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IRRIGATION ENGINEERING IN INDIA

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The development in irrigation engineering in India before 18th century before the advent of the British is described. The sections of earth dams and masonry weirs adopted for construction by Indian and British engineers are compared. The similarity of irrigation management by Indian and British method is shown. The advances in the knowledge of design of high masonry dams, construction of inundation canals with desilting arrangements, in mechanical and electrical engineering, brought to India, by 19th century by British engineers, are discussed.

INTRODUCTION

Irrigation of culturable land is practised in India from immemorable time. Irrigation is done by two methods, by lift irrigation and by gravity flow of water. Lift irrigation in India is mostly from wells. Irrigation by gravity flow of water is by canals. Water is fed to fields (*a*) by canals from tanks which are either rain fed or filled by a trench connecting the tank with a river; (*b*) by canals from a reservoir formed by constructing a dam, earth or masonry, across a river; and (*c*) by inundation canals. The head work is formed by breaching the bank of a river and allowing flood water to enter in the canal.

Above methods of irrigation were practised in India before British started ruling India. Ennumerable wells and tanks were constructed from very ancient times to the 18th century all over India. The practice of irrigation by inundation canals was followed in Punjab and Sind provinces as the rivers are perennial and are in flood for eight months.

The majority of dams constructed across rivers were meant to divert river water to the canals and large storage reservoirs with high dams were rarely constructed in India before her occupancy by British. They have constructed high dams with an idea of developing storage reservoirs so that the stored water could be utilized even during drought period, as is claimed by British engineers.[1,2]

STATE OF IRRIGATION BEFORE 18TH CENTURY

Kauṭilīya Arthaśāstra (4th century B.C.) gives copious information regarding construction of dams, canals, management of canal water including levying of tax.

The irrigation works used to be constructed privately by individuals or co-operatively. If the work is large, the king was also lending his hand for its construction.[3] Rules for location of tanks are also detailed.[4] According to different Smṛties (200 A.D.-900 A.D.) a man who breaches tank is to be given death penalty by drowning him in the water of that tank.[5-10]

Earth as well as masonry dams were constructed in very large numbers, in tens of thousands, from 2nd century to 17th century. Many of these are functioning even at present time. Some of these tanks are listed with their locations and salient features in tables 1 and 2. Table 1 gives this information for dams constructed in 2nd to 3rd century A.D. and table 2 gives this information for dams constructed from 1000 A.D. to 1800 A.D. Fig. 1 gives cross-sections of some of these dams.

In North as well as in South India, inundation canals across perennial rivers were constructed. In South India, wherever water level in the river goes down considerably in fair season an earth or masonry dam was constructed so that the level of water will be always high which was led by canals for irrigation. The dams were constructed across the same river one below the other as well as across its tributaries. As much quantity of river water as possible was utilized for irrigation. This scheme also worked as flood protection system. Fig. 2 illustrates such a system of tanks in the basin of the river Ponniar, in Salem district.

TABLE 1

Earth Dams constructed in 2nd to 3rd Century A.D.

Ref.	Name of tank	District	Remarks
Smith p. 6	Poonary	Trichinapoly	30 miles in length, Area of reservoir 60 to 80 sq. miles.
Smith p. 6	Veeranum	Tanjore	10 miles in length, Area of reservoir 35 sq. miles, capacity of canals 1,500 and 1,000 cusecs.
Smith p. 142	Chumbrumbankum	Chinglepeet	19,200 ft. in length, reservoir area 9½ sq. miles, maximum height 26 ft.
Smith p. 143	Cauverypauk	Northern Arcot	19,800 ft. in length, reservoir area 7 sq. miles, maximum height 31 ft., U/s slope 2½:1, D/s slope 1½:1.
Buckley p. 7	Cumbam	Kurnool	300 ft. in length, reservoir area 8 sq. miles, 80 to 90 ft. height.
Buckley p. 9	Nuggar	Mysore	1,000 ft. long, 84 ft. height.
Buckley p. 9	Tank on tributory of Locain	Mysore	225 ft. long, 117 ft. high.

