Behaviour of Recent Earth Dams and Levees in India

Le Comportement des Barrages et Digues de Construction Récente dans l'Inde

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Summary

A large number of multi-purpose earth dams have been completed recently in India and more than 1000 miles of new levees have been built to serve as flood protection measures. As these earth structures spread all over India, different designs were evolved to suit the local materials. The paper briefly explains the variations of designs with differences in properties of soils.

During the construction of the dams and the filling of the reservoirs there have been a few cases of failure and excessive seepage.

Observations of settlement and seepage are being made on the dams and at one or two sites the pore pressures are also being observed. A reservoir was partially filled and bore holes put in along an oblique section of the earth dam built on rocky river bed. There was a deep narrow channel in the river bed, crossing the earth dam at an angle. The bore hole indicated some sandwiched thin patches of saturated or supersaturated soil at different levels below the general bed level of the river. The presence of these soft layers had to be accounted for and its effects on the stability of the dam investigated.

The observations kept at different earth dam sites and levees are briefly reviewed to give information regarding the behaviour of the earth structures in use.

Sommaire

Un grand nombre de barrages en terre, destinés à différents usages, ont été construits récemment dans l'Inde. Plus de 1000 miles anglais de digues ont été construit également pour servir de protection contre les inondations. Comme ces constructions sont réparties dans toute l'Inde, on a élaboré les projets différents pour les matériaux des différentes régions. Cette communication explique brièvement ces variations du projet pour faire face aux variations dans les propriétés des sols.

Il y a eu certains cas de rupture et de percolation excessive au cours de la construction et du remplissage de ces barrages.

On a mesuré le tassement et la filtration des barrages ainsi que les pressions interstitielles dans un ou deux cas. Un réservoir a été rempli en partie et des trous de forage ont été disposés le long d'une coupe oblique dans le barrage de terre bâti sur le lit rocheux d'un fleuve. Ce lit comprenait un chenal étroit, passant à travers l'emplacement du barrage en oblique. Le trou de forage a révélé la présence de couches de terre saturée ou sursaturée à différentes profondeurs en dessous du lit du fleuve. Il a fallu expliquer leur présence et estimer leur influence sur la stabilité de l'ouvrage.

On passe en revue les résultats des mesures faites sur plusieurs barrages et digues afin d'obtenir des informations sur leur comportement.

The great activity in the construction of dams in recent times in India involves building many earth dams. In five of the large earth dams, earthwork of more than 45 million cu. yd. has been deposited. Hirakud Dam (Orissa State) is perhaps the longest earth dam, the total length being 15 miles including dykes, besides 0·73 miles of masonry structure. Also, there has been a recent trend to build the earth dams to increased heights and more economical sections. This can be seen from Table 1. Every dam site presented some difficulty or other and adequate measures had to be adopted to ensure safe construction. Many of the dams are nearing completion and waters are being stored in some of the reservoirs. The behaviour of these reservoirs under actual working conditions will provide many useful lessons.

Table 1
Data on recent earth dams in India (1930–56)
Barrages en terre exècutés rècemment en Inde

S. No.	*Dam*	*Height* ft.	*State*	*Period*
1	Hirakud	195	Orissa	1949–56
2	Maithon	162	Bihar	1952–56
3	Konar	160	Bihar	1950–54
4	Panchet Hill	132	West Bengal	1951–57
5	Gangapur	123	Bombay	1949–54
6	Mata Tila	120	Uttar Pradesh	1949–56
7	Lower Bhawani	105	Madras	1948–53
8	Rangawan	100	Uttar Pradesh	1951–53
9	Harsi	96	Madhya Pradesh	1919–37
10	Maniari	95	Madhya Pradesh	1924–37
11	Dindi	77	Hyderabad	1940–43
12	Rampur	75	Madhya Bharat	1908–31
13	Sirsi	72	Uttar Pradesh	1952–55
14	Aunjhar	70	Uttar Pradesh	1918–31
15	Kharang	69	Madhya Pradesh	1920–31
16	Markonahally	65	Mysore	1937–41
16	Byramangala	65	Mysore	1939–45
17	Aujanapur	63	Mysore	1925–38
17	Forebay Lower	63	Madras	1930–32
18	Forebay Upper	46	Madras	1930–32
19	Pendlipakala	54	Hyderabad	1935–40
20	Nagwa	50	Uttar Pradesh	1946–50
21	Aoda	50	Madhya Bharat	1927–34
22	Rooty	46	Hyderabad	1937–39
23	Nandargi	42	Bombay	1939–42
24	Kanva	56	Mysore	1940–46

Construction Problems

Some of the difficulties experienced in the construction of earth dams are reviewed first as these may be of assistance in understanding the behaviour of the structures in actual use.

