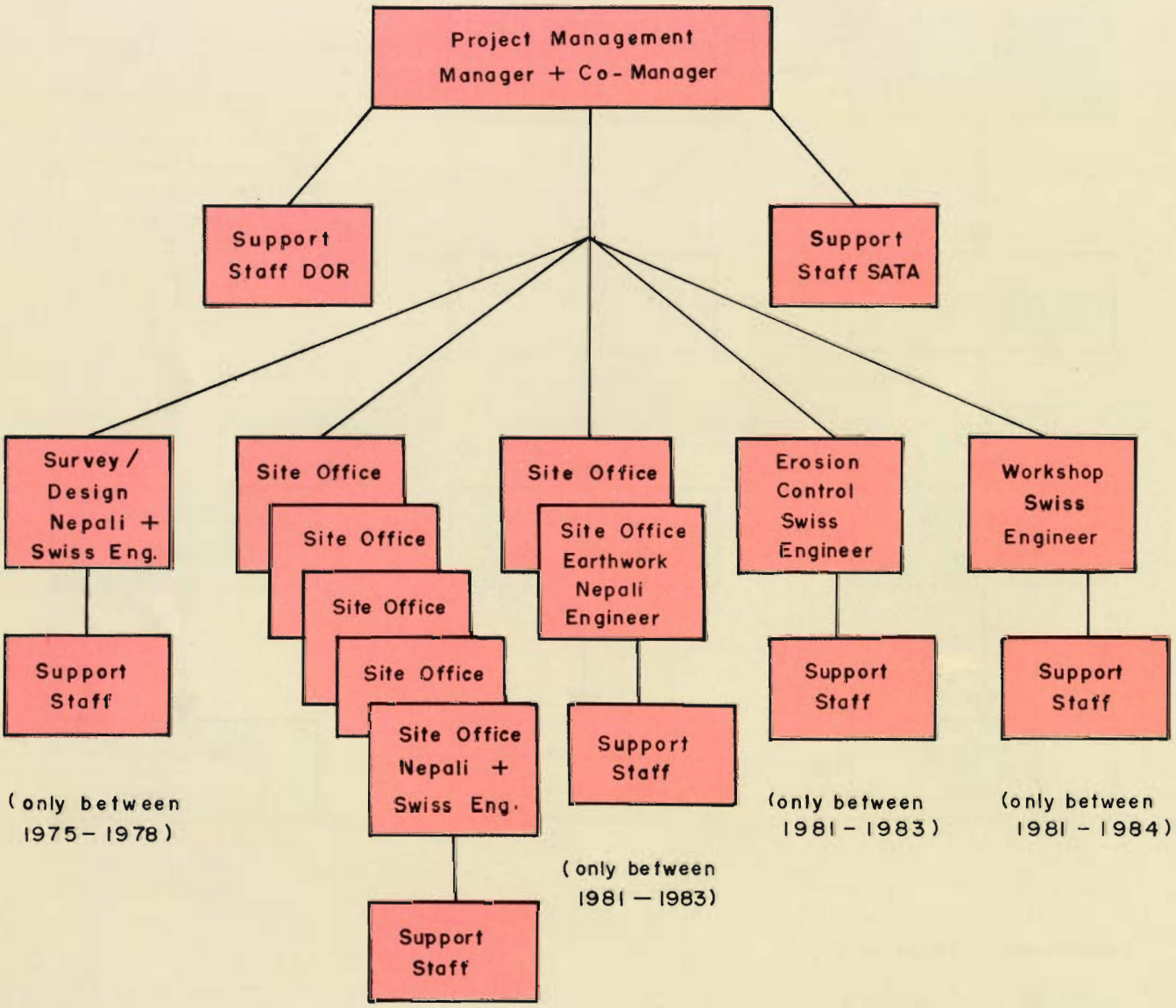


FIG. 5 ROAD BASE STANDARD SECTION