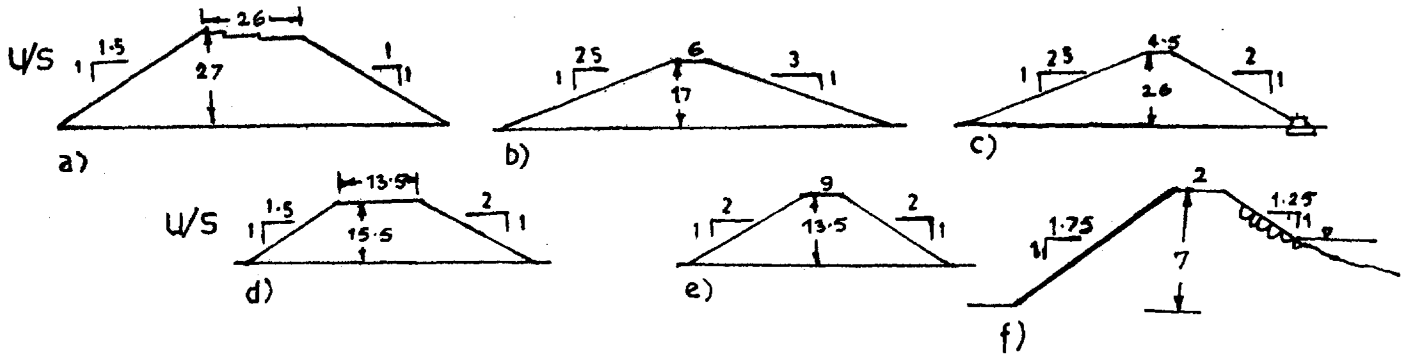

FIG. 1 Cross-sections of dams from 2nd to 18th century. (*a*) Motitalav dam, (*b*) Ramappa dam, (*c*) Pakhal dam, (*d*) Cumbum dam, (*e*) Ananthasagaram dam, (*f*) Chumbrumbankum dam.