Gangapur Dam—At Gangapur Dam (Bombay State), the available soil is black fissured clay known as black cotton soil. Gangapur dam is 12,300 ft. long with a maximum height of 123 ft. in the river crossing. The foundation consists mostly of black fissured clay and the problem arose as to what precautions should be taken to ensure safe construction on such soils. Field bearing tests on 1 ft. square, 2 ft. square and 3 ft. square plates were done to determine the bearing strength of the clay under saturated conditions. The section adopted is shown in an earlier paper (Rao, K. L. (1953). Applications of soil mechanics in river structures (India) *Proc. 3rd International Conference on Soil Mechanics and Foundation Engineering*, Vol. 2, pp. 277–82). Precautions finally adopted included stripping the black fissured clay to a depth of 5 ft., digging a trench and backfilling with compacted clay and providing longitudinal and cross drains inside the dam and an outfall drain

Table 2

Properties of soils used in the construction of the Gangapur Earth Dam
Propriétés des sols employés pour le barrage en terre de Gangapur

Description		*Mechanical analysis*					*Atterberg Limits*			*Proctor compaction test*	
Common name	*Colour*	*% Clay* L.0·005mm	*% Silt* 0·005–0·05 mm	*% Fine sand* 0·05–0·2 mm	*% Coarse sand* 0·2–2 mm	*% Gravel above* 2 mm	*Plastic limit*	*Liquid limit*	*Plasticity index*	*Optimum % moisture*	*Optimum dry density*
Man soil	—	3·89	13·86	25·68	24·31	32·25	30·63	40·0	9·37	18·57	113·1
Soil	Yellow	10·39	30·41	41·22	9·35	8·74	29·3	52·2	22·9	19·28	108·5
Man	Yellow	27·56	33·77	24·66	4·55	9·28	31·67	57·75	26·08	20·3	104·0
Man	Whitish	5·98	26·93	38·14	12·07	16·9	28·96	49·9	20·94	18·5	11·1
Man	Yellow	7·122	14·03	34·98	1·665	42·19	24·39	40·0	15·61	20·42	106·0
Man	Yellow	7·727	21·37	42·76	1·608	26·55	27·51	49·0	21·49	17·22	109·1
Coarse murum soil	—	19·95	48·57	19·42	7·452	4·61	27·05	51·5	24·45	15·73	111·0
Coarse murum soil	—	22·83	48·62	12·88	3·298	12·44	30·98	60·0	29·02	19·5	106·4
Hard murum	—	3·00	1·0	2·0	29·0	65·0	—	—	—	11·52	131·8
Soft murum	—	1·74	3·41	5·521	22·78	66·54	N.P.	36·6	—	16·58	119·1

10 ft. outside. The longitudinal and cross drains have been filled in with river gravel. Graded filters were provided for the outfall drain.

For the gorge or river section, the foundation conditions were not too bad. In this portion the maximum thickness of river gravel layer was 18 ft. above good hard rock. The top 5 ft. of loose gravel was removed and the rest retained as it was. The drainage system consists of collector pipes leading to an outfall drain which also collects the water from 12 in. vertical relief wells.

The general properties of the available soils at the site are given in Table 2 and the constants adopted in the design are given in Table 3.

Table 3

Soil properties assumed in the design of section for Gangapur Earth Dam
Propriétés définies au projet du barrage en terre de Gangapur

Material	*c* lb./sq. ft.	tan ϕ	*W dry* lb./cu. ft.	*Ws* 60% *saturation*
Hearting	600	0·3	108	120
Casing	0	0·63	120	—
Foundation	0	0·63	120	—

D.V.C. Dams—Panchet Hill on Damodar and Maithon on Barakar (Bihar) are 132 and 162 ft. high respectively. In both cases the river portions are closed by earth dams. The depth to rock in the river bed is 70 to 80 ft. and the intervening layers are pure sand. Prevention of seepage and piping were the major problems to be dealt with. The section adopted for Maithon and Panchet Hill Dams are shown in Figs. 1 and 2 respectively. After considerable controversy whether to adopt sheet pile cutoffs or upstream blankets, both were adopted.

At Kotah Barrage across Chambal (Rajasthan) a similar difficulty exists at the river crossing. Here the earth dam is 122 ft. high. Heavy rock toes were adopted due partly to the availability of rock at the site but more to prevent piping due to possible excessive seepage.

The overburden in the river bed of 40 to 60 ft. thickness consists of boulders of different sizes and sand, and heavy seepage is feared. Attempts are being made to provide a sheet pile cutoff but unsatisfactory results are anticipated. An upstream clay blanket is expected to reduce the seepage. Clay injections to seal off the gaps in the sheet pile cutoff especially at the contact with the bed rock are to be tried. There are many instances in India of river crossings of similar nature where earth dams are to be founded on pervious subsoil. Open cutoff trenches are expensive and other methods as described above are used.

