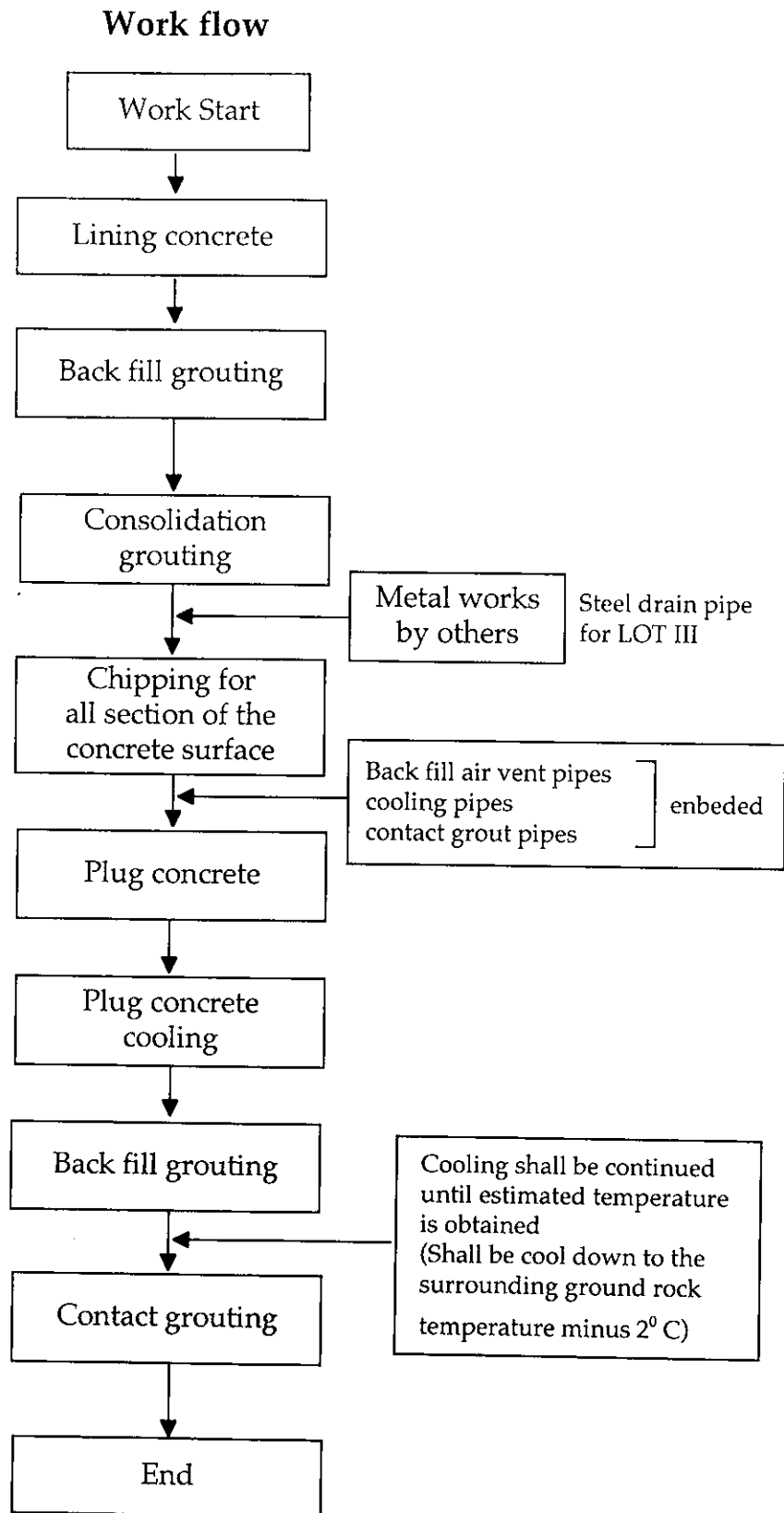


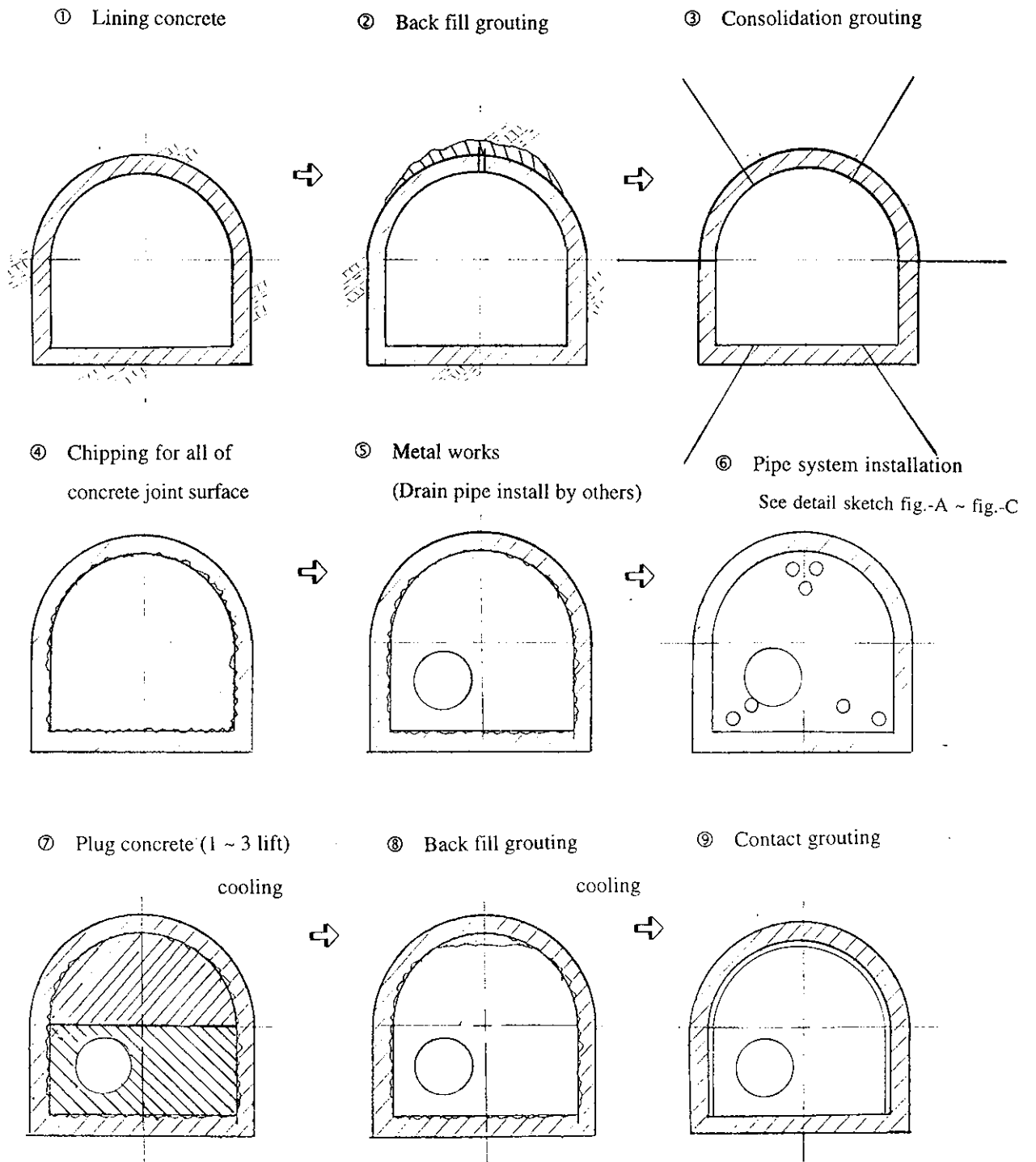
PART - C
TUNNEL PLUG WORKS

1. Tunnel plug works



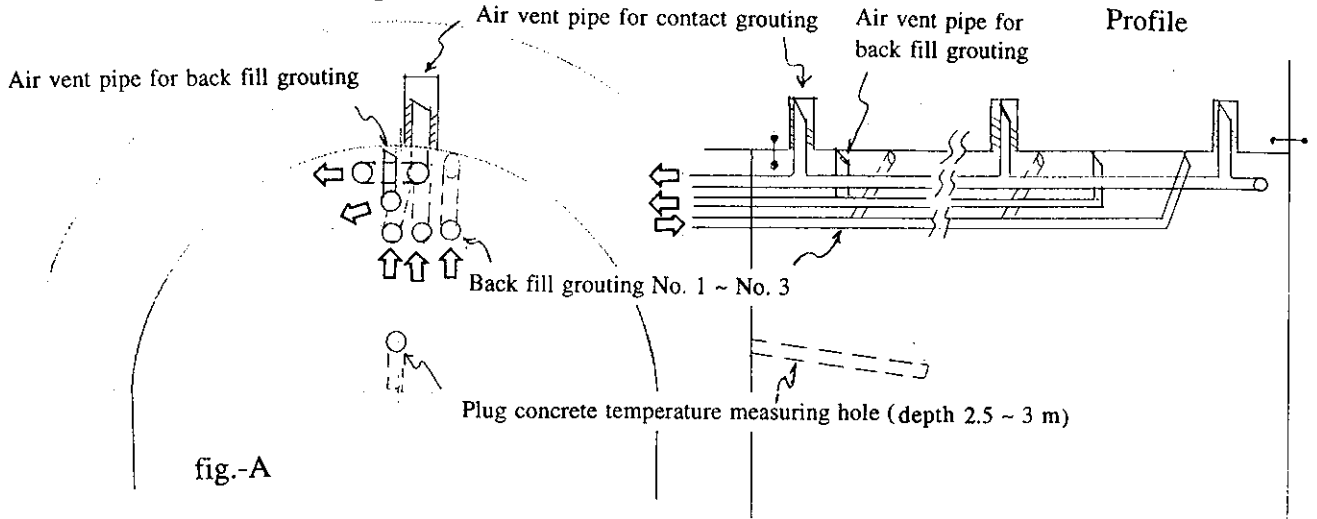
2. Procedure of plug works

Purpose is protection for headrace tunnel lining concrete and a water tightness for drain tunnel