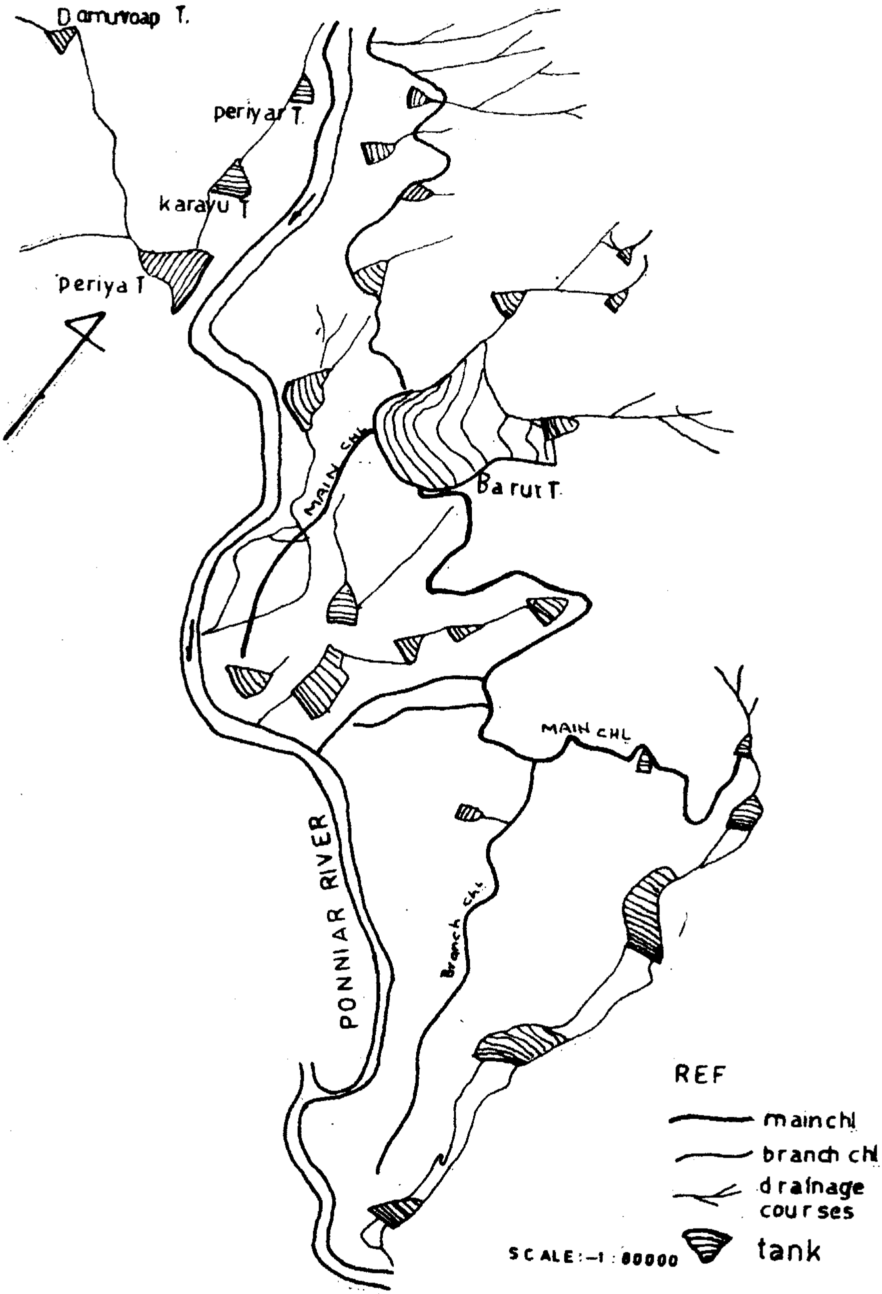

FIG. 2 Tank system in the Ponniar basin (Ref. 1).

One such series of tanks in Mysore had no fewer than 1,200 interdependent tanks. The total numbers of tanks in Mysore was 37,000, the largest of which had a surface of 40 sq. kms..[11]

There were about 550 weirs across rivers in Madras, each connected with a series of tanks.[12] There were 43,000 tanks in Madras which were functioning in the 19th century and 10,000 tanks were in disrepair.[13] The area irrigated from these tanks exceeded 1.415 million hectares. Smith stated that the length of embankments of these tanks may be taken on average of 0.85 kms. The numbers of masonry works as sluices for irrigation, waste weirs & C could be six per tank. This shows that the total length of embankments of these 53,000 tanks would be 50,790 kms. This is sufficient to put a girdle round the globe not less than 1.80 m. thick and three million separate masonry works.

In Madhya Pradesh there were 50,000 small private tanks which irrigated 2,62,600 hectares in years of high demand.[14]

Masonry or earth 'Bandharas' about 200 of which were in operation (in 19th century) and many were in ruined state, were constructed by Indian Engineers on rock foundation. They exist on every perennial stream of Dhule district. Most of these bandharas consist of solid masonry weirs.[15] Fig. 3 gives cross-section of a typical masonry weir.

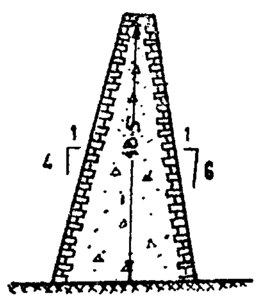

FIG. 3 Typical cross-section of masonry weir from Dhule district (Ref. 12).

The above description of irrigation works in India before the advent of the British gives the idea of the vastness of the system and it could be stated that anything comparable of it did not exist in any other part of the world. Tank irrigation as described above was practised all over India except in the provinces of Punjab and Sind. Irrigation by inundation canals was practised in these provinces. The inhabitants on the banks of the river Indus learnt to excavate small channels through the higher lands on the immediate brink of the stream to irrigate lands. This system of inundation canals was used from unknown ages by which the rising water of Indus was tapped and used to irrigate fertile lands laying in the comparative rainless plains of the valley. Fig. 4 gives plan and cross-section at the mouth of an inundation canal. The examples of such canals are the Western and Eastern Yamuna Canals on the Yamuna and the Hasli Canal on the Ravi. These were dug during the 14th and 18th centuries[16] respectively.

