รายงานฉบับที่ วว. 47 กองวิเคราะห์และวิจัย
REPORT NO. MR 47 MATERIALS & RESEARCH DIVISION

# EMBANKMENT FAILURES OF LAMPANG-DENCHAI HIGHWAY CONSTRCTION PROJECT

BY

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# PREFACE

Construction and maintenance cost of roads in the mountainous area is usually high in comparison with the roads in other conditions. A high percentage of the roads in Thailand are constructed in the typical area since many parts of the country are mountainous, especially the north, and the west. One of the main factors that raise up the costs is the occurance of slope failures during and after the construction. The cause of failure can be due to the lack of knowledge about some special characteristics of the mountains in the local areas. The department of highways is trying to reduce the high expenditure rate by putting more details in the work and, in the consequence, urging more research in this field.

(Seree Suebsanguan)
Director - General

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## ABSTRACT

During the construction of the Lampang - Denchai highway, settlement and cracks were found at seven portions of the road embankment , which was lifted up to the subbase course. The phenomenon occur after a period of rain in the rainy season of the year 1978. Some investigations were done and the conclusion can be drawn from the investigation result that the occurance is due to lacking of the protection system and unadequacy of the drainage system at those portions of the road embankment which are locate at the stream valley and composed of non plastic soils. From the condusion, the design for correction can be done by assigning proper protection system, and the ground and surface water drainage systems.


## GENERAL BACKGROUND AND THE INVESTIGATION

The composer was assigned to investigate and make a design to prevent the embankment failure of some locations on the Lampang - Denchai highway construction project. The construction of the highway was on the process up to the finished base or subbase course. It was found after a rainy period that at some locations a portion of the embankment settled. Cracks were found on the top of the

embankment. The investigation was done and it was found that at least seven locations were in the severe condition. Those locations are at the stations 34+900, 35+576, 36+785, 38+718, 38+852, 40+242.5 and 41+164. They are at the mountains valley where the rushing stream of water used to flows through. Part of the water can flow through the road embankment by a circular pipe which is burried appoximately at the midheight of the embankment. The embankment soil is a well graded soil which falls mainly in the class of silt and sand. The small particles part is expected to be nonplastic. It is then also expected that the soil will have high permeabilitity and will have strength reduction as subjected to the water. It was finally concluded that failures are mainly due to the destruction of the embankment soil strength by the seeping ground water during the rainy period. With the silty sand embankment, the water can seep through the embankment with in short period of time, destroying the soil strength, especially at the vicinity of the toe slope, and pushing the embankment to move under the low resisting at the embankment base. With the movement of the embankment mass, tension cracks were induced on the top surface. It is espected that severe damage will occur at the locations if they are left to face with another period of rains.

PRINCIPLE OF DESIGN

There are many ways to design for the improvement. Only the one that is less in cost is introduced here. The principle for the designing is to prevent the water to seep into the embankment. Preventing the water to get into the embankment can keep the soil in the dry state.

At dry state the soil under the high burden pressure is very strong and strong enought to resist the lateral water pressure. To prevent the water seeping into the embankment, the proper protection and drainage system should be provided in the sensitive area. In the design, the high plastic soils and the clay soil with grassing are used to protect the surface water and the trench of the high plastic soil is used to prevent the ground water to seep into the embankment. Scouring of the toe slope is protected by the R/C slab protection or the dumped rocks. The side ditch, gutter or spillway and shoulder curb are assigned at the proper locations for the surface drainage system. For the purpose of assisting the subdrain, age layer (or layers) of sand - rocks is provided at the tail - water slope. Repairing of the existing R/C cross - drain pipe at the joints is required to prevent leakage of water into the embankment. At some locations the pipe is considered to be incapable for the drainage. It is then replaced by a bigger one.

DETAIL OF EACH STATION

- Station 34+860 - 34+920. (Figs. 1a and 1b). The station shows crack and settlement at the right hand side of the embankment. The portion of the embankmentis at the stream way, and it is expected to be effected by the part of water that can not get into the cross - pipe and seep through. Reduction of the soil strength and the seepage force induce the movement of the embankment. The improvement is proposed by recompacting the top part of the embankment to the depth of about one meter to eliminate the crack, covering the side slope surfaces to prevent the water seeping into the embankment, covering the ground area of

the high water side introduce the sediment pond, repairing the joints of the original pipes, and the gutter to carry the water from the outlet end of the pipe away from the toe slope. At this location the protection is not so tight since the amount of the flow is expected to be low.

- Station: 35+576 (Figs. 2a and 2b). This location seems to be the most difficult one for improving since the problem is due to the deep under ground water and the height of the embankment which is very high, about 14 meters. It is found from the investigation that the big area of the mountains volleys was filled up to about half of the total embankment height and the filled meterials is rock and granular soils which is highly permeable and can be a water collector. It is also found that the orignal drain - pipes is not capable for the cross drainage and partly damaged. The cause of the embankment movement, forming cracks consequently, is expected to be due to the seepage of the water in the collector through the embankment. In the design, the plastic soil trench at the left hand side is used to prevent the seeping water. Both sides of the slopes are protected by the clay and grassing. A new pipe is assigned at another location to reduce the distance of the outlet flow. A layer of sand - rock is recommend at the tail side to allow free flow of the under ground water that may leak through the soil trench. Recompaction of the embankment is recommened only for the top one meter layer only.

- Station 36+785 (Figs. 3a and 3b). At this location the movement is expected to be mainly caused by the softenning and scouring at the toe slope of the right side of the embankment. Seepage of the Water through the embankment is an additional cause. Preventing of the seeping water is also done by protecting the side slopes, introducing sediment pond and recommending for repairing of the pipe joints. To prevent the softenning and scouring of the toe slope, the embankment soil at the toe is replaced by the plastic soil aggregate, and covered with clay - grassing and a layer of big rocks. The top of the embankment is recompacted to eliminate crack and to level it up.

- Stations 38+718 (Figs. 4a and 4b).and 38+852 (Figs. 5a and 5b). The two locations are similar in nature. Cracks and settlement were found at the portion of the embankment across the valley. Only at the station 38+718, the circular pipe is raised up above the orignal ground and the left hand side is filled with a berm embankment. With these situations an amount of water will caught at the left side of the embankment. The design is also similar to those proviously mentioned. The only difference between the two station is the sand - rock layer at the toe of the top slope assigned at the station 38+718. The sand - rock layer is used to catch the small amount of water that may be able seep from the stored water at left side of the embankment.

- Station 40+242.5 (Figs. 6a and 6b). This location is similar to the station 38+718. Only the amount of stored water is greater and the toe slope at the right hand side can be softened and scoured by the attached water way. The toe slope material is then replaced and covered with big rock. The gutter persented in the drafting is the existing one, and it should be avoid from any disturbance.

- Station 41+164 (Figs. 7a and 7b). It was found during the investigation that at this station the movement of the embankment caused severe damage to the right side of the embankment. Recompaction of the side is then assigned in the form of the step benching process as shown in the drafting. The R/C slab protection at the toe of the RHS slope will be able to protect the severe damage from the rushing water in the attached stream channel. The other assignments for the location are used for the purposes that are similar to those previously mentioned.

SUMMARY AND CONCLUSION.

It can be summerised and concluded as the following:

1. During the construction of the Lampang - Denchai Highway and after a rainy period, cracks and settlement were found at about 7 locations, ie; stations 34+900, 35+576, 36+785, 38+718, 38+852, 40+242.5 and 41+164.

2. After a visual in vestigation the cause of the occurance can be estimated and concluded that all the portions of the road are located at the mountains valley where the stream channel is passing through.

Since the embankment materials are granulated and nonplastic with the lack of the proper protection and drainage systems, part of the water can seep into the embankment reducing the material strength and pushing the embankment to move. The movement causes the cracks and the settlement.