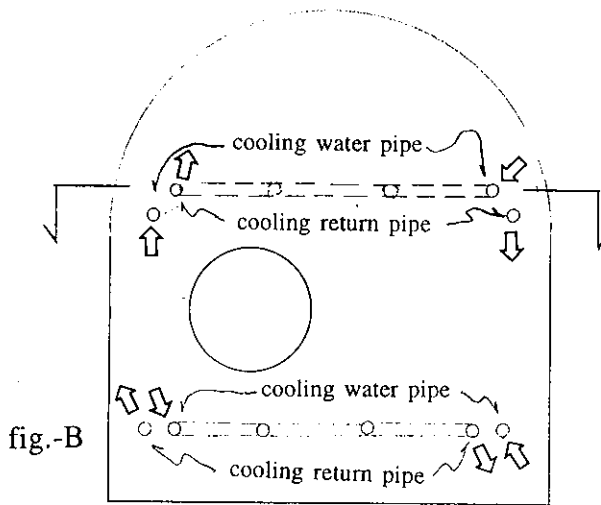


Pipe system illustration

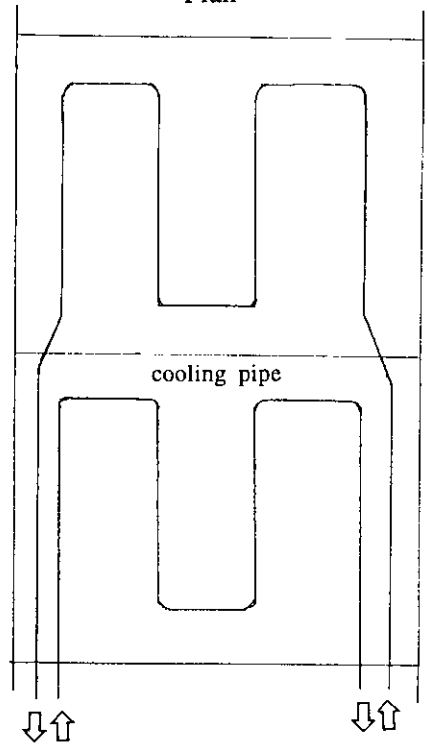
Back fill and contact grouting



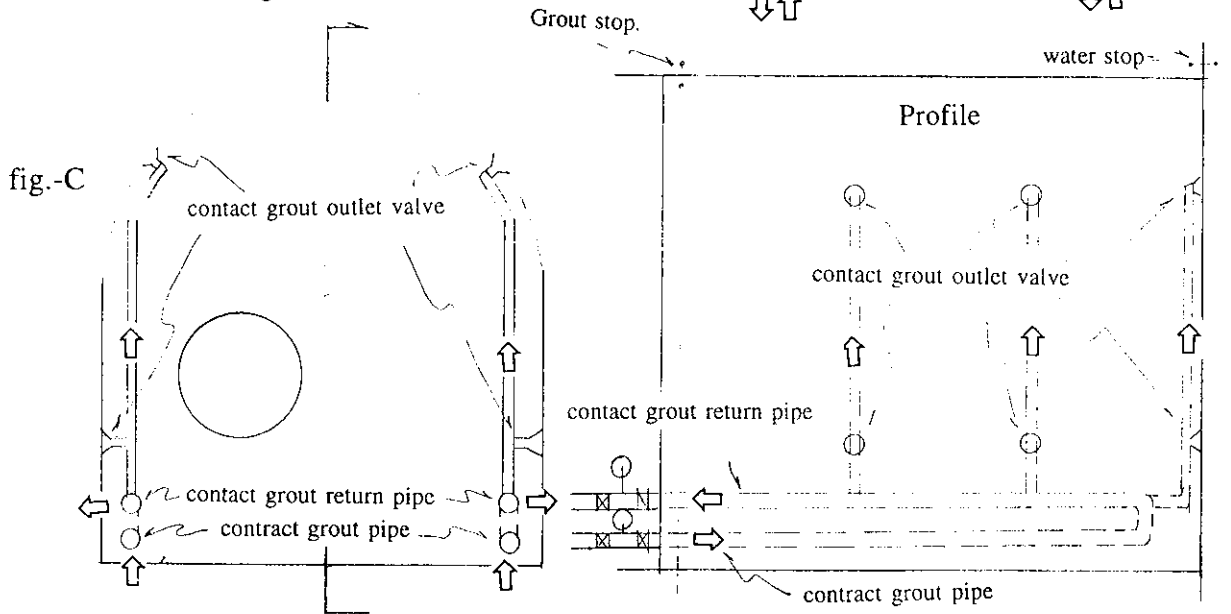
Cooling system



Plan



Contact grouting



PART - D
REPAIRING WORKS

1. Location map of defects

Concrete lining has ongoing of the headrace tunnel at the LOT I.

Location maps of the following defects subject to repair are required.

- (1) All cracks in the longitudinal direction shall be repaired.
- (2) Cracks in the cross sectional direction which meet with either one of the next conditions
 - a) width larger than 0.3 mm in dry condition of cracks
 - b) water leakage is observed
- (3) Irregularities at horizontal joints between arch and invert linings.
- (4) Irregularities at construction joints and at where inspection windows of steel formwork were placed.
- (5) Honeycomb

2. Method of repair

2.1 Cracks in longitudinal direction

Refer to Fig. 1. Details are shown stepwise as next

- Step 1. Clean the repairing area
- Step 2. Drill holes on the surface of lining concrete at a crack to be repaired, by electric drilling machine after hardening of concrete. The depth of a hole shall be about 5cm and hole interval is about 0.8m. Insert a brass nipple about \varnothing 14mm at drilled hole.
- Step 3. Seal with Sika monotop 615 HB the crack and its surrounding area. The sealing shall be about 5mm thick. about 5cm wide (2.5 cm wide at one side of the crack). length being as long as the crack.
- Step 4. Clean and moisten the hole
- Step 5. Inject cement milk into the hole by using a manually operated pump. The mix proportion in weight of cement milk shall be between 1 cement to 3

water 1 cement to 1 water. A maximum of pressure of injection shall be 2.0 kg/cm² or as directly instructed by the Engineer at site.

- Step 6. Stop injection of cement milk 10 minutes after cement milk starts leaking from the mouth of the downward direction crack on the surface of lining concrete of 20 minutes after reaching the maximum pressure of the upwards crack.
- Step 7. Fill the hole with Sika 102 by hand.
- Step 8. Remove the sealing and clean the surface of lining concrete. Inspection will be done for grouting results.
- Step 9. Epoxy coating after completion
- Step 10. In case the leak of water from cracks is not stopped by grouting, the filling method should be applied. U shape cut is better than V shape cut for peel off. (refer to fig. 1-2)
 - Step 10 - 1. U shape cut by electric breaker and mark leakage locations.
 - Step 10 - 2. Drill holes for temporary drain locations with a large quantities of leakage.
 - Step 10 - 3. Clean the grooves.
 - Step 10 - 4. Fill Sika 102 from small seepage to leakage. Leaking water shall be concentrated to the temporary drain.
 - Step 10 - 5. Put a nipple to the drain holes and tighten.
 - Step 10 - 6. Plug the nipple and cover by Sika 102 after hardening of surrounding filled material.
 - Step 10 - 7. Epoxy coating after hardened.

2.2 Cracks in cross sectional direction

(The same method shown in 2.1 Cracks in longitudinal direction is applied)

2.3 Irregularities at horizontal joints between arch and invert linings

- (1) Small depressions at horizontal joints

Smooth out joints by cutting irregularities by grinder (refer to Fig. 2)

More than 90% of depressions at defective horizontal joints are repaired by this method.

(2) Large depressions at horizontal joints

Refer to Fig. 3. Details are shown stepwise as next

Step 1 : Cut the horizontal joint both horizontal and vertically. Remove the cut portion.

Step 2 : Clean the cut surface and coat with a special type of mortar such as SIKA 731 to enhance the bondage between existing concrete and newly filled mortar.

Step 3 : Fill the cut portion with mortar (mix proportion in weight of 2 cement to 1 water and 2 sand) and smooth the surface.

(3) Projections at horizontal joints

Smooth out joints by cutting irregularities by an electric percussion breaker and finishing by grinder (refer to Fig. 4)

2.4 Irregularities at construction joints and at where inspection windows of steel formwork were placed.

Smooth out joints by cutting irregularities by an percussion breaker and finishing by grinder (refer to Fig. 5)

2.5 Honeycomb

(1) Dry condition (refer to fig. 6-1-1) Details are shown as next

(1)-1 Depth less than 5cm

Step 1 : Cut the honeycomb portion (location area and depth shall be directed by the Engineer).

Step 2 : Clean the cut surface and fill with strong bond type of mortar (Sika monotop 615 HB) by hand.