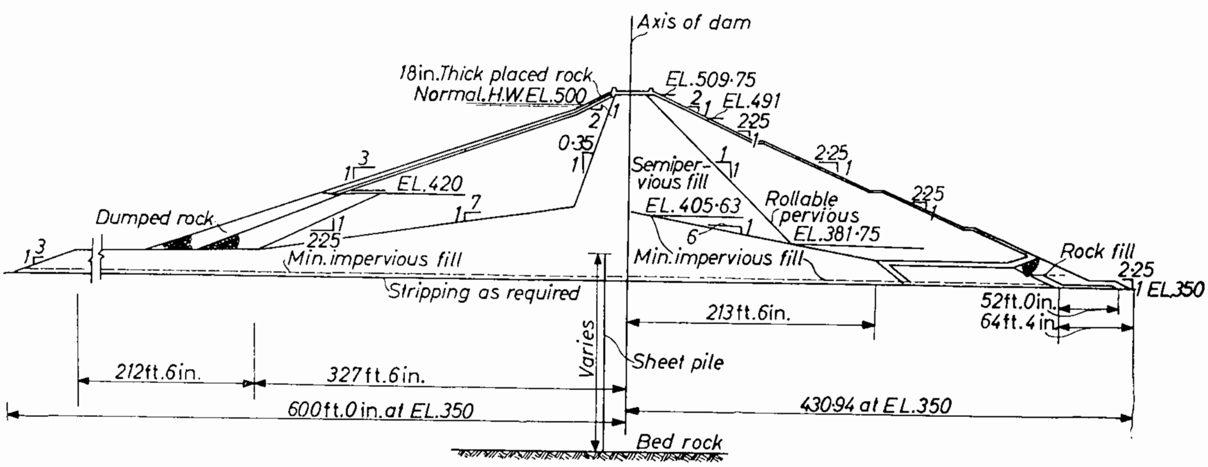

Fig. 1 Typical section—Maithon Earth Dam (DVC)
Section typique du barrage en terre à Maithon

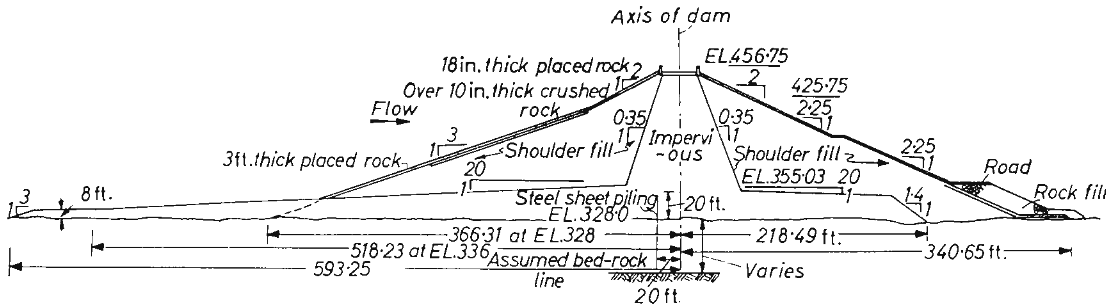

Fig. 2 Typical section—Panchet Hill Earth Dam
Section typique du barrage en terre à Panchet

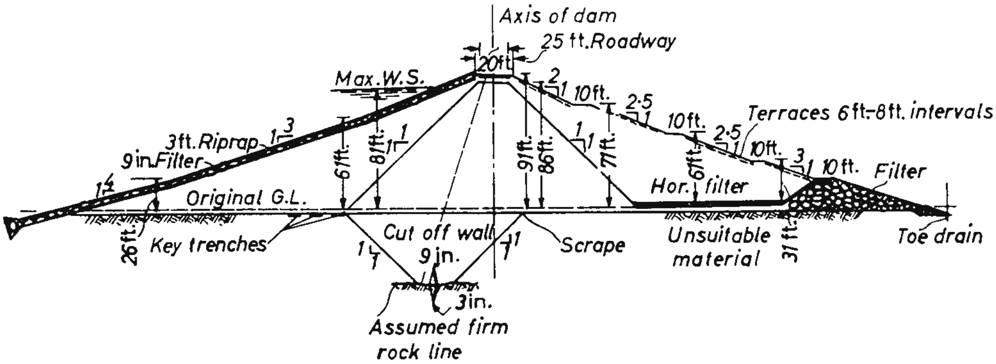

Fig. 3 Typical section—Lower Bhawani Earth Dam
Section typique du barrage en terre à Lower Bhawani

Table 4
Properties of soils used in the construction of Lower Bhawani Dam
Propriétés des sols employés dans le barrage de Lower Bhawani