3. The design for failure prevention was introduced for the locations under the principle that by keeping the embankment materials in the dry state the embankment will be able to resist the lateral movement induced by the natural disturbances. As presented in the drafting, the protection and the drainage systems are assigned to prevent the water seeping into the road embankment. The detail of assignment for each location is not the same, since the requirements are different.

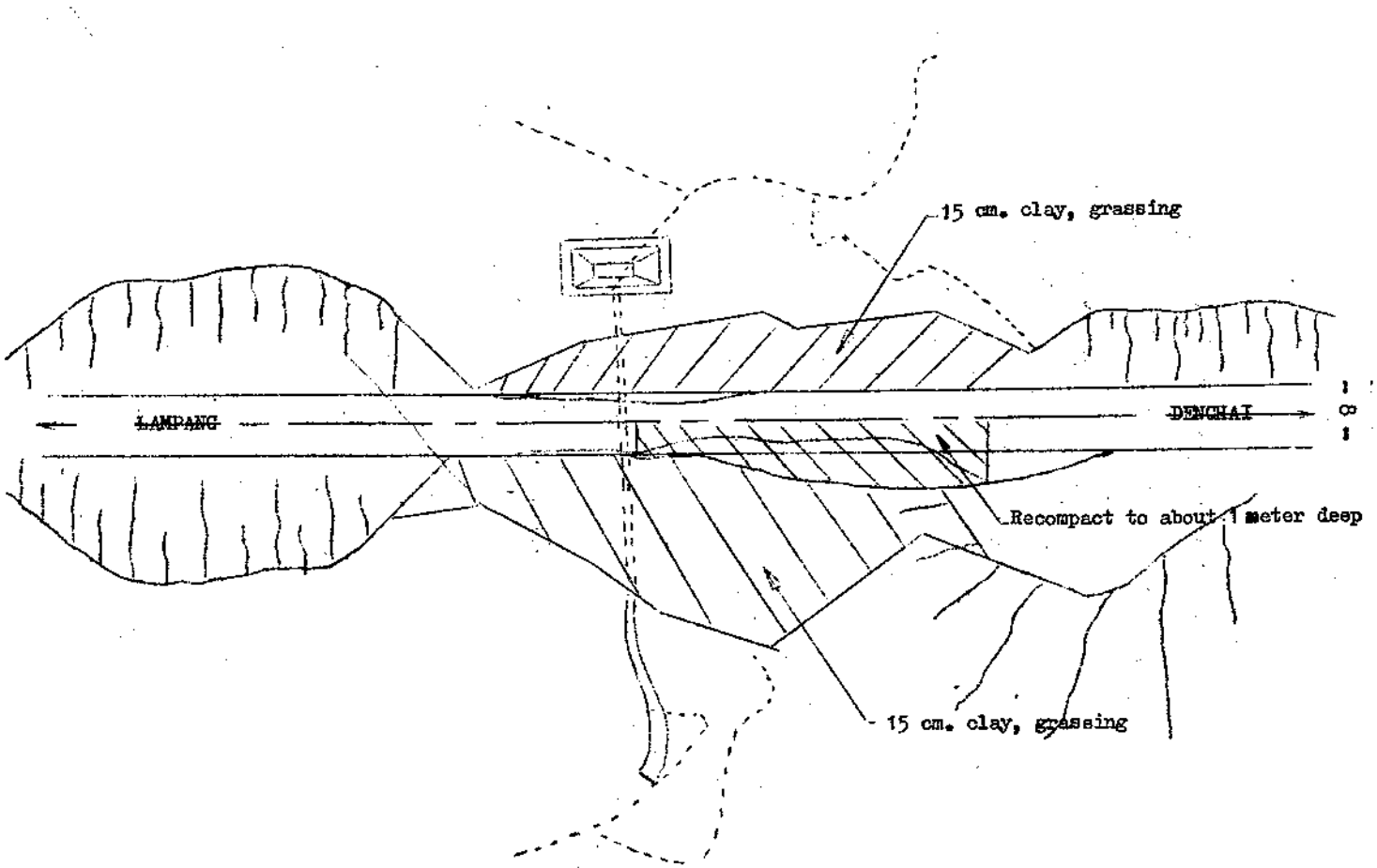


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Fig. 1a

Station 34+860-34+920