Step 3 : Epoxy coating after hardened.

(1)-2 Depth more than 5cm

Step 1 : Cut the honeycomb until the fresh concrete expose

Step 2 : Clean chipped surface and moistening

- Step 3 : Coat by Sika monotop 615 HB for bonding (t : 2 cm)
- Step 4 : Fill cement mortar (C:W:S 1:1:2).
- Step 5 : Epoxy coating after hardened.

(2) Leaking water condition

- Step 1 : Same as dry condition at step 1 (refer to fig. 6-1)
- Step 2 : Clean the cut surface and then fill the Sika 102 with nipple and pipe for leaking water divert (refer fig. 6-2)
- Step 3 : Cement milk injection into the hole by using manually operated pump, the mix proportion on weight of cement milk shall be between 1 cement to 3 water and 1 cement to 1 water. Maximum of pressure of injection shall be 4 kg/cm² or as directed by the Engineer at site.
- Step 4 : Blocking shall be carried out at least 10 minutes after reaching the maximum pressure, also after reaching mix proportion by 1:1.
- Step 5 : Fill the hole of nipple using Sika monotop 615 HB by hand after confirming hardened grout material and leakage water stopped.
- Step 6 : Epoxy coating after hardened.

3. Construction Tolerances for Tunnel Lining with Clause 4.1.9 (3)(iii) of Technical Specification

- | | | |
|----|--|-------|
| a. | Departur from established
alignment or from established
grade but parallel to it | 12 mm |
| b. | Variation from inside dimensions in 5 m | 8 mm |
| c. | Variation in thickness at any point Minus | 0 mm |

Formed Surface

The classes of finished surfaces are designated by use of symbols F1, F2, F3 and F4.
(Clause 4.1.13(2) of Technical Specification)

- | | | |
|----|---|-----------------------|
| F1 | : • Depression exceed | 25 mm |
| F2 | : • Abrupt irregularities shall not exceed
• Gradual irregularities shall not exceed | 6 mm
15 mm |
| F3 | : • Abrupt irregularities shall not exceed
• Gradual irregularities shall not exceed | 3 mm
6 mm |
| F4 | : • Shall not exceed for abrupt irregularities
not parallel to the direction of flow
• Shall not exceed for abrupt irregularities
parallel to the direction of flow
• All gradual irregularities
• All abrupt irregularities in excess of the allowed limits shall be ground to a
slope of a vertical to 20 horizontal. | 3 mm
6 mm
10 mm |

Note :

Shall be applied clause "F4" for water way (tunnel lining)
Repairing work also shall be accordance with this clauses above.