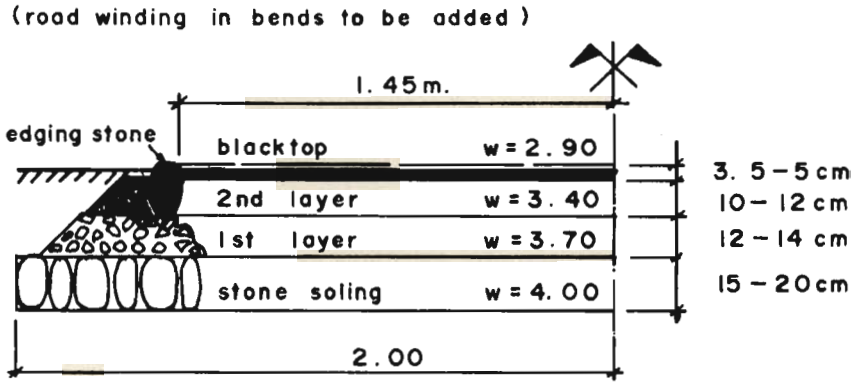


FIG. 6 STANDARD CROSS SECTION

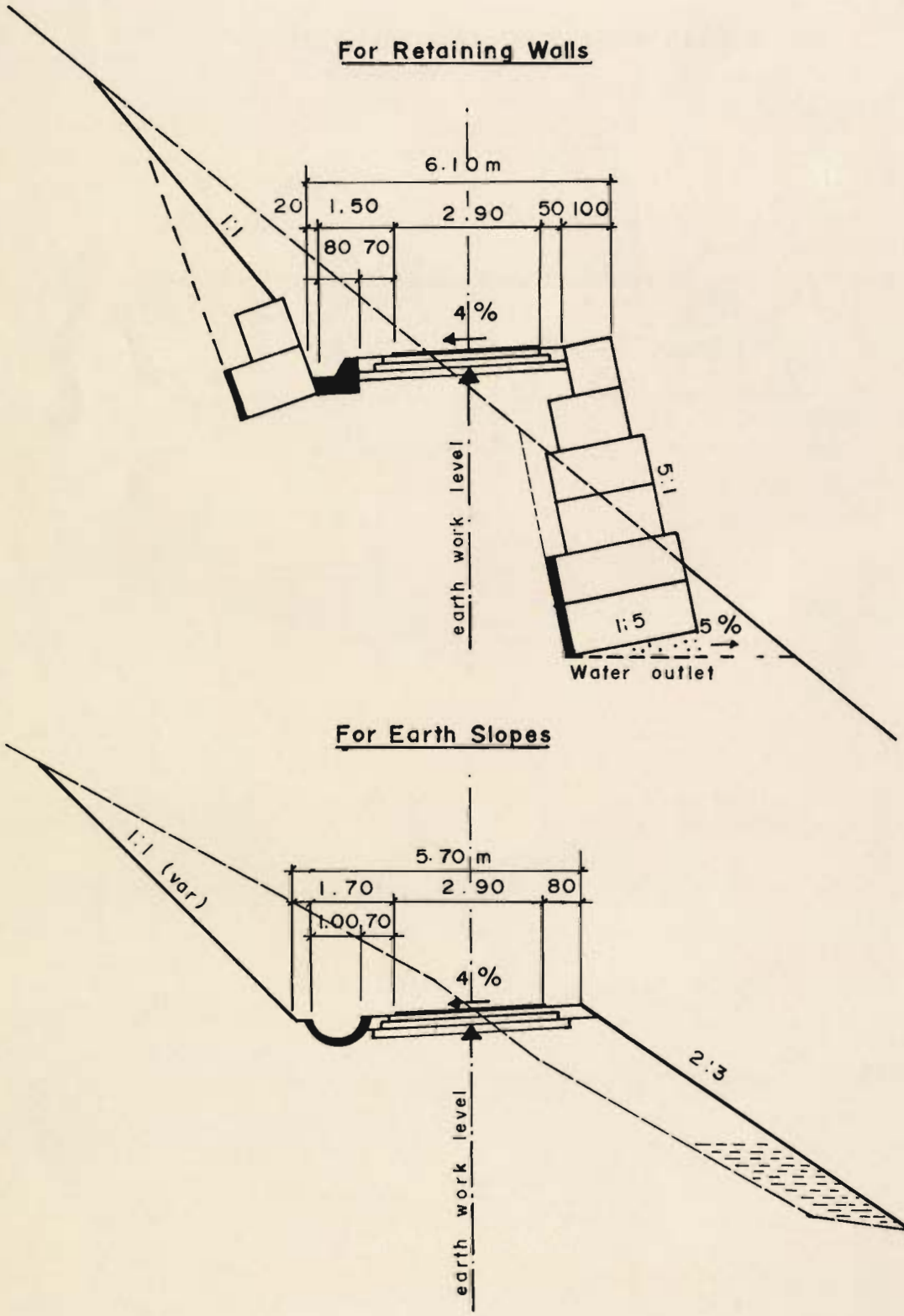