Pit No.	*Depth of sample* ft.	*Mechanical analysis*					*Liquid limit* %	*Plasticity index* %	*Optimum moisture* %	*Dry density at maximum compression* lb./sq. ft.	*Permeability ft./year*
		Gravel %	*Sand* %	*Silt* %	*Clay* %	*Total fines* %					
A or 4	5½–8	Nil	34	40	26	66	51	24	12	104	0·99
B or 7	0–8	Nil	37	36	27	63	50	32	14	118	0·13
D or 12	7–10	Nil	43	38	19	57	42	23	14	110	0·63
E or 16	3½–7½	Nil	50	39	11	50	45	20	12	106	0·18
F or 19	6½–8	42	40	13	5	18	25	15	14	121	—
G or 22	8½–10½	37	52	8	3	11	28	8	10	132	—
H or 25	6½–8½	28	58	10	4	14	25	7	10	130	—
J or 23	0–½	—	50	34	16	50	41	18	12	102·2	—
J or 23	6–7½	56	32	7	5	12	39	24	12	123	—
K or 21	5½–2½	—	40	35	25	60	48	29	12	109	—
N or 20	5–8	—	33	24	23	67	59	38	14	105	—

Lower Bhawani Dam—Lower Bhawani Dam (Madras State) is 28,000 ft. long and has a maximum earth dam section of 105 ft. in height. The properties of the soil used in the embankment are given in Table 4. Cutoff walls 5 to 10 ft. high were constructed as shown in Fig. 3 even though the Congress on large dams held at Delhi favoured the omission of cutoff walls in earth dams.

Hirakud Dam (*Orissa*)—This is the largest earth dam in India involving 24 million cu. yd. of earth work. The average height of the dam in the river sections is 130 ft. and the section adopted is shown in Fig. 4. There is one length of the dam where the height is nearly 200 ft. as the river bed is eroded forming a deep rock channel. This deep channel runs obliquely across the axis of the dam. After pumping out the water and taking usual precautions of removing all loose rock, earth was deposited and compacted. The dam was raised in front sufficiently to prevent the river passing over the earth-filling during the monsoon. On the downstream side, however, due to the back waters, water stood on portions of completed impervious zone sections.

In between the monsoons the work was resumed, the total building period lasting from 1952 to 1956. During monsoon months the work was completely stopped due to heavy rainfall which amounted to more than 80 in. From June 1953 water has been standing, up to a depth of 50 ft. and more, continuously against the upstream slope in the deep channel section.

For the first time in India, settlement and pore pressure measuring instruments were installed in the dam. These are similar to the ones adopted by the Bureau of Reclamation.

The first two cross arms were installed in May 1952 after digging a pit 8 ft. deep and placing about 15 ft. of embankment. The entire pit was backfilled by manual labour and hand tamped

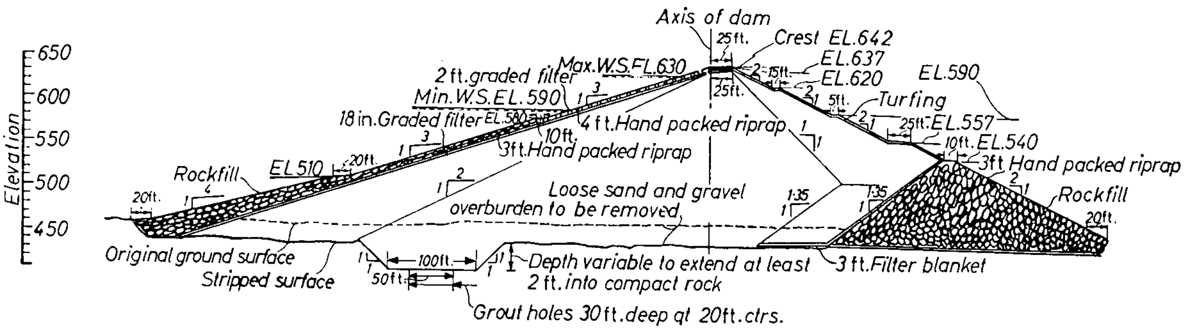

Fig. 4 Typical section where depth of water exceeds 120 ft—Hirakud Earth Dam
Section typique, ou la profondeur d'eau est superieure à 120 pieds (barrage en terre à Hirakud)

Table 5
Properties of soils used in the construction of earth dams in deep channel portion of Hirakud Dam
Propriétés des sols employés dans la partie profonde de canal de la barrage en terre de Hirakud