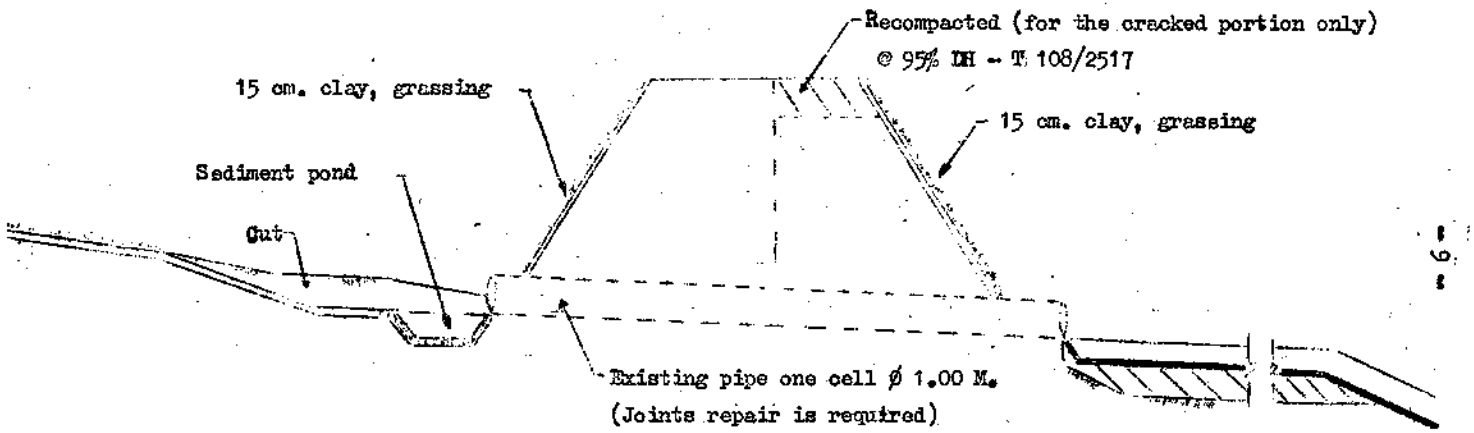


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Fig. 1b

Station 34+860-34+920

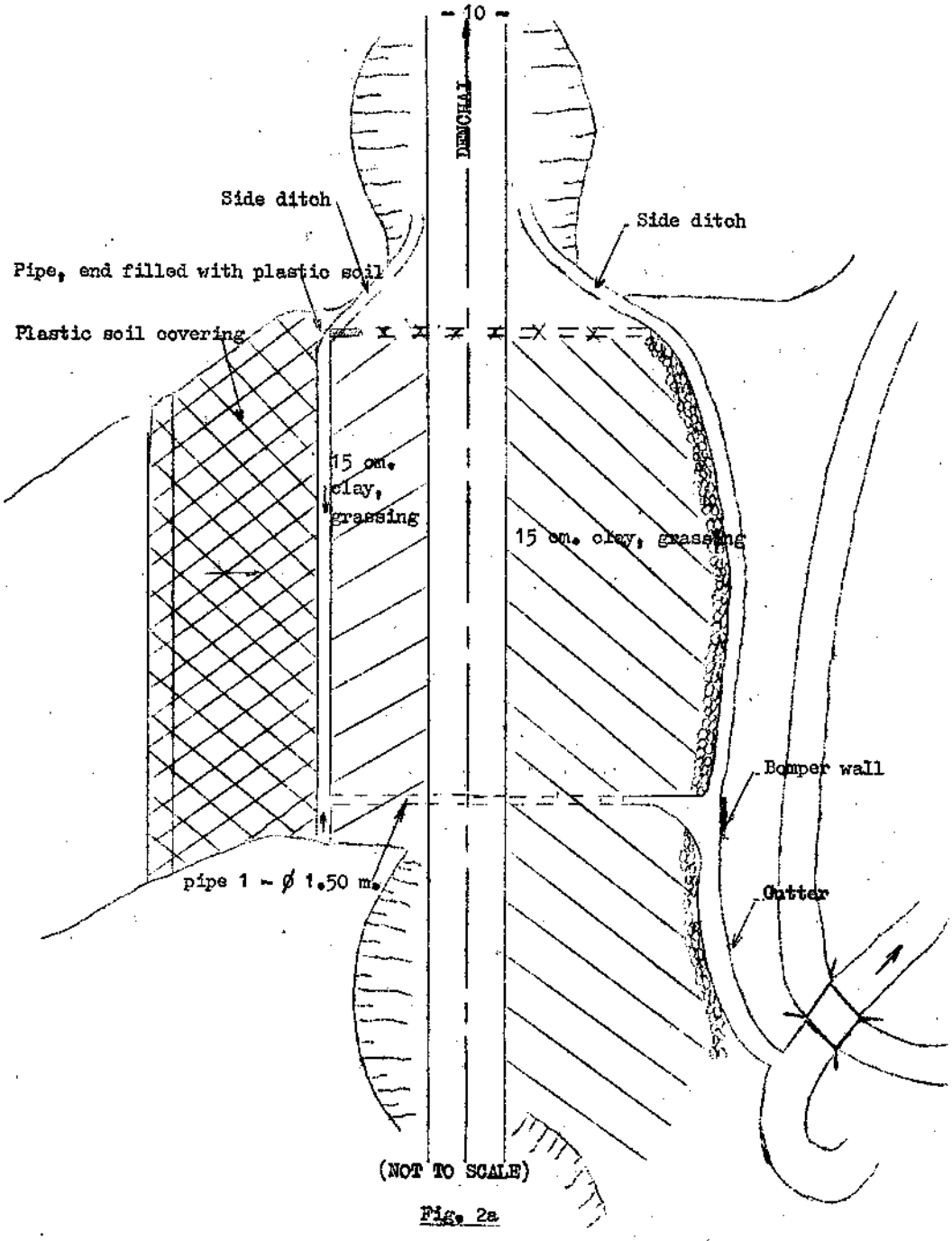


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Fig. 2a

Station 35+576

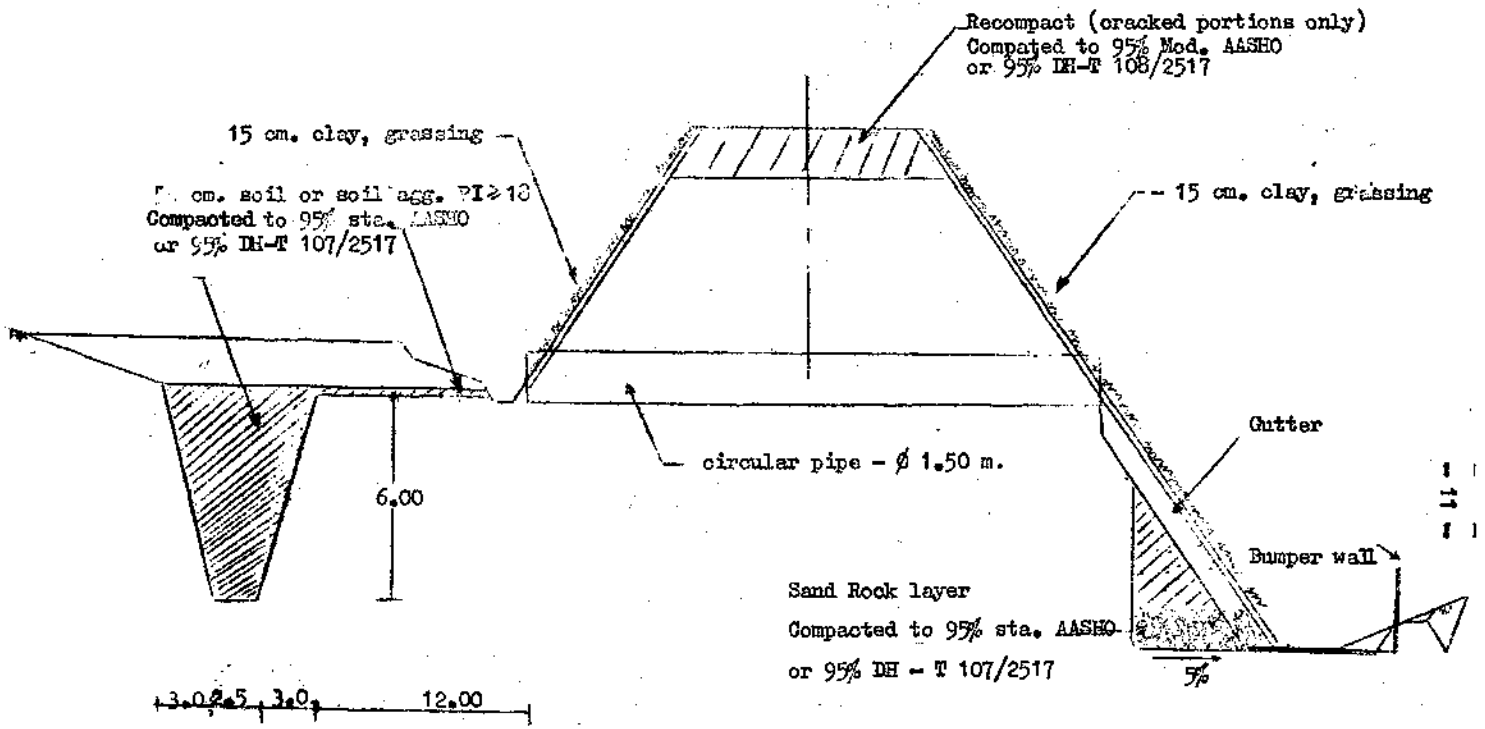


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Fig. 2b

S station 35+576

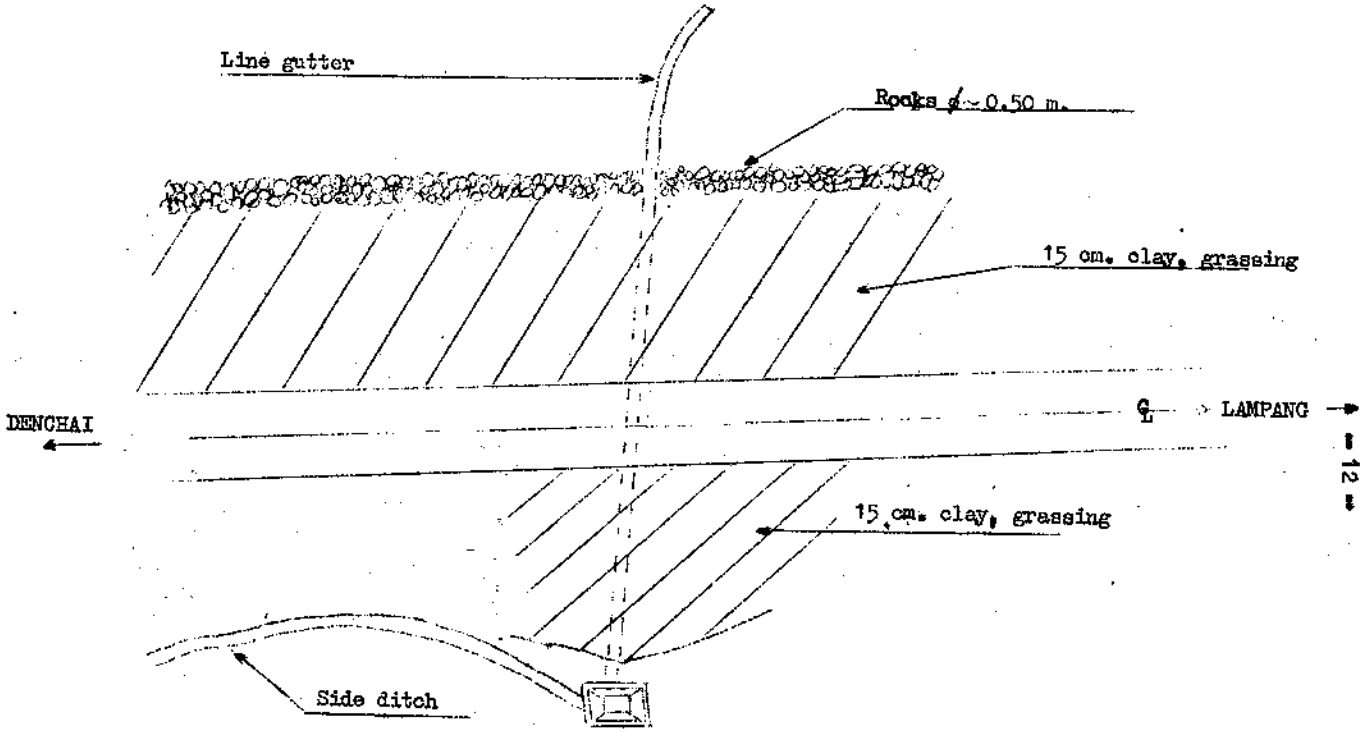


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Fig. 3a

Station 36+785

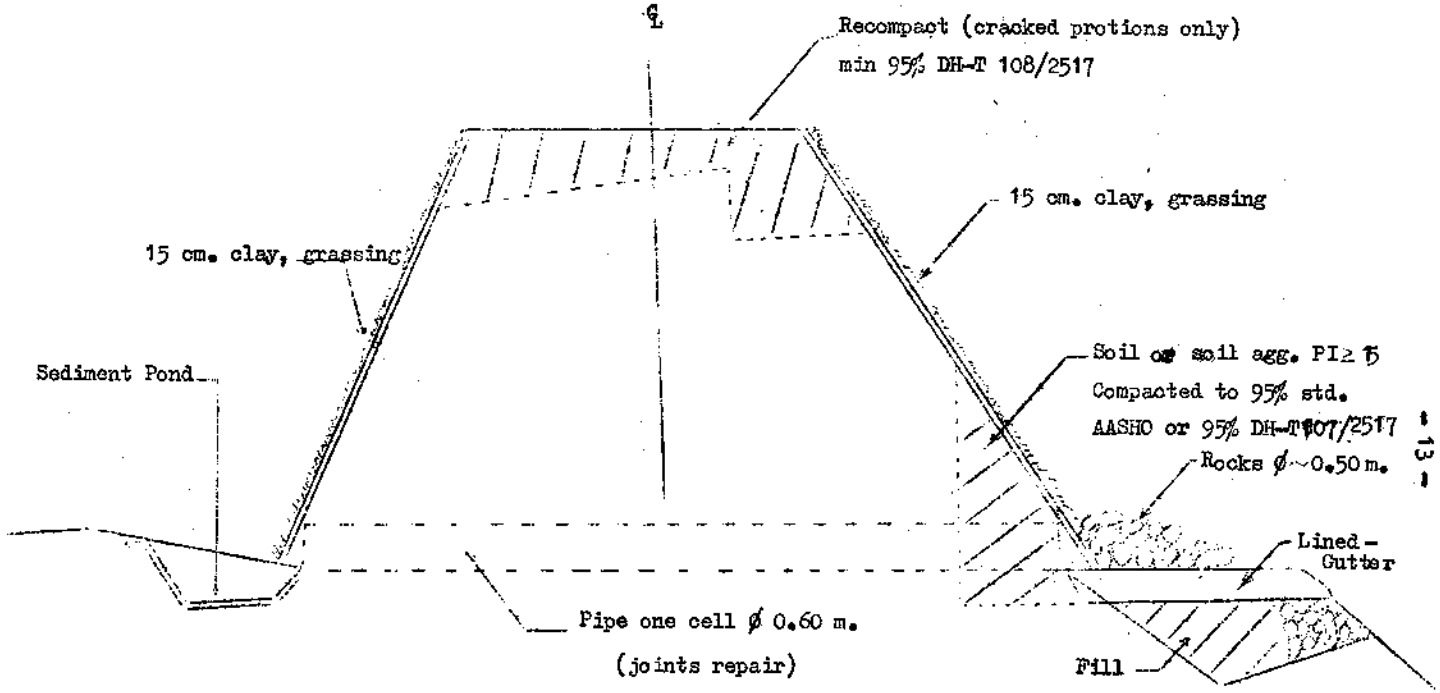


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Fig. 3b

Station 36+785