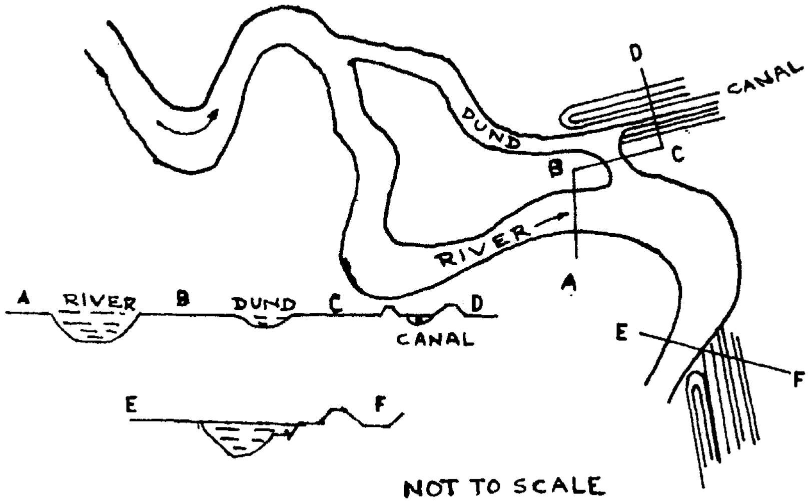

FIG. 4 Mouth of an inundation canal (Ref. 12).

The British engineers at the beginning of the 19th century began irrigation development with the renovation, improvement and extension of existing works like Grand Anicut, Yamuna and Hasli canals etc. After studying the Indian practice of irrigation British engineers ventured on new major works. One of the eminent British engineers stated regarding Indian irrigation works that, "......in the works of Irrigation there is a great boldness of design, considerable knowledge of hydraulic principles......and occassionally a neatness of finish which it was pleasant to see .... The tank system of Madras being, ..., essentially native in its origine and nearly all its details does not present unobjectionable models for introduction elsewhere....... The professional details......present ideas that might be carefully adopted by ourselves."[17] It is stated that nearly $3\frac{1}{4}$ million hectares were irrigated from tanks in India before the British occupation (see ref. 14).

THE DEVELOPMENT OF IRRIGATION IN BRITISH INDIA DURING 18TH-19TH CENTURY

The period from 1836 to 1866 is marked with a spurt of irrigation works in British India. In the forties the delta works of the Godavary and the Cauvery were inaugurated and extended. In the fifties the Bari Doab canal in the Punjab, the Ganges canal in the North West and the Krisna Delta system in Madras came into operation. In the sixtees four canal systems in Bombay and two in Bengal were added. In the seventies the Sone canals in Bengal, the lower Ganges and Agra canals in the North-West, the Mutha and Nira systems in Bombay began to collect irrigation revenue. In the eighties the Sirhind canal and in nineties Chenab canal were commenced.[18]

By the end of the 19th century, the gross area irrigated in British India by public works was about 7.5 million hectares, of this 4.5 million hectares was from productive and protective works and 3 million hectares from minor works like tanks, inundation canals, etc. The area irrigated by private works was 5.7 million hectares about 70 per cent of it by wells and remaining by tanks, streams, channels etc. The total irrigated area (from all sources) in 1900 was 13.4 million hectares of which public works accounted for 56 per cent. The gross area sown was 82.2 million hectares of which about 16 per cent was irrigated. Canals irrigated about 45 per cent of the area, wells 35 per cent, tanks 15 per cent and other sources 5 per cent.[19]

Design of Earth and Masonry Dams

Earth dams

The upstream and downstream slopes that are given to the earth dam by Indian engineers that are located in South India vary from 1½:1 to 3:1. The majority of earth dams below 15 m. height are having slopes of 1½:1. These dams are constructed of gravelly soils. These sections are time tested and stable (Table 2).

TABLE 2

Earth Dams constructed during 1000 to 1800 A.D.