Sl. No.	*Laboratory sample No.*	*Classification*	*Mechanical analysis*							*Atterberg Limits*		
			Clay 0·002 mm	*Silt* 0·002–0·02 mm	*Fine sand* 0·02–0·2 mm	*Coarse sand* 0·2–2·0 mm	*Gravel* 2·0–20·0 mm	*Cobbles and boulders* ¾-in. *upwards*	*% Pass* ¾-in. *mesh*	*Liquid limit*	*Plastic limit*	*Plasticity index*
						Borrow Area No. 4						
1	191		18·5	12·0	19·4	28·2	16·4	5·7	80·2	34·6	16·5	18·1
2	194		19·5	12·7	25·4	40·0	2·5	5·7	100	37·0	13·4	23·6
3	220	Clayey sand	6·5	13·9	35·3	37·2	7·0	—	100	38·5	17·8	21·7
4	222	Sand	6·0	7·4	40·5	43·8	2·5	—	100	19·0	19·0	—
						Borrow Area No. 4D						
5	9,303	Clayey murum and fine gravel	24·2	3·4	10·7	22·4	39·3	—	88·0	35·0	11·2	23·8
6	9,429	D.R.	24·6	17·7	—	57·7	—	—	—	46·2	11·7	34·5
						Borrow Area No. 5						
7	592		15·1	9·2	68·42	7·28	—	—	100	27·13	16·85	10·28
8	616		23·3	21·2	41·6	13·26	0·66	—	100	32·1	14·65	17·45
9	8,118	Clayey W. rock	25·9	8·05	9·53	15·48	41·04	—	55·1	39·6	11·2	28·4
10	8,169	Decomposed rock	21·5	9·3	18·10	43·9	7·2	—	47·2	40·0	12·9	27·7
11	9,411	Clayey murum	27·2	8·6	13·0	20·9	30·3	—	66·7	45·8	15·0	30·8
						Borrow Area No. 6						
12	12,145	Sandy murum and gravel	11·7	2·1	4·7	8·4	61·4	11·7	54·4	59·6	14·8	44·8
13	12,216	Sandy clay	25·0	5·4	41·1	23·5	3·0	—	100	26·8	12·3	14·5
						Borrow Area No. 8						
14	268	Clayey sand	9·0	6·5	34·6	49·9	—	—	100	23·2	14·9	8·3
						Borrow Area No. 9						
15	10,819	Sandy clay	30·0	7·7	37·8	22·4	2·1	—	100	31·6	12·5	19·1
						Borrow Area No. 11						
16	11,792	Sandy gravel	8·6	2·5	4·9	6·4	58·2	19·4	54·1	51·1	16·4	34·7

in 3 to 4 in. layers. The cross arm installation was not taken down to rock as originally intended. Six cross arms in each of the two sites were installed before the monsoon of 1952. From July to the end of December 1952 both the cross arm installations remained under water. No water was observed in the holes of the installations before the monsoon of 1952 but later on the water levels rose with the upstream and downstream water levels. The installation of cross arms was continued as the work progressed.

In the deep channel area, investigations to determine the state of earth in the bank were made by putting down bore holes at different times. One hole was put in November 1952 and nearly 15 holes in 1955–56. The sampling procedure was as follows:

Sampling was done by means of a 2½ in. diameter × 2 ft. split spoon sampler driven by a 150 lb. hammer falling 3 ft. Each core was 18 in. in length. Percussion drilling was adopted: 4 in. diameter casing was used in all the holes except one. Sampling was normally done about 10 to 12 ft. ahead of casing and then one more length of 10 ft. casing was driven in. A number of tests were done. These included determinations of moisture content, dry density, core recovery, number of blows, etc. Some of the properties of soils used in the construction of the deep channel portion are given in Table 5. The settlements of cross arm installation C are plotted in Fig. 5. The individual consolidation between layers is also shown. The following observations are made from the drawings: (1) the consolidation movement of both the installations is similar; (2) a large percentage of the settlement is in the bottom layers; (3) large settlements have occurred during construction and the monsoon of 1952 when water was standing on a portion of the earth dam; (4) the settlement during construction periods is considerable; (5) the initial void ratio of the fill material in the bottom layers is large and is now reduced after placement of the top layers.

Some of the cores taken from the bore holes showed existence of soft soil patches at different elevations in the bottom 70 ft. of bank. The moisture contents of some of the samples were high, being 25 to 30 per cent, while the optimum moisture content of the soil was 15 to 20 per cent. The reason for this excessive moisture is not apparent. The sampling procedure, where samples were taken 5 to 10 ft. ahead of the casing, may perhaps result in the presence of extra moisture. It may be due to saturation of soils placed relatively dry and with low densities or it may be that these soft patches are due to excessive placement water content of the soil.

In five of the completed earth dams in the T.V.A. (U.S.A.) similar experiments showed some restricted zones of extremely soft wet material. This was attributed to cracks and subsequent swelling.

Pore pressure measurements were unfortunately not taken until recently. These measurements show the presence of pore pressures in the fill and it is not known whether the presence of soft patches represent zones where high pore pressures were developed. It may be that they mean soils of different void ratios and compaction. Thus the field observations kept at Hirakud have given rise to interesting thoughts and further observations after filling of the reservoir will prove useful.