FIG. 7 FIXING OF CENTRELINE IN SLOPE

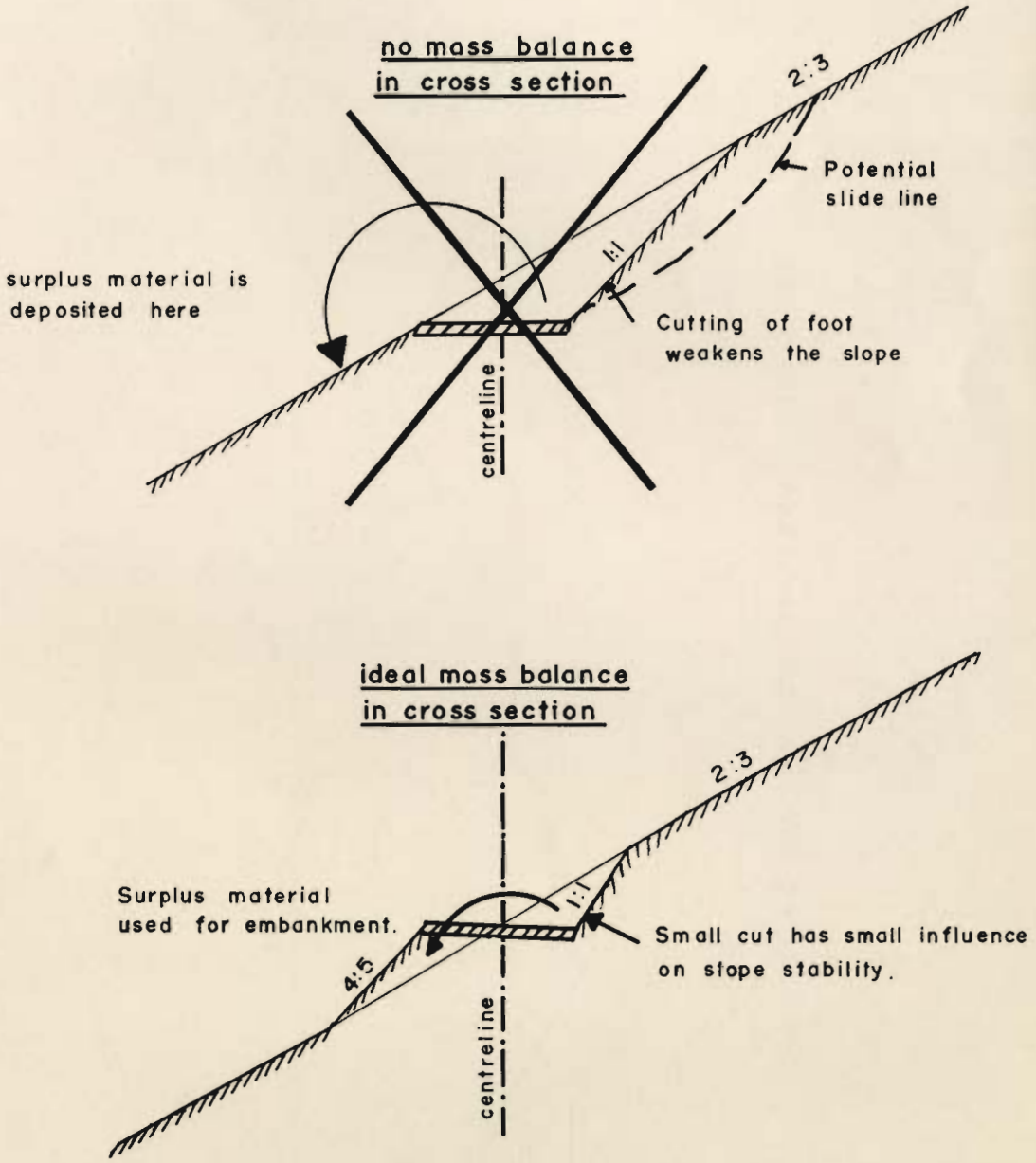