Sr. No.	Name of tank	Year of construction	Length	Max. height	Top width	Side slopes	
						U/s	D/s
1.	Motitalaw tank	1000-1100 A.D.	13,200′	80′	47′ to 50′	1.75:1	1.4:1 to 5.6:1
2.	Malkapur tank	-do-	12,400′	38′	12′	2:1	3:1
3.	Veeranam tank	1011 A.D.	52,800′	30′	20′	1.5:1	1.5:1
4.	Pakhal tank	1213 A.D.	4,000′	63′	15′ to 40′	2:1	2:1
5.	Ramappa tank	-do-	2,000′	56′	20′	2.5:1	3:1
6.	Lakhnawaram tank	-do-	2,000′	50′	15′ to 20′	2.5:1	3:1
7.	Cumbum tank	1300-1400 A.D.	1,000′	52′	66′ to 100′	1.5:1	2:1
8.	Anantbarambakam tank	-do-	—	46-98′	30′	2:1	2:1
9.	Chembarambakam tank	-do-	29,040′	32′	8′ to 10′	1.75:1	2:1
10.	Rasool tank	-do-	4,200′	42′	2½′	1.5:1	2:1
11.	Anantharajasagaram tank	1369 A.D.	14,000′	36′	12′	2:1	2:1
12.	Kesari tank	1400-1500 A.D.	5,000′	40′	15′	2:1	2:1
13.	Kaveripakam tank	1400 A.D.	23,760′	39.78′	9′	1½:1	2:1
14.	Peddatippa samudram tank	1520 A.D.	4,150′	52.42′	40′ to 80′	2:1	3:1
15.	Ibrahimpatan tank	1500-1600 A.D.	7,920′	50′	10′	3:1	2:1
16.	Raverial tank	1600 A.D.	5,700′	45′	10′	2.5:1	2.5:1
17.	Laksminarayana tank	1700 A.D.	8,500′	40′	3½′	3:1	2.5:1
18.	Venkateswara tank	1800 A.D.	3,000′	50′	2½′	1.5:1	2:1

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In central India there are some ancient tanks built over 800 years ago in the districts of Tikamgarh and Chattarpur. These dams are constructed of clay soil and have side slopes as flat as 3:1 to 4:1. It seems that the side slopes of earth dams as constructed by Indian engineers were dependent on type of soil used for construction of embankment. The side slopes provided were 1½: 1 to 2:1 for dams constructed of gravelly soils whereas these were flattened to 3:1 to 4:1 if the construction material was clay.

British engineers thought that the earth dams constructed by Indian engineers have excessively flat slopes. Table 3 gives side slopes of earth dams of different heights that were recommended by Strange.[20]

TABLE 3

Dimensions of earth dams according to British Engineers

Height of dam above G.L.	Height of dam above H.F.L. ft.	Top width ft.	Slopes		Width of dam at H.F.L. ft.
			U/s	D/s	
15 ft. and under	4 to 5	6	2 to 1	1 ½ to 1	20 to 23½
15 ft. to 25 ft.	5 to 6	6	2½ to 1	2 to 1	28½ to 33
25 ft. to 50 ft.	6	8	3 to 1	2 to 1	38
50 ft. to 75 ft.	6 to 7	10	3 to 1	2 to 1	40 to 45

Even by the close of 19th century, a rational analytical method of design of earth dam was not developed and British engineers used to construct earth dams with empirically developed sections. Number of earth dams in Bombay province were constructed by British engineers by following these empirical sections (Table 4). All these dams are homogeneous and constructed of the best black cotton soil available and of murum mixed in 1:1 proportion. It may be noted that excepting Waghad dam, none of these dams are more than 23 m. height and majority of them are below 15 m. height. It is to be pointed out that many of these earth dams have shown distresses throughout their service life of 90 years or so and consequently their slopes have to be flattened so that the final section achieved was similar to the one approved by Indian engineers. Waghad dam in Nasik district is a pertinent example in this respect. The dam was constructed with side slopes of 2½:1 to 3:1 in the year 1888. In the very first year (July 1883) the dam breached because of overtopping. During the next fair weather season downstream slope slipped on April 1884 for a length of 60.96 m. The downstream toe of the dam moved about 15.24 m. and the top of embankment subsided by 6.40 m. In April 1919 upstream slip occurred for a length of 60 m. A shallow slip of downstream slope occurred in the year 1976. Fig. 5*b* gives the section of the dam in the gorge as originally built in the year 1884 and the section finally developed after effecting remedial measures. The hatched portion gives the

TABLE 4

Table gives the salient features of the earthen dams that were constructed in the 19th century in Bombay and Saurashtra state