Failures

There have been a few instances where difficulties have cropped up during construction of earth dams, resulting in breaches. These have led some engineers in India to doubt the safety of earth dams. One of the interesting cases is that of Ahraura Dam in Uttar Pradesh. The earth dam is 4000 ft. long with a flank spillway of 550 ft. on the extreme left. Irrigation water is supplied by two sluices, one on the left and the other on the right. The deepest section is 75 ft. and the total earth-work is ¾ million cu. yd. The earth dam on the right side abuts directly against a hill with a lot of loose boulders and weathered exposed rock. A masonry sluice with arch roof was built within a few feet of the edge of the rock which dips practically vertically. Gates were located in the middle of the earth dam so that the water in the sluice was under pressure when the gates were closed.

The construction of the dam was commenced in February 1952; the work continued through two seasons and the river section was closed just before the monsoon in the last week of June 1953. The cutoff trench in the river portion was excavated and filled in 1951–52 and the floods of the monsoon of 1952 were allowed to pass over the trench. Building was resumed on the top of the trench in the next season.

After the closure of the river section in the last week of June 1953, water collected in the reservoir and the level gradually rose. On 5 July 1953 there was heavy rainfall and the reservoir level rose by 30 ft. The water level on the downstream side in the bed of the river was 37 ft. lower than the upstream. Water was found oozing out of the downstream face of the dam next to the masonry sluice on the right. The labourers living in a thatched hut near the top of the dam at the edge of the hill along the river observed a small leak at 6 a.m. on 6 July and immediately reported to the overseer staying at the other end of the dam. The overseer collected labour and got a bulldozer to the site. He tried tamping from the top and placed the roof thatch of the hut at the upper edge.

A whirlpool was sighted close to the upstream toe near the entrance to the sluice. Attempts made by the local staff to close the gap were not successful. A scour hole was soon observed on the downstream side and it is stated that the thatched roof of the hut thrown in the whirlpool, on the upstream side, came out of the downstream scour hole. Soon after, at 9 a.m., a breach 100 ft. wide occurred and the entire masonry downstream wall and the arch roof of the sluice barrel up to the gate were all destroyed. Also, at the beginning of the breach, water was observed to come out at the downstream rock toe level and the filter at the back of the rock was first blown off, before the breach occurred.

The events preceding the failure clearly indicate that the water had been percolating slowly underneath the earth dam just adjacent to the sluice walls for some days. The filter and revetment toe were omitted on the downstream side for a length of 25 ft. adjacent to the masonry wall of the sluice. So the pressure of the flowing water was not dissipated and it gradually rose. Due to the passage of water underneath, earthwork adjacent to the masonry sluice settled and the earth laid on the hillslope slid down. Due to this great force, the masonry side wall on the river side must have been deflected, resulting in the collapse of the masonry arch. The water was under pressure upstream of the gate in the sluice way barely 80 ft. away from the toe of the dam. The pressure of water was 37 ft. and the distance from the gate to filter was too short to retard the water flow. The free and violent flow of water through the sluice is clearly indicated by the whirlpool at the entrance to the sluice.

The properties of the soil used in the construction of the dam were as follows:

Liquid limit	25–29
Plastic limit	17–20
Optimum moisture	12 to 14 per cent
Maximum density	114 lb./cu. ft.
Coefficient of permeability	35×10^{-4} ft./yr.
Cohesion	0·45 ton/sq. ft.
Angle of internal friction	28·5 degree
On saturation the figures are	0·18 ton/sq. ft. and 26·5 degree respectively

After the occurrence of the breach, samples were taken from the banks at various depths and densities and moisture contents determined. The percentage of laboratory compaction optimum moisture content was calculated. The percentage compaction varied from 81·2 to 95·6 showing that the compaction of the banks as built was satisfactory.

The sluice was re-designed, gates being placed in the upstream portion, and the work reconstructed.

Palakmati Dam (Bhopal) provides an example of how an earth dam of even 40 ft. to 50 ft. height can give trouble if proper precautions are not taken in its construction. The dam is 3300 ft. long and was built on black cotton soil overlying clayey soil mixed with pebbles. The last two soils are known to possess very little shear strength under saturated conditions. The dam was built with an upstream slope of 2:1 and downstream slope of 3:1. The upstream slope was pitched with stones 1 ft. thick overlying 6 in. filter material. Fifteen years after construction, during a year of heavy rainfall, a slide occurred on the upstream slope in June 1953. Dumping of earth resulted in a further slide. Fig. 6 shows the section of the dam, the slide and suggested remedial measures, which consisted mainly in flattening the upstream slope to 3:1 and providing an upstream rock toe.