Fig. 8

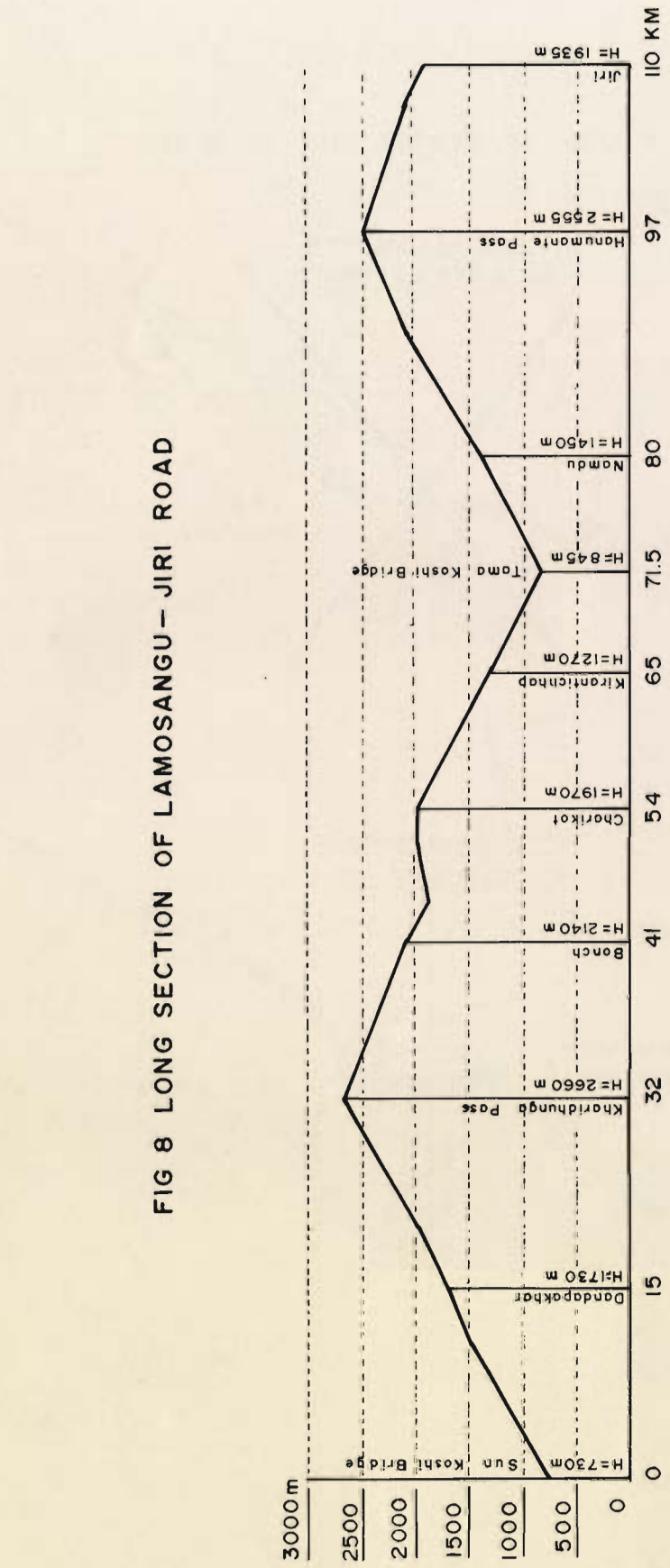
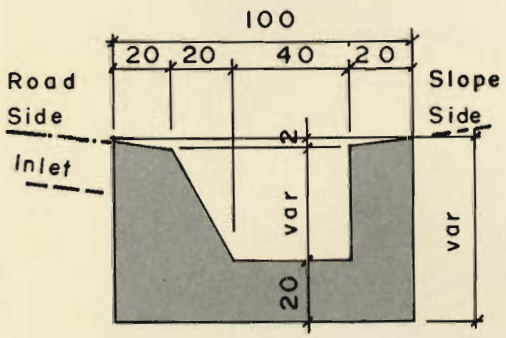