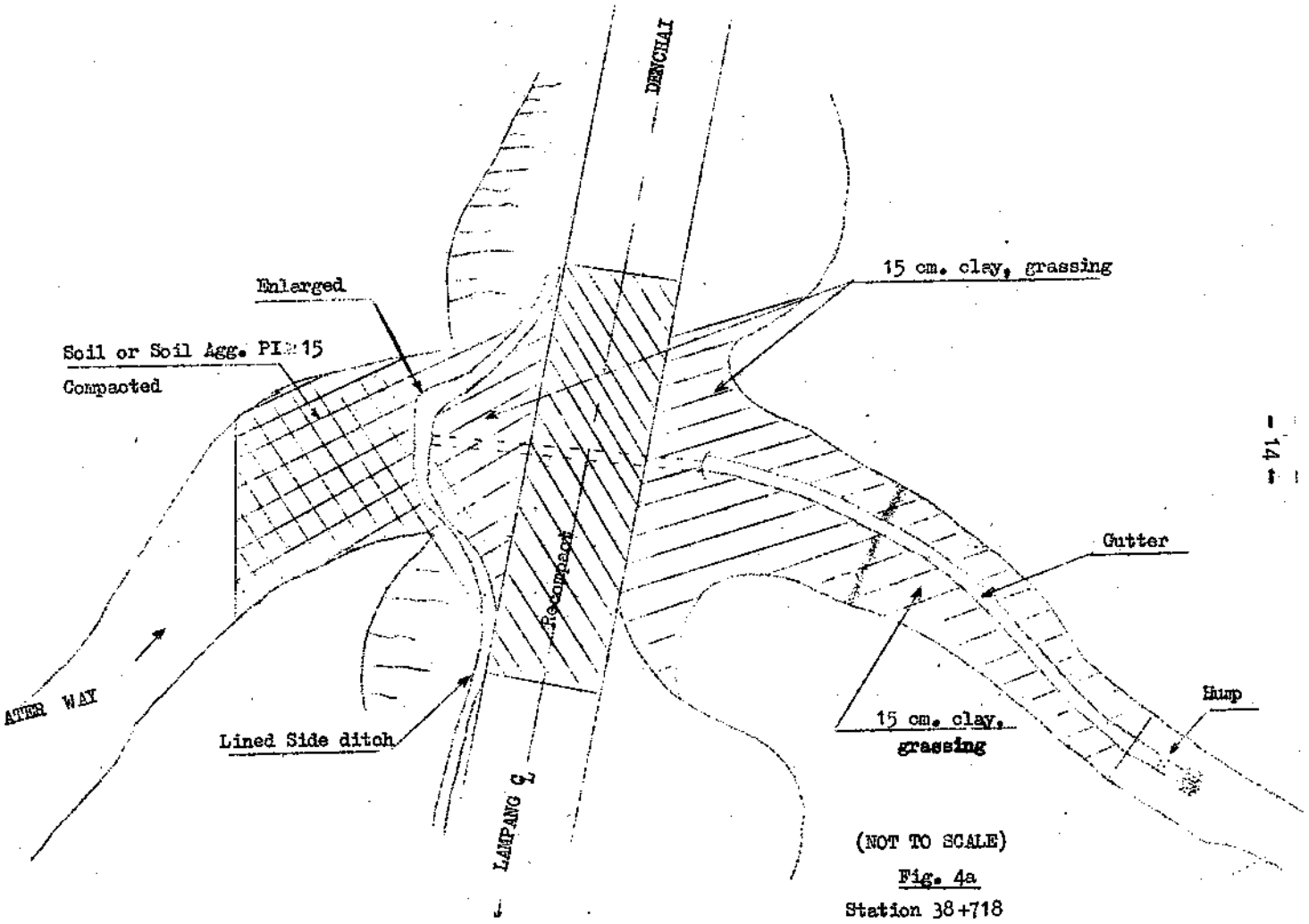


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Fig. 4a

Station 38+718

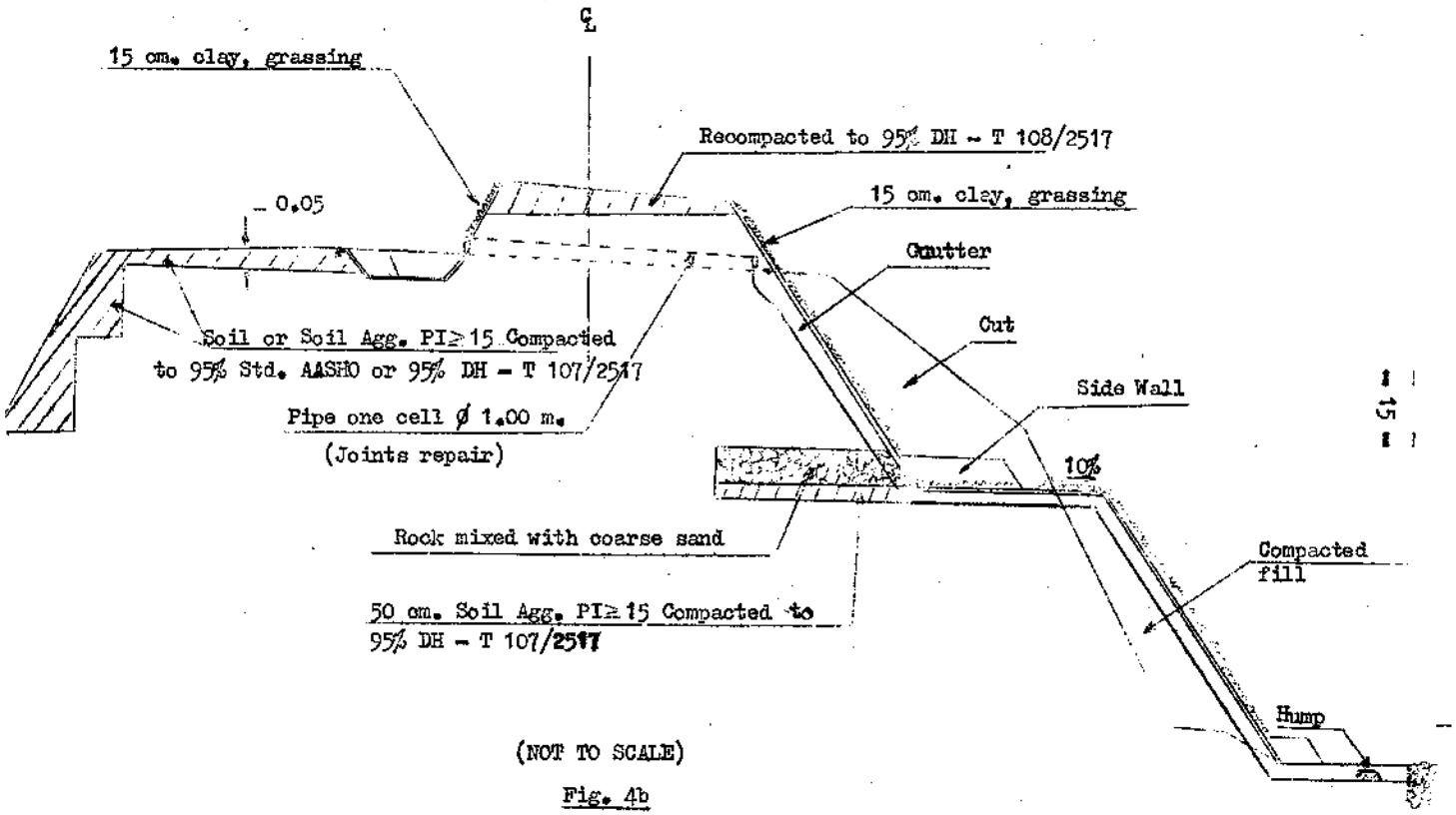


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Fig. 4b

Station 38 + 718

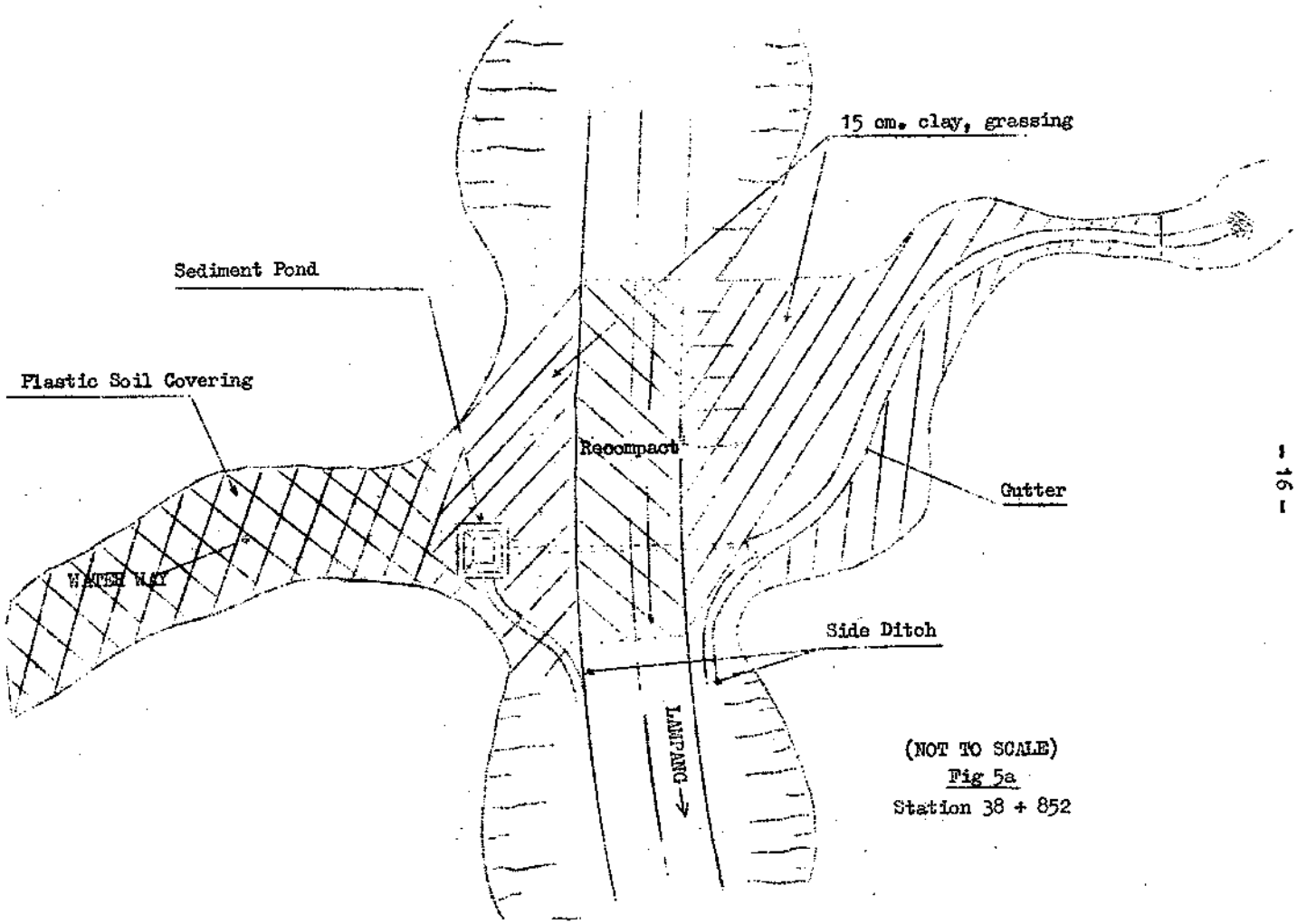


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Fig 5a
Station 38 + 852

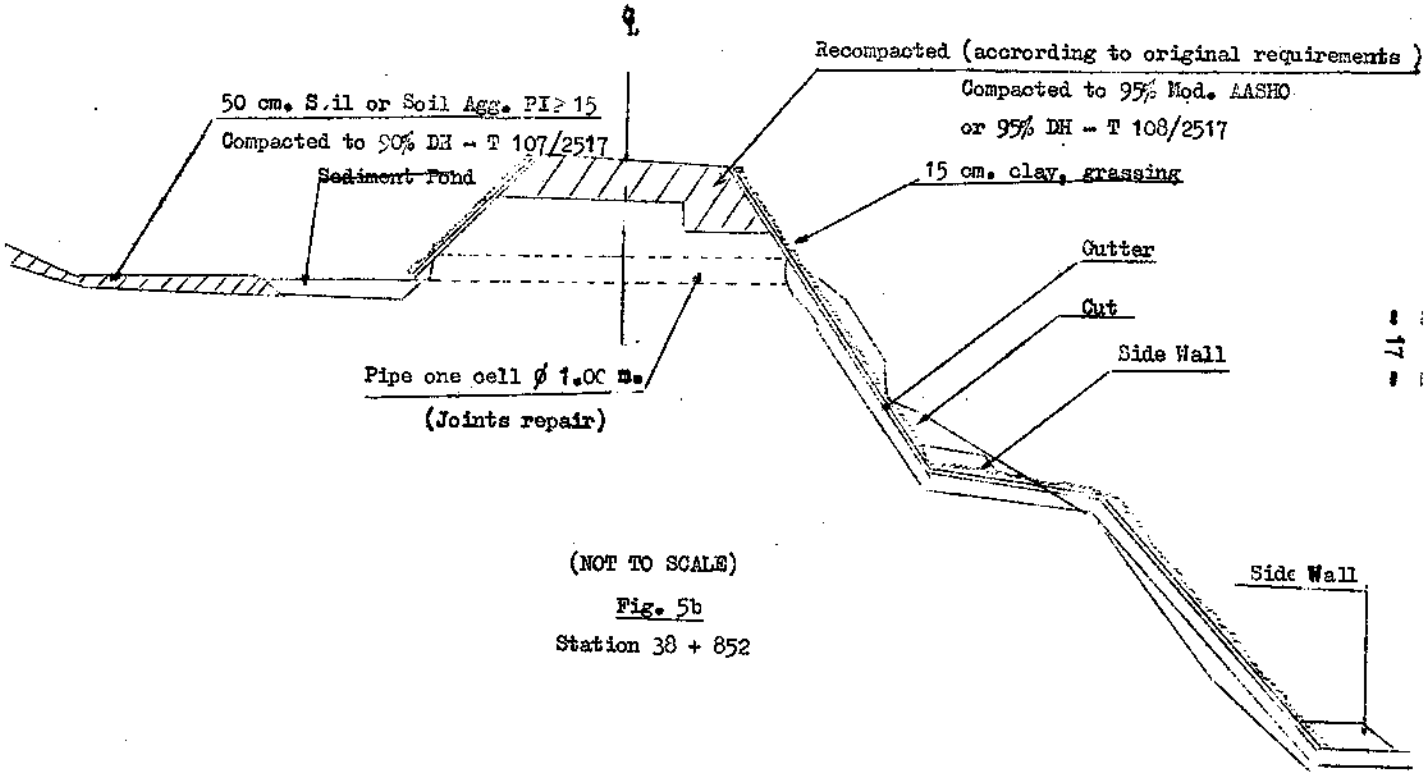


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Fig. 5b

Station 38 + 852

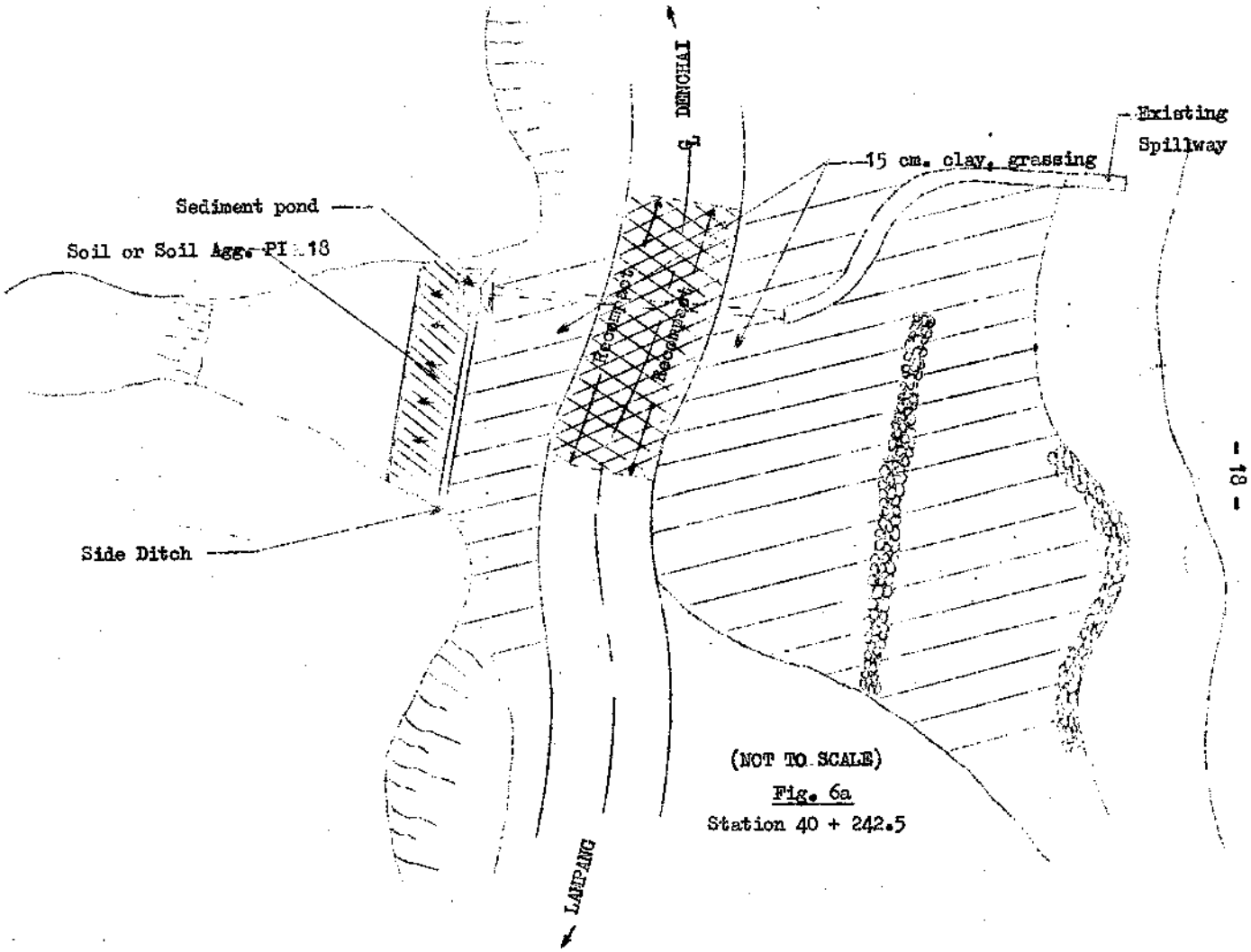


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Fig. 6a