Another interesting example, where failure occurred due to heavy seepage through foundation material, is provided by

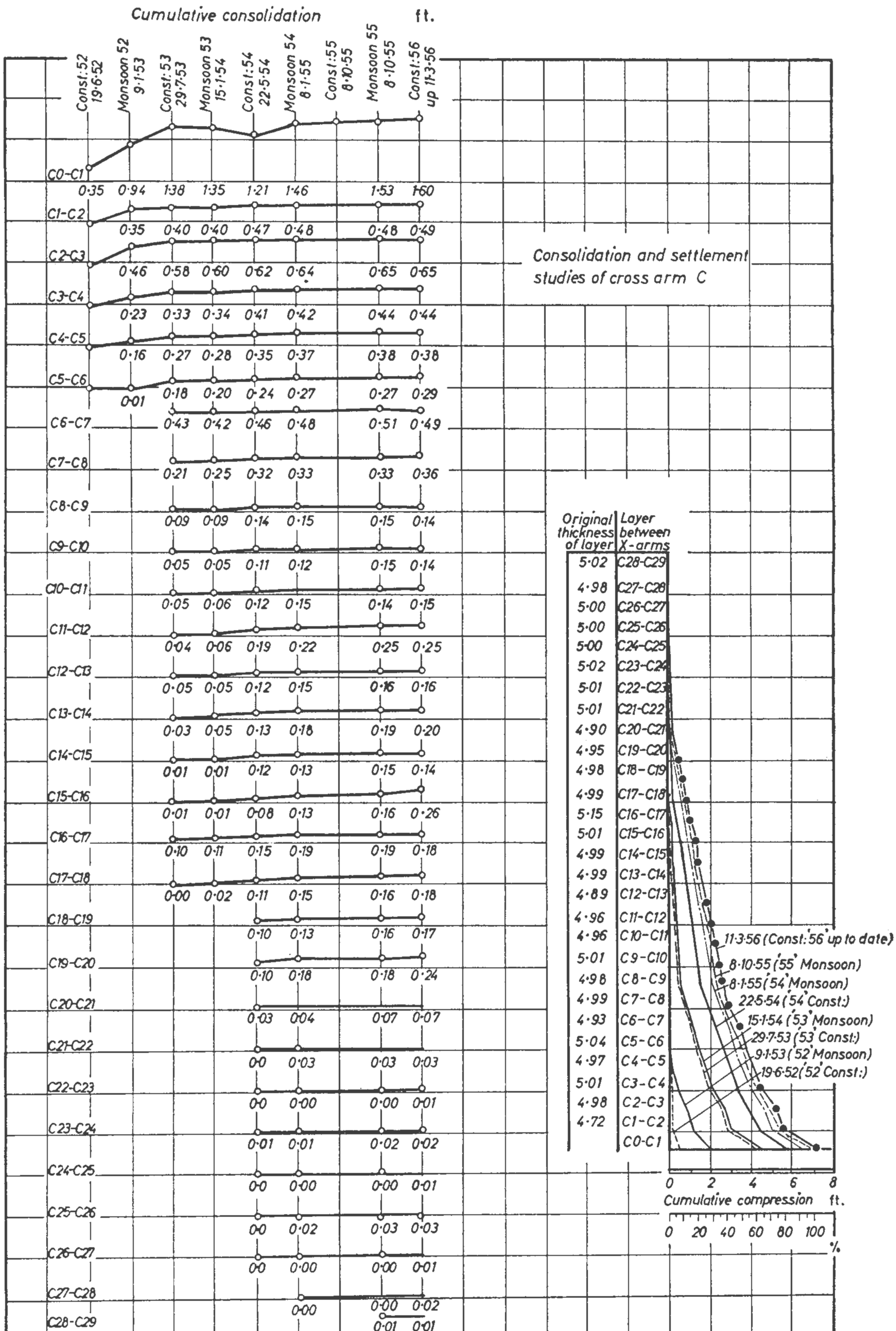

Fig. 5 Settlements of cross arm installation *C*—Hirakud Earth Dam
Tassements d'appareil *C*—barrage en terre à Hirakud