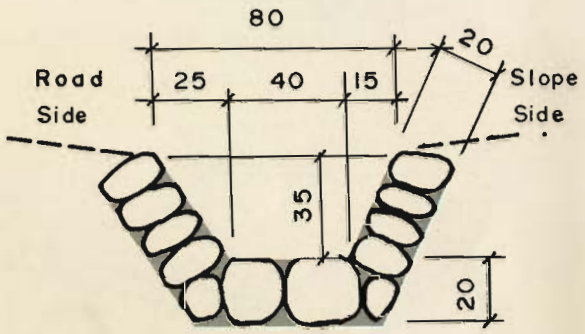
FIG 8 LONG SECTION OF LAMOSANGU – JIRI ROAD

FIG. 9 SIDE DRAINS — STANDARD TYPES

Cement Masonry



Dry Masonry: Type A



Type B

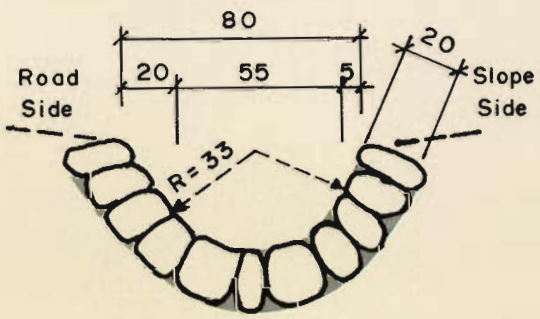


FIG. 10 SLOPE DRAINAGE SYSTEM

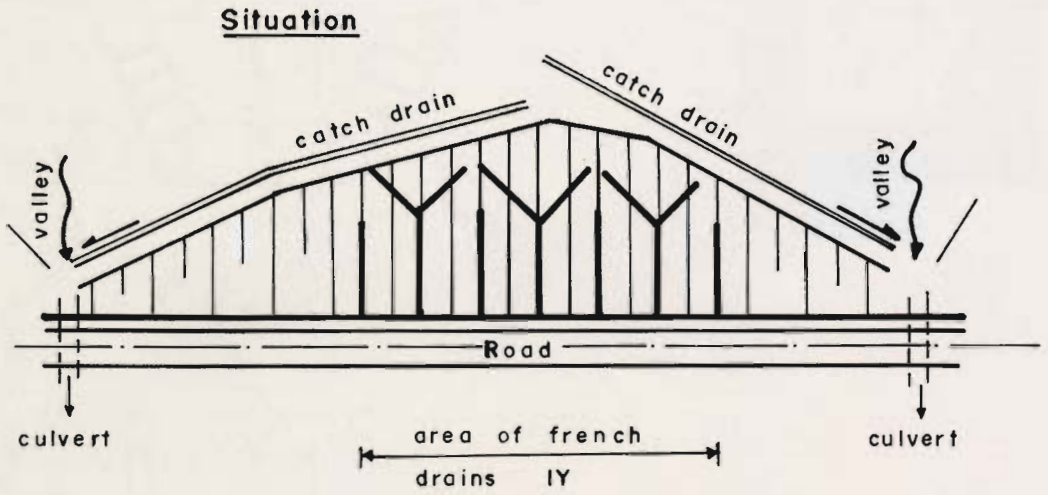
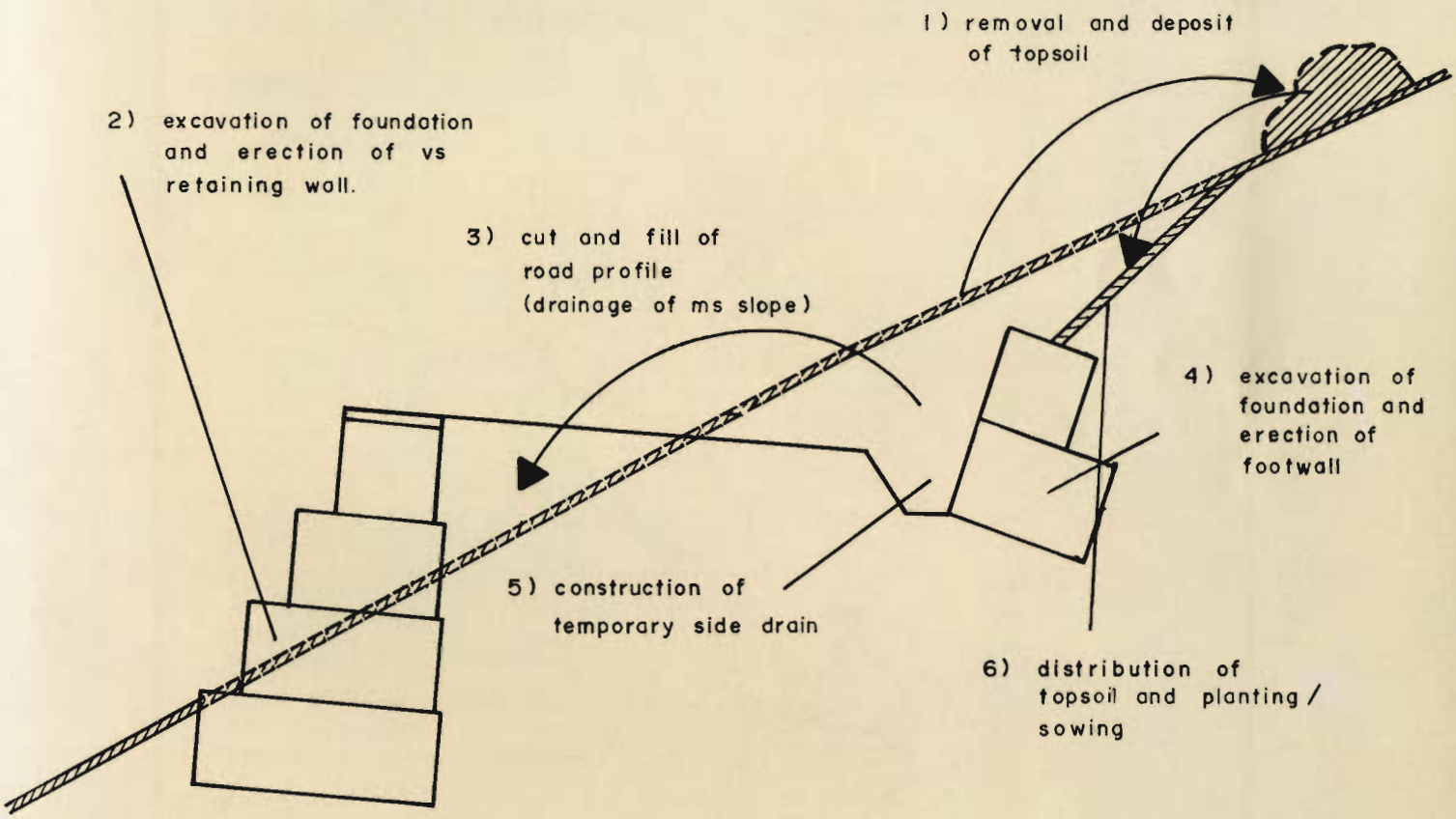