fig1-1 injection method

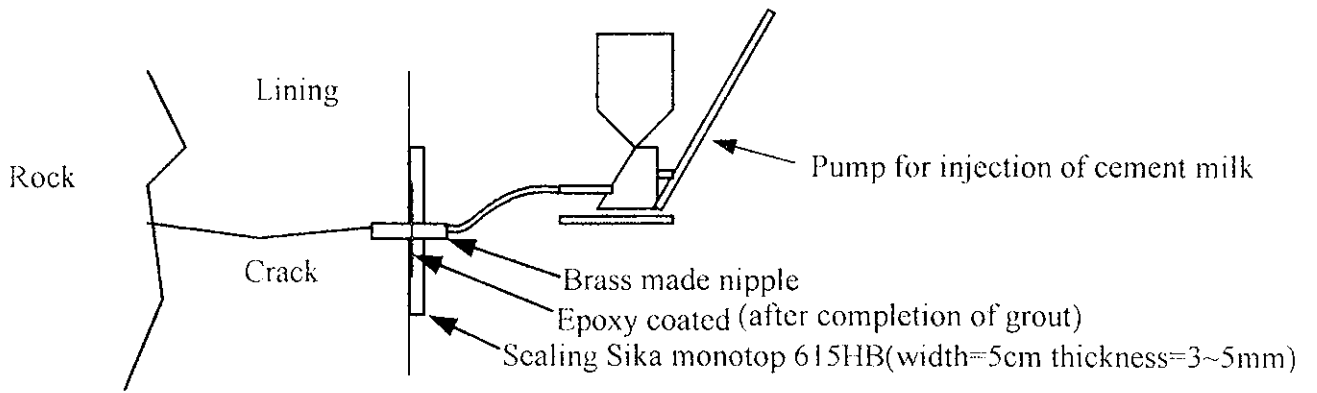


fig1-2 filling method

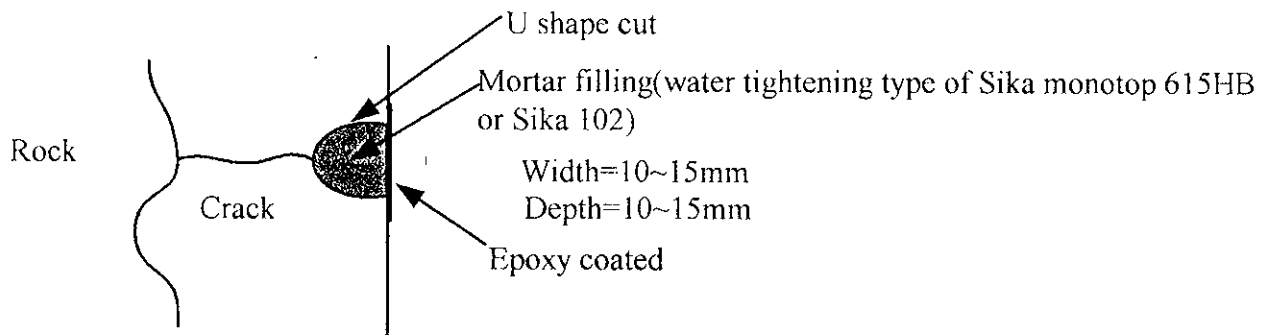


Fig 1 Method of Repair of Cracks in Longitudinal and Cross Sectional Directions

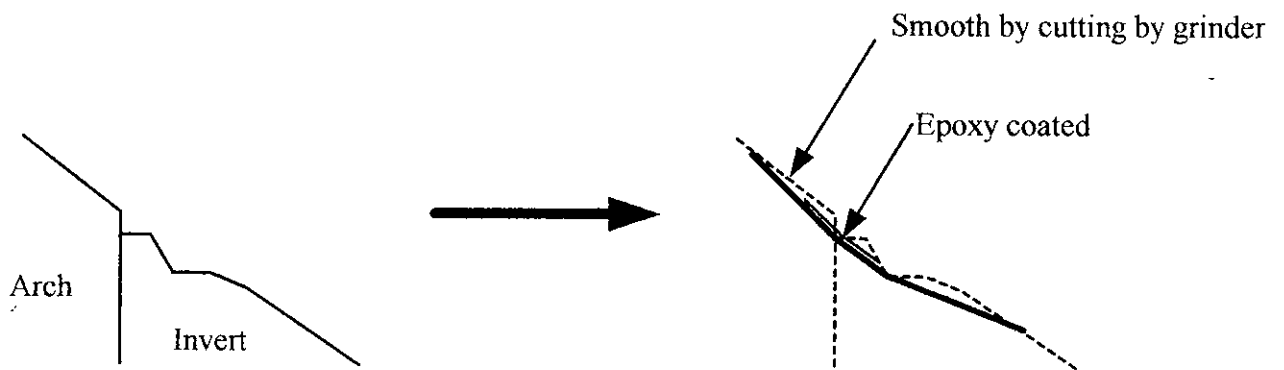


Fig.2 Method of Repair of Small Depressions at Horizontal Joints

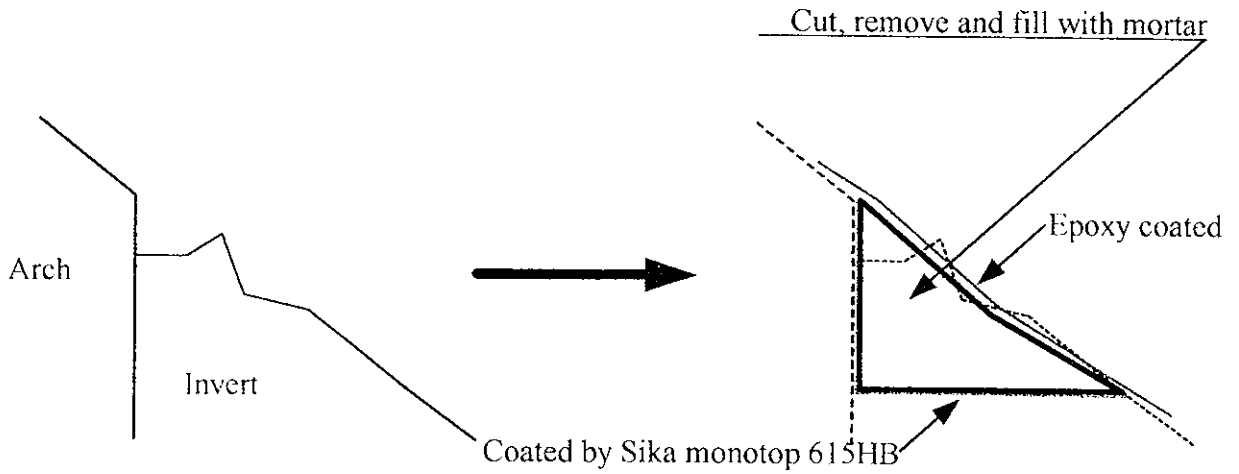