Name of dam Bombay state	Year of construction	Length ft.	Max. height ft.	Top width ft.	Side slopes	
					U/s	D/s
Dist						
Mukti, Dhule		3,000	65	10	2.5:1	2:1
Mhasva		1,494	44.1	10	3:1	2:1
Parsul, Nasik		2,770	62.2	6 to 8	3:1	2:1
Sirsuphal, Pune		2,188	54.3	4	3:1	2:1
Matoba, Pune		6,095	48.4	9	3:1	2:1
Bhadalwadi, Pune		2,590	55	6	$2\frac{1}{2}$:1	2:1
Pashan, Pune		2,750	52	6		
Ekruk, Sholapur		7,000	76	6	3:1	2:1
Ashti, Sholapur		12,700	57.7	6	3:1	2:1
Pandharpur, Sholapur		3,500	44	4		
Mhasvad, Satara		9,080	79.8	8	3:1	2:1
Nher, Satara		4,820	74	8	3:1	2:1
Pingli, Satara		5,553	53.5	6	3:1	2:1
Maini, Pune		3,605	61.3	10	3:1	2:1
Medleri, Dharwar		2,250	41.0	6		
Dedargaon, Dhule		1,420	47.6	6	$3\frac{1}{4}$:1	2:1
Waghad, Nasik		4,060	96.0	10	3:1	$2\frac{1}{2}$:1

increase in the section. The final stable section of the earth dam that was developed because of remedial measures taken from time to time to strengthen the side slopes is the same as developed by Indian engineers for earth embankments constructed of clay soil.

Another earth dam located near Kolhapur, Kalamba tank, was constructed in the year 1884 with maximum height of 12.2 m. It is a homogeneous dam constructed of highly plastic black clay soil. It has also shown distresses from time to time and its slopes were strengthened as required. Fig. 5*a* gives the original sections of Kalamba dam. The final stable section is shown superimposed.

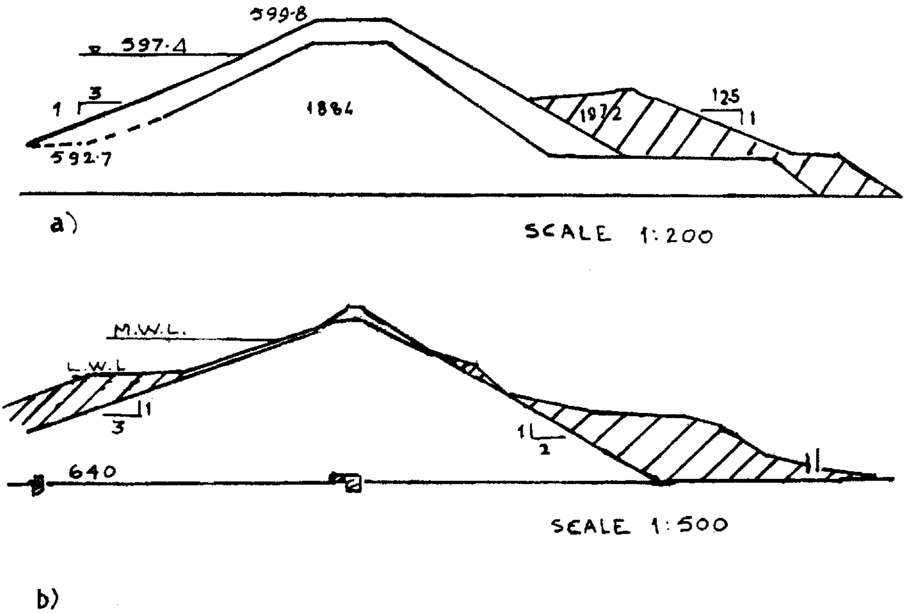

FIG. 5 (*a*) Original and modified section of Kalamb dam district Kolhapur, (*b*) Waghad dam in Nasik district.

It may be observed that the sections of earth dams, depending upon the type of soil used and height of dam, as developed by Indian engineers on the basis of their long experience are found to be same as are now developed with modern concepts of science of soil mechanics.

The earth dams constructed by British engineers in Jaypore state, were somewhat different than the usual homogeneous dams, in that they were provided with masonry core walls. These were provided to prevent failure of earth dams by piping from holes formed by burrowing animals during dry season (Fig. 6).

Another type of dam illustrated on the same figure with thin masonry wall on the upstream side backed by earth embankment on its downstream was also developed by British engineers.

Masonry dams

A number of masonry weirs were constructed across rivers in North India. Fig. 7 gives sections of some of the weirs across rivers in Orissa. The similarity of these weirs with that of Grand Anicut, illustrated on the same figure, is obvious.