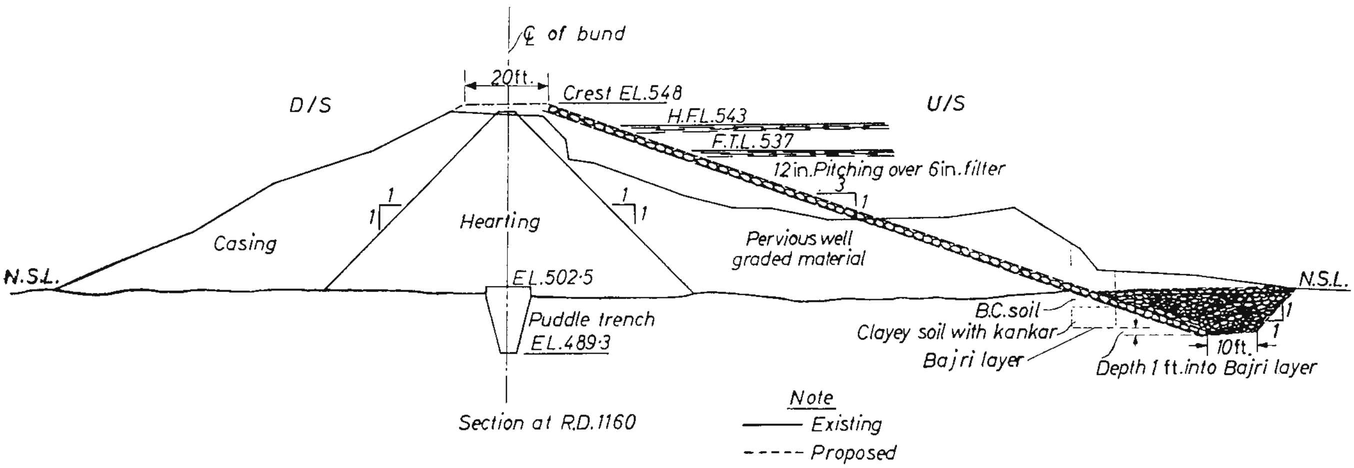

Fig. 6 Section of Palakmati Earth Dam showing slide and remedial measure suggested
Profil du barrage de Palakmati, montrant le glissement et les dispositions suggerées pour y remédier

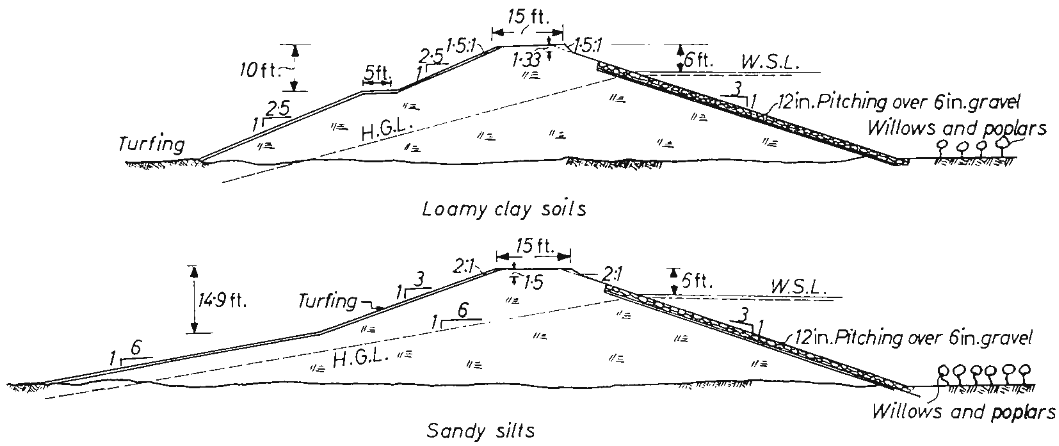

Fig. 7 Typical sections of flood embankments—Kosi River
Sections typiques de digues contre les inundations—Kosi River

Moorum Nala Tank bund (Madhya Pradesh). The bund is 5250 ft. long and has a maximum height of 62 ft. The tank was filled in September 1946. A month later, muddy water was found leaking on the downstream slope. To prevent any mishap, it was decided that the water level should not be allowed to rise above 10 ft. below the designed full tank level and a waste weir was proposed in the earthen bund. During construction of the weir the bund breached. It was reconstructed and a waste weir provided in the flank. There was no trouble until 1954 when again the depth of water rose to 40 ft. and excessive seepage was noticed. At one section there is a depression on the downstream side and the bank slipped at this place indicating failure due to heavy seepage. After the slip, water started coming out of the hole formed at about 40 ft. away from the centre line of the bund. Remedial measures suggested included a clay blanket on the upstream side and provision of a rock toe on the downstream side.

Levees

Flood Control works have been undertaken all over India since 1954. The first phase works consist mainly in the construction of earth banks on either side of the rivers to prevent inundation of low-lying inhabited areas. Nearly 1000 miles have been constructed. The embankment works in progress on Kosi river (Bihar) are meant not only to prevent inundation but also to confine its course, preventing its lateral movement. Kosi river is notorious for changes of its course, and during the last 100 years it has shifted nearly 75 miles to the west. There are various reasons for this which include steep gradients, excessive coarse silt, and lateral slopes, etc. The remedial measures undertaken consist of the construction of a barrage and 150 miles of embankment protected with spurs in reaches of excessive velocity. In most of the reaches of the river sand is the only material available for the construction of the banks. Clayey material has to be transported from long distances. Sections adopted are shown in Fig. 7. It is believed that unless the banks are attacked directly by the river causing erosion at the toe, they would be safe.

Conclusions

Of high dams recently constructed, two dams, viz. Lower Bhawani and Konar, are under operation and are functioning satisfactorily. During the monsoon of 1956 the filling of a number of other reservoirs will be started and it will be possible to give a supplementary note at the time of the session in 1957 on the actual behaviour of high earth dams.

I wish to thank Mr H. L. Wadhwa and Mrs U. R. Sainani, Officers of the Central Water and Power Commission, for their help in preparing this paper.