Station 40 + 242.5

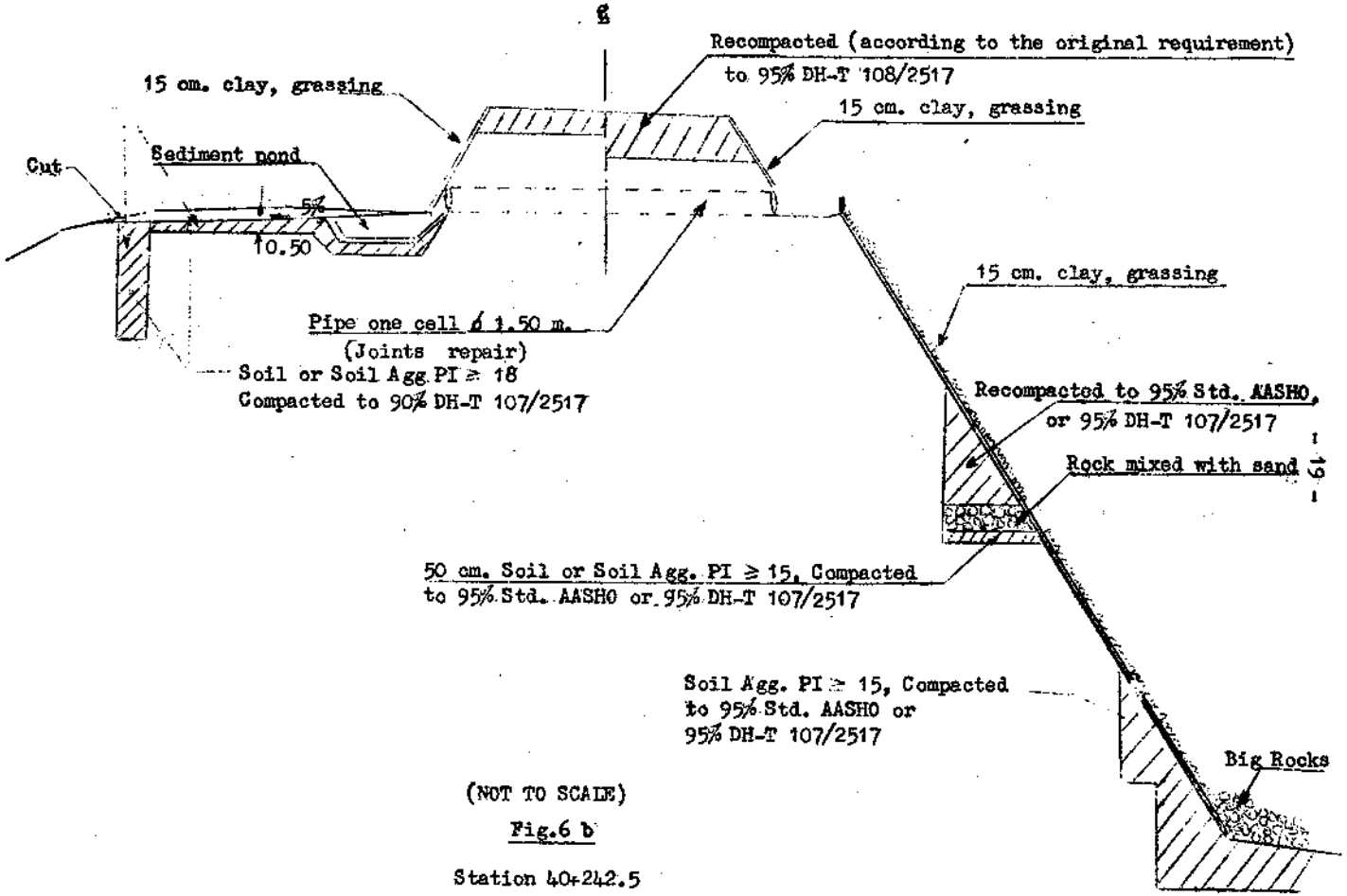


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Fig.6 b

Station 40+242.5

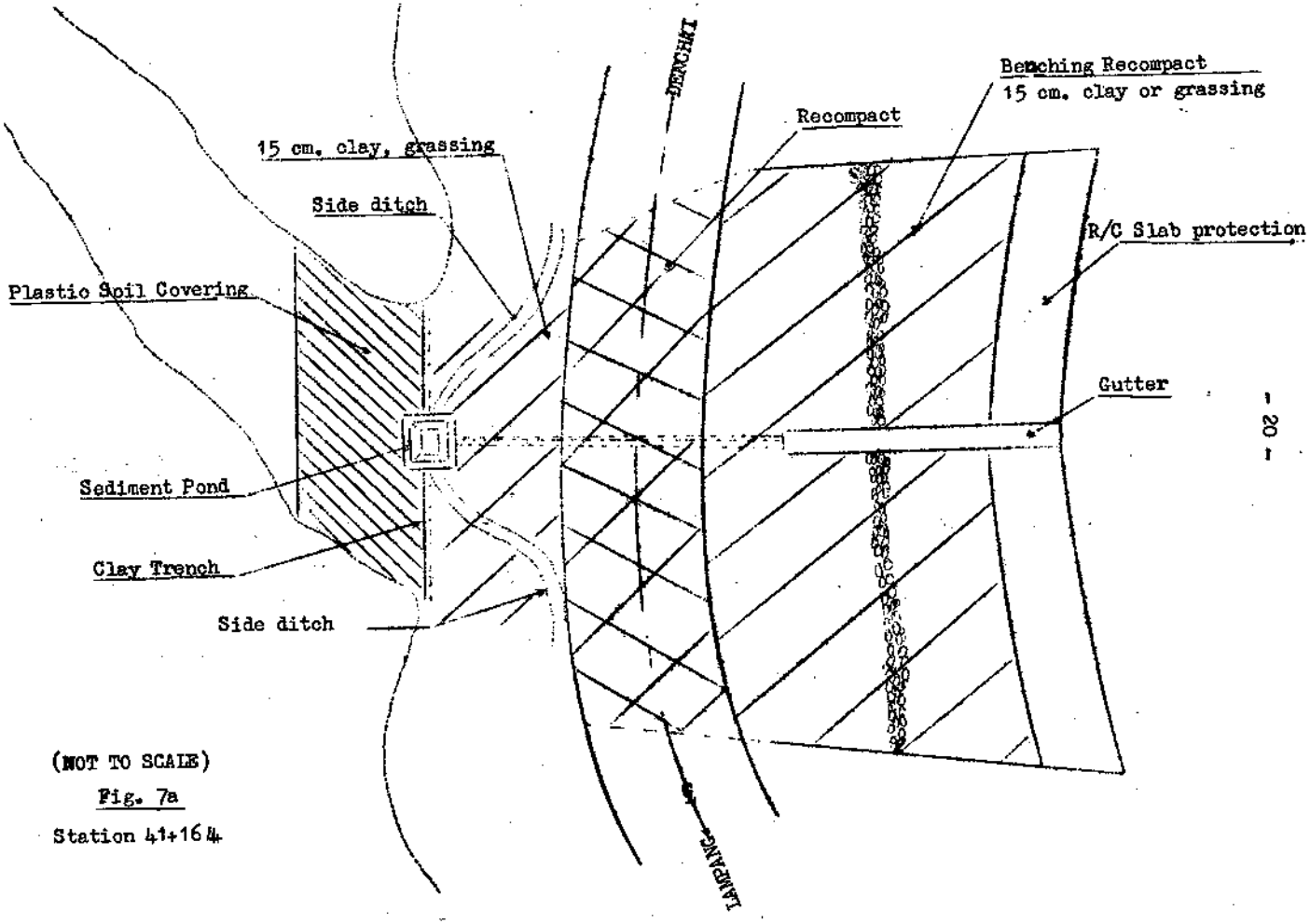


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Fig. 7a

Station 41+164

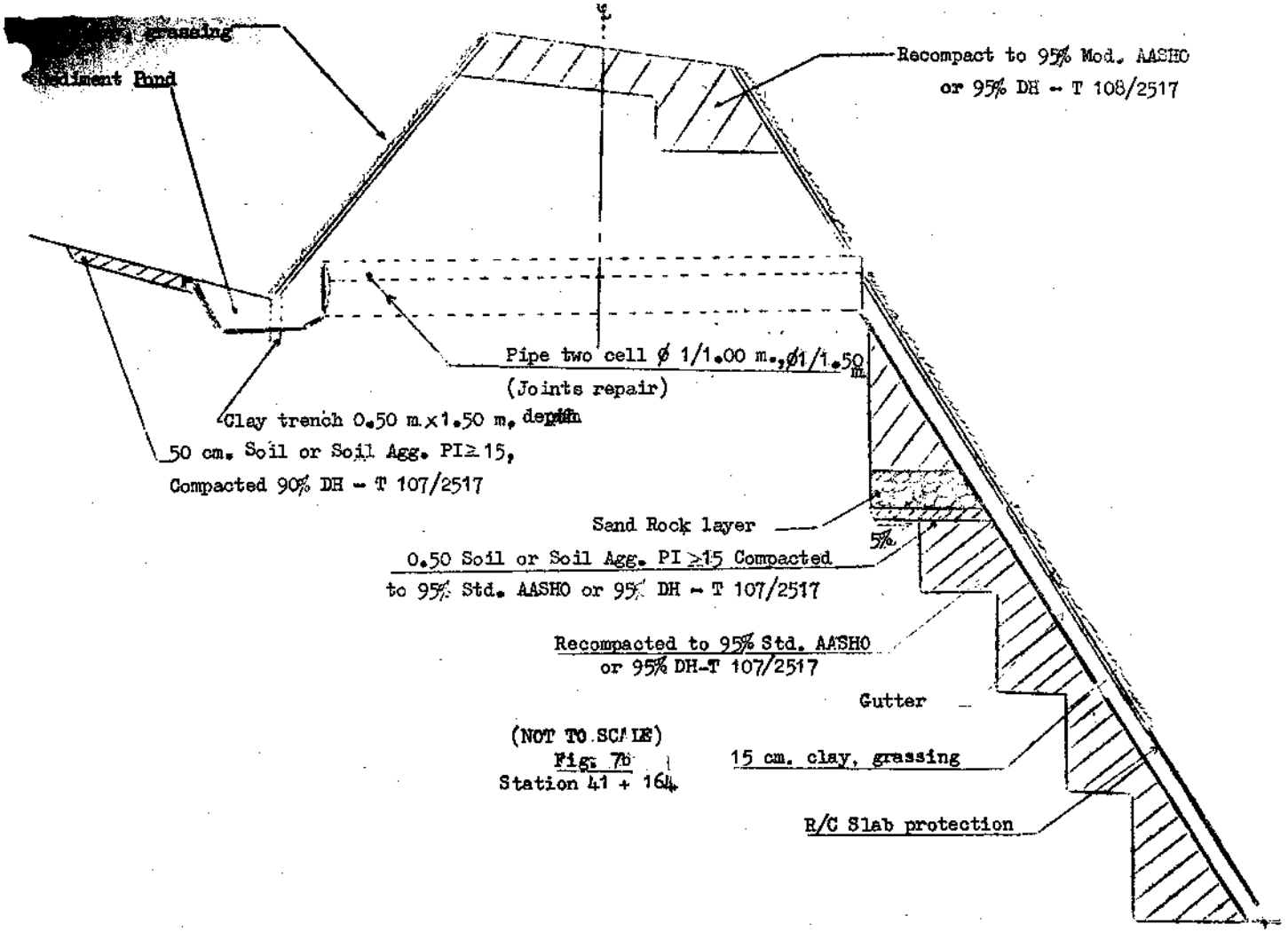


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Fig. 76
Station 41 + 164

รายงานฉบับที่ วว. 47 กองวิเคราะห์และวิจัย กรมทางหลวง

ผู้เขียน : ดร.วิชาญ ภู่พัฒน์

ชื่อเรื่อง : ความเสียหายของดินถมบนทางหลวงสายลำปาง–เด่นชัย