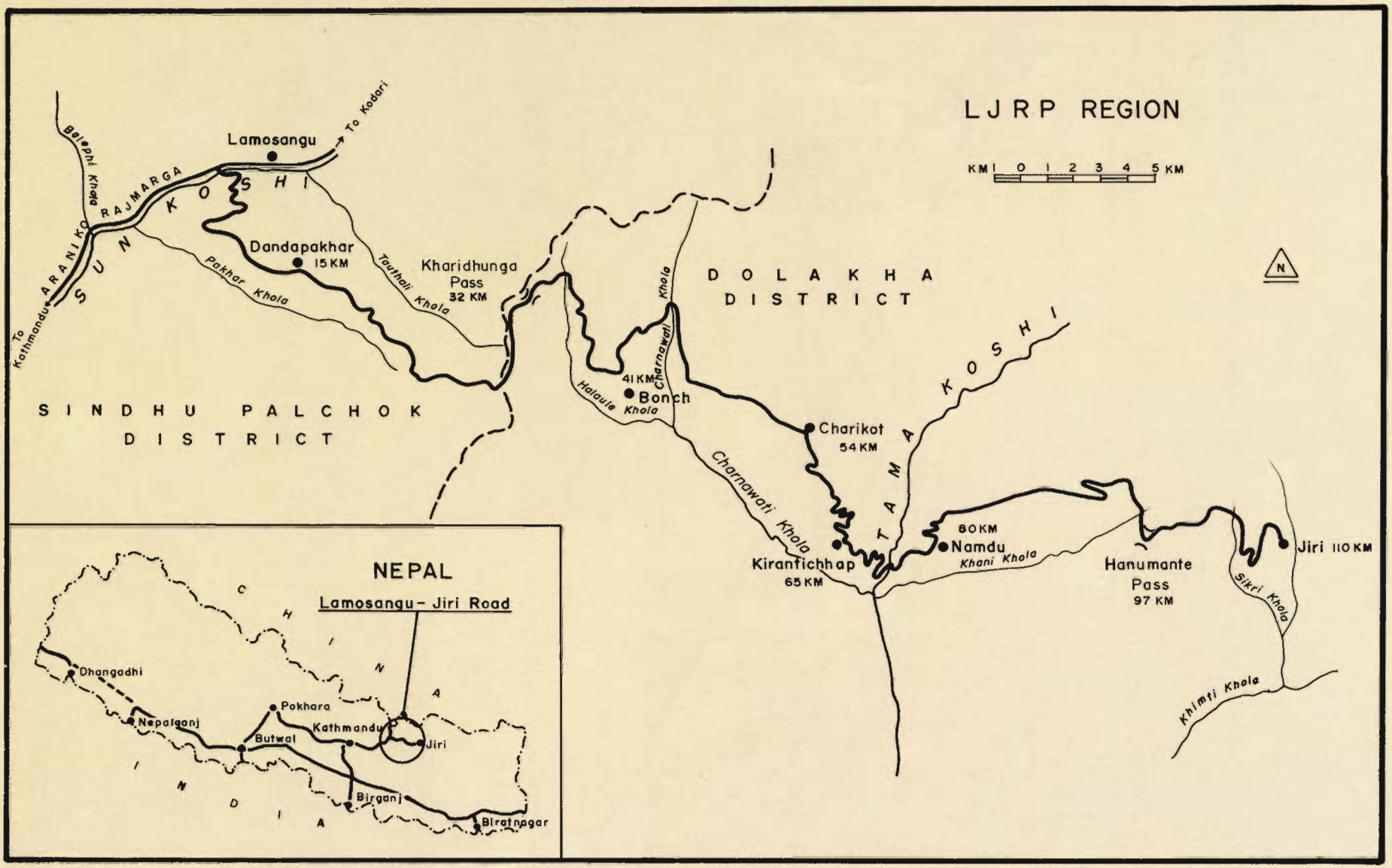


FIG. 11 RECOMMENDED SEQUENCE OF EARTHWORK STEPS WITHIN CROSS SECTION



MAP I PROJECT . AREA



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