Fig.3 Method of Repair of Large Depressions at Horizontal Joints

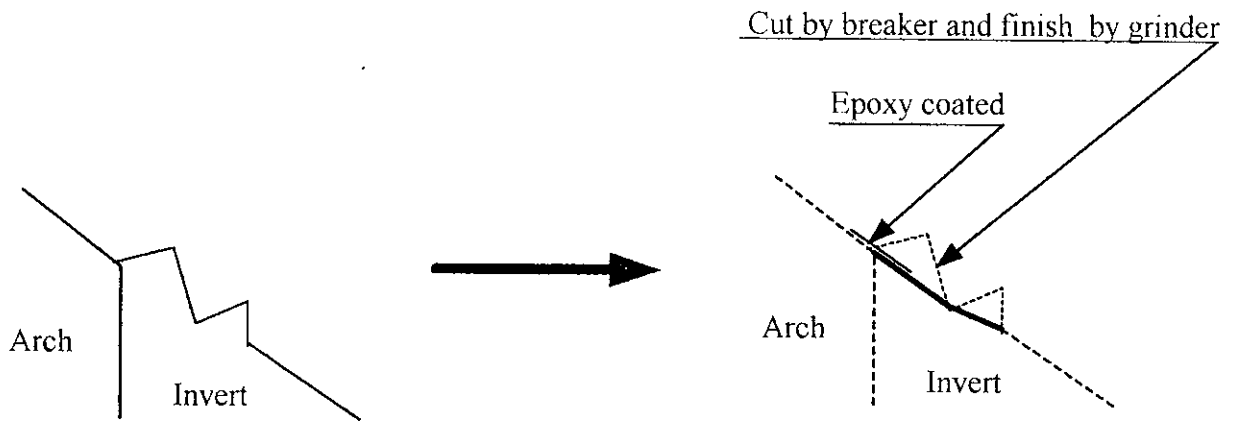


Fig. 4 Method of Repair of Projections at Horizontal Joints

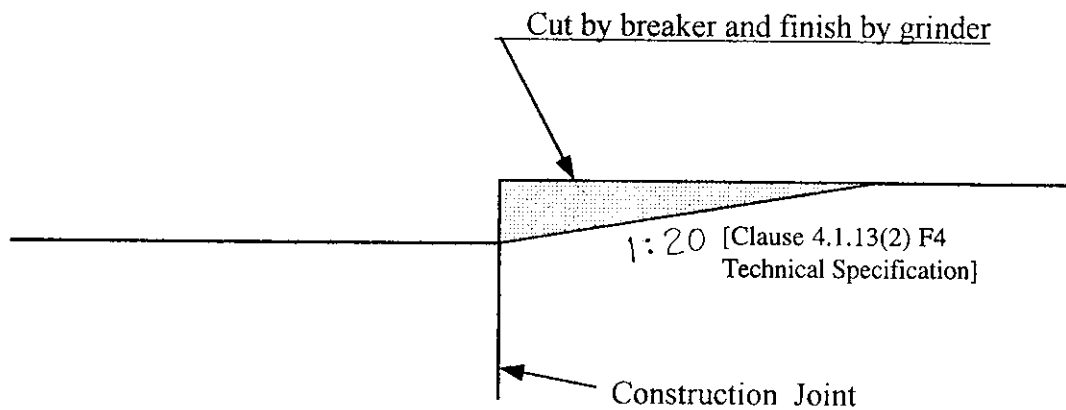


Fig. 5 Method of Repair of Irrguralities at Construction Joints and at Where Inspection Windows of Steel Formwork Were Placed