บทคัดย่อ : ระหว่างการก่อสร้างถึงชั้นรองพื้นทางของทางหลวงสายลำปาง–เด่นชัย ในปี พ.ศ. 2521 ภายหลังฝนตกหนัก พบว่า ดินถมที่บริเวณโกรกเขา 7 แห่งทรุดตัวและบนหลังถนนมีรอยแตกอยู่หลายแห่ง บริเวณโกรกเขาเหล่านี้เดิมเป็นทางน้ำไหล เมื่อก่อสร้างถมถนนข้ามทางน้ำ จึงออกแบบวางท่อกลม ขนาดไม่เกิน 1.50 เมตรไว้ แต่เนื่องจากดินถมเป็นคันทางสูงซึ่งท่อกลมจะไม่สามารถรับน้ำหนักได้ ทางโครงการจึงพิจารณายกระดับท่อขึ้น และถมดินเป็น berm ที่ด้านต้นน้ำ เพื่อป้องกันน้ำทำลายตัวถนน และเพราะเหตุที่ระดับท่อสูงนี้เอง ทำให้น้ำบางส่วนถูกกักไว้ ประกอบกับดินถมเป็นดินประเภท Silty Sand (ซึ่งมีค่า Peameabitity สูง และเมื่อถูกน้ำ กำลังของดินจะลดลงมาก) น้ำจึงซึมผ่านลงในตัวดินถมได้สะดวก ทำให้กำลังของดินลดลงและเกิดการเคลื่อนตัวของดินเนื่องจากแรงน้ำไหล จนเป็นผลให้ดินถมทรุดตัวและเกิดรอยแตกบนหลังถนน จากการสำรวจตรวจสอบ พบว่า การออกแบบป้องกันน้ำซึมเข้าตัวดินถมและระบบการระบายน้ำ ยังไม่ดีพอ ในการออกแบบแก้ไข ได้นำทั้งสองระบบเสริมเข้าไป โดยมีการปลอดใหม่บริเวณที่เกิดรอยแตกด้วย.

ทล. วว. / ร. 42 / 2522 /อ.

Report No. MR 47, Materials & Research Division, Department of Highways

Author : Visharn Poopath

Title : Embankment Failures of Lampang-Denchai Highway Construction Project

Abstract : During the construction of the Lampang-Denchai highway, settlement and cracks were found at seven portions of the road embankment which was lifted up to the subbase course. The phenomenon occur after a period of rain in the rainy season of the year 1978. Some investigations were done and the conclusion can be drawn from the investigation result that the occurance is due to lacking of the protection system and unadequacy of the drainage system at those portions of the road embankment which are locate at the stream valley and composed of non plastic soils. From the conclusion, the design for correction can be done by assigning proper protection system, and the ground and surface water drainage systems.

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