Fig.6-1 Repair method for dry condition of honeycomb

Fig.6-1-1 shallow honeycomb

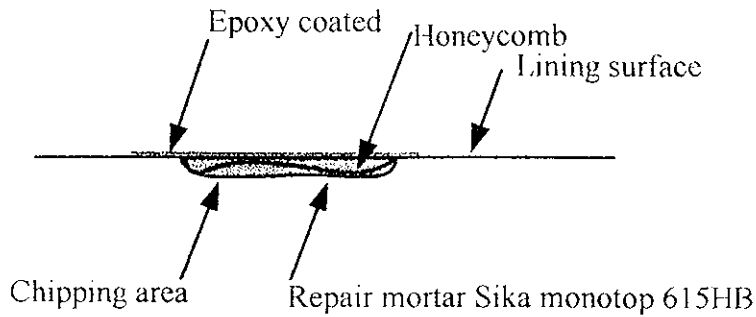


Fig.6-1-2 deeper honeycomb

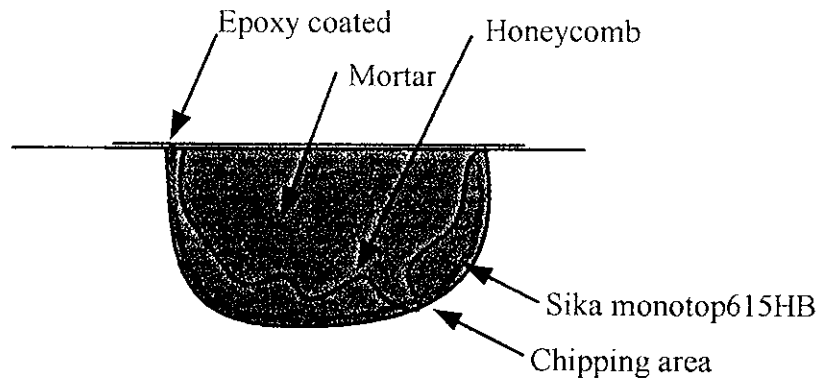


Fig.6-2 Repair method for water leakage condition of honeycomb

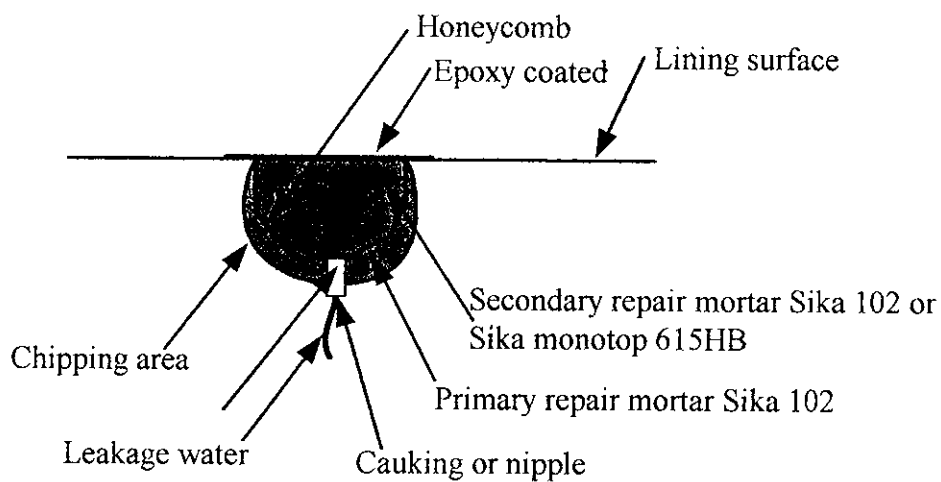
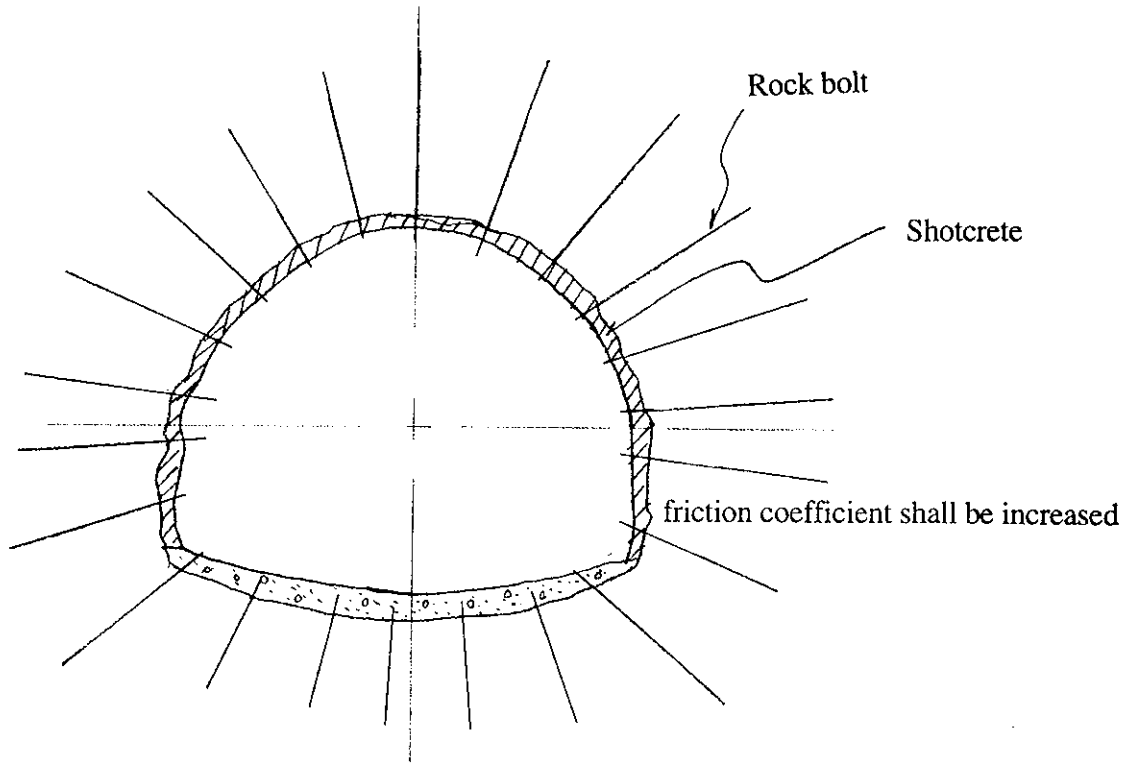


Fig. 6 Method of Repair of honeycomb

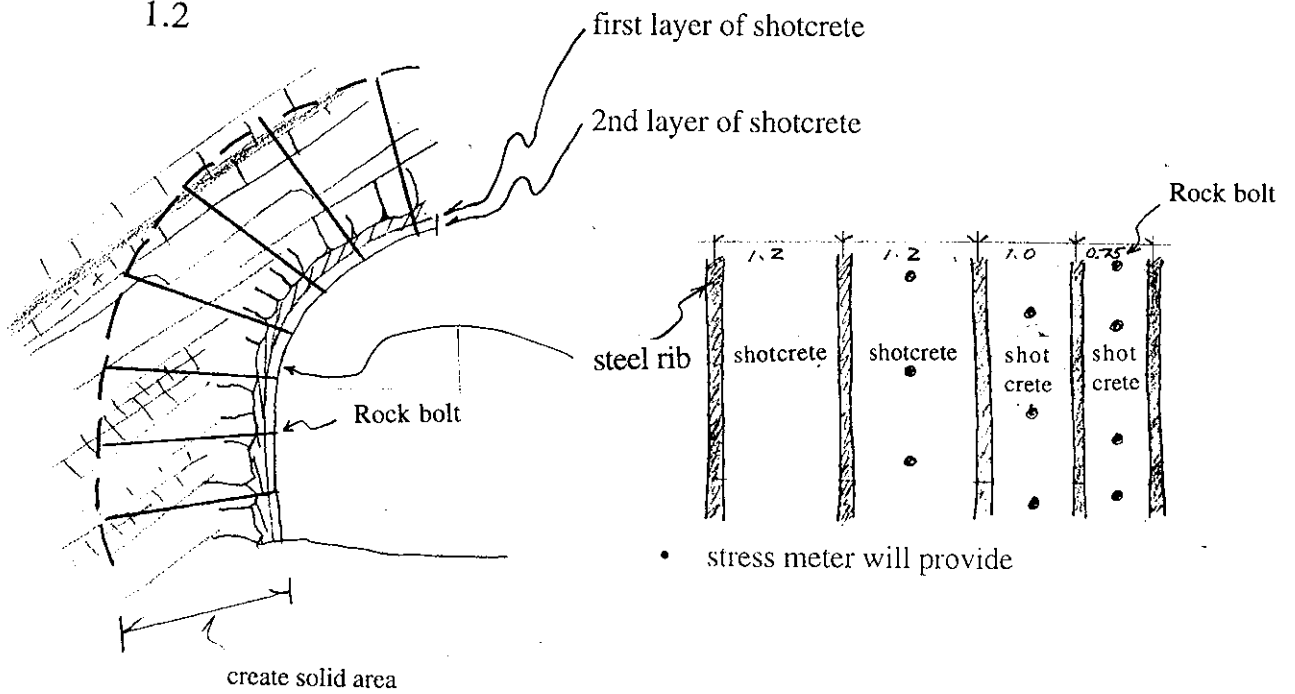
PART - E
for REFERENCE

1. NATM method

1.1



1.2



- * above method concept is make one body. with in the rock bolt area and be create solid area and so against ground rock mass.
- * concrete lining shall not commenced while convergent. is continued
- * shall be observe ground sinkage at the crown

FLOW OF WORK

Zone 1 Excavation : Full-face excavation

Zone 2 Excavation

Enlargement for Type III shall be carried out at end of Zone 1. Excavation method shall be full face, and arch rib, shotcrete and rockbolts shall be applied for temporary support to each step.

Zone 3 Excavation

Excavation method shall be full face, arch section shall be supported by rockbolts and shotcrete.

Zone 4 Excavation (Toward upstream)

Excavation method shall be full face. Rockbolts and/or shotcrete support shall be applied depend on rock condition.

Zone 5 Excavation (Toward downstream)

Excavation method shall be full face. Rockbolts and shotcrete shall be applied at area in conjunction with Zone 3.

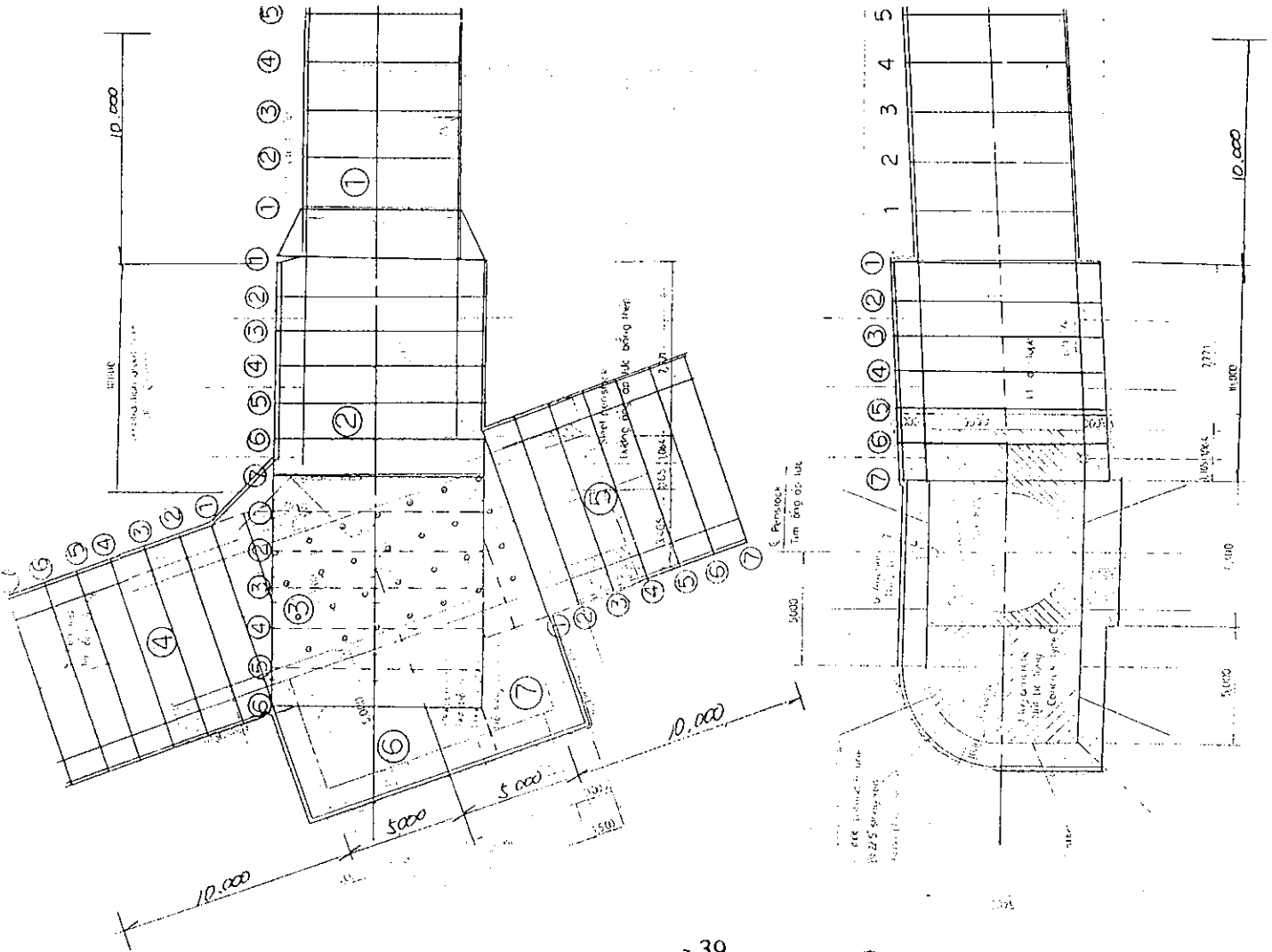
Zone 6 & 7 Excavation

Enlargement of these Zone shall be employed full face method. Excavation work will be carried out after the Tailrace excavation depend on these progress.

Note. 1. If full face method can not used due to geological condition at Zone 2 to 5, it will be used upper half heading method, but lower half will be excavated before Zone 6 & 7 excavation.

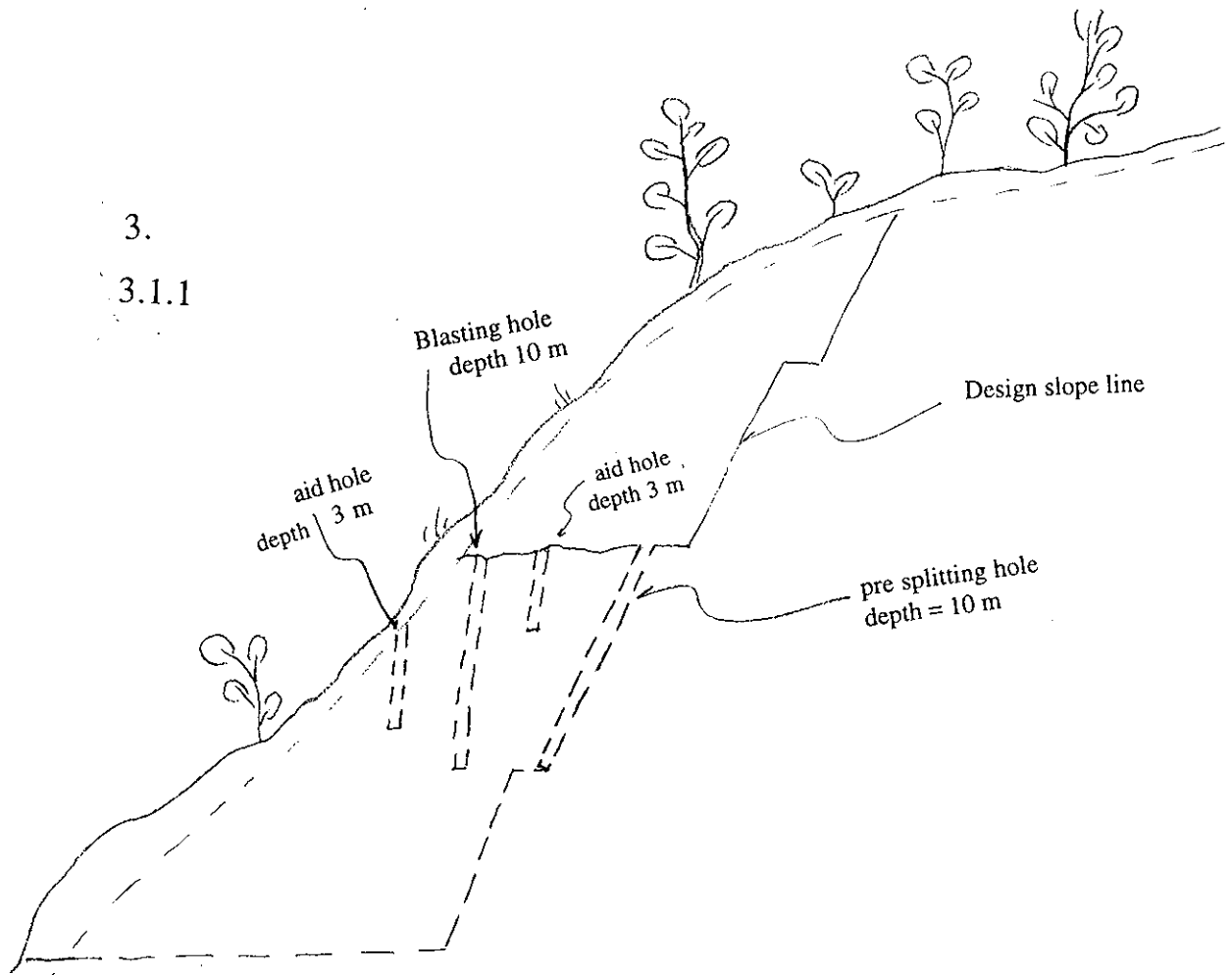
2.

Example of method statement for excavation and supporting at around junction



3.

3.1.1



Presplitting method blasting for smooth slope cutting

3.1.2