The real contribution to dam engineering by British engineers is in construction of high masonry dams. Masonry dams to such heights were not constructed in India. Fig. 8 illustrates cross-sections of masonry dams of different heights as constructed

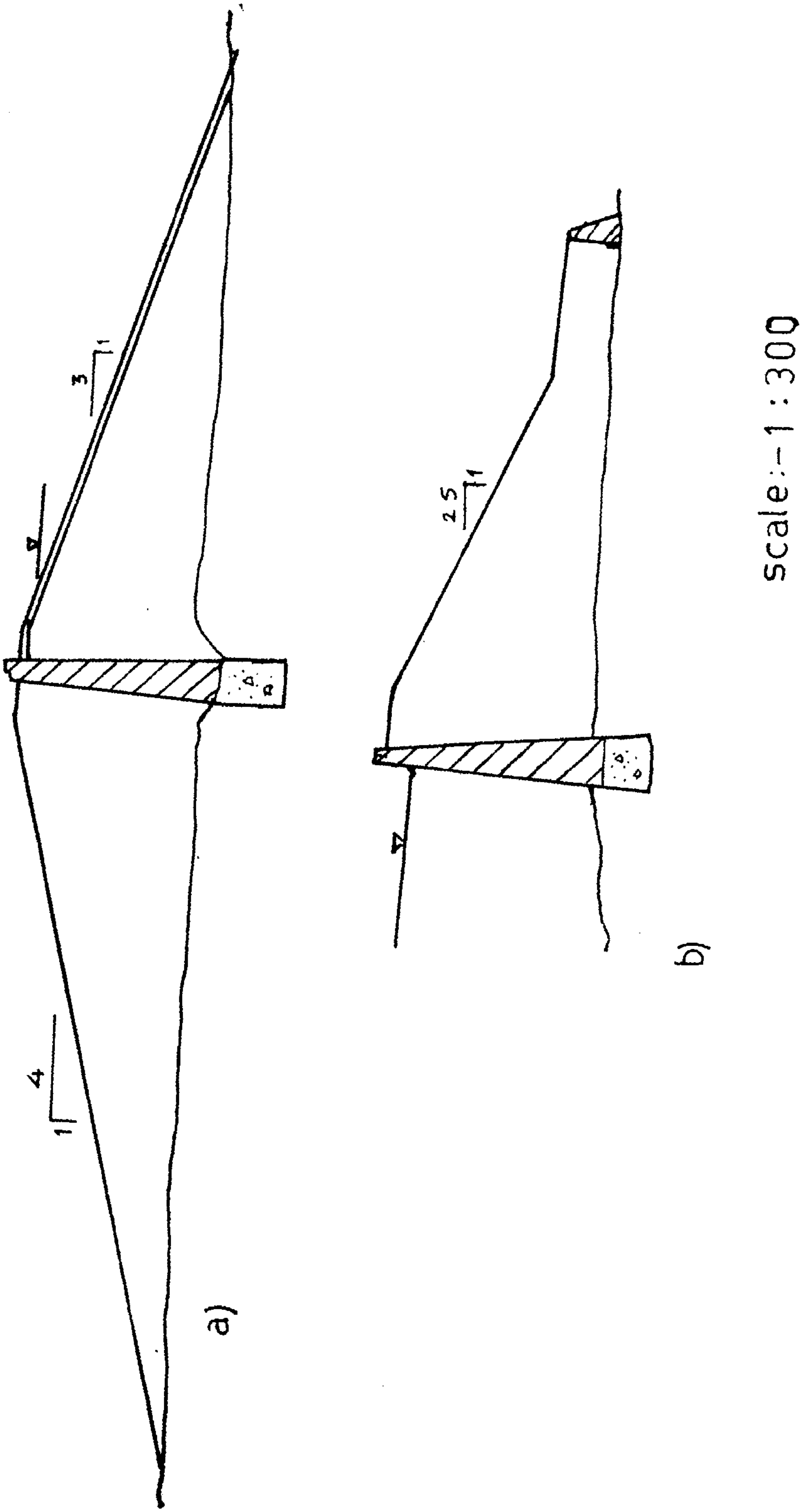

FIG. 6 Earth dams with masonry walls, Jayapore state (*a*) Kair dam, (*b*) Foysagar dam (Ref. 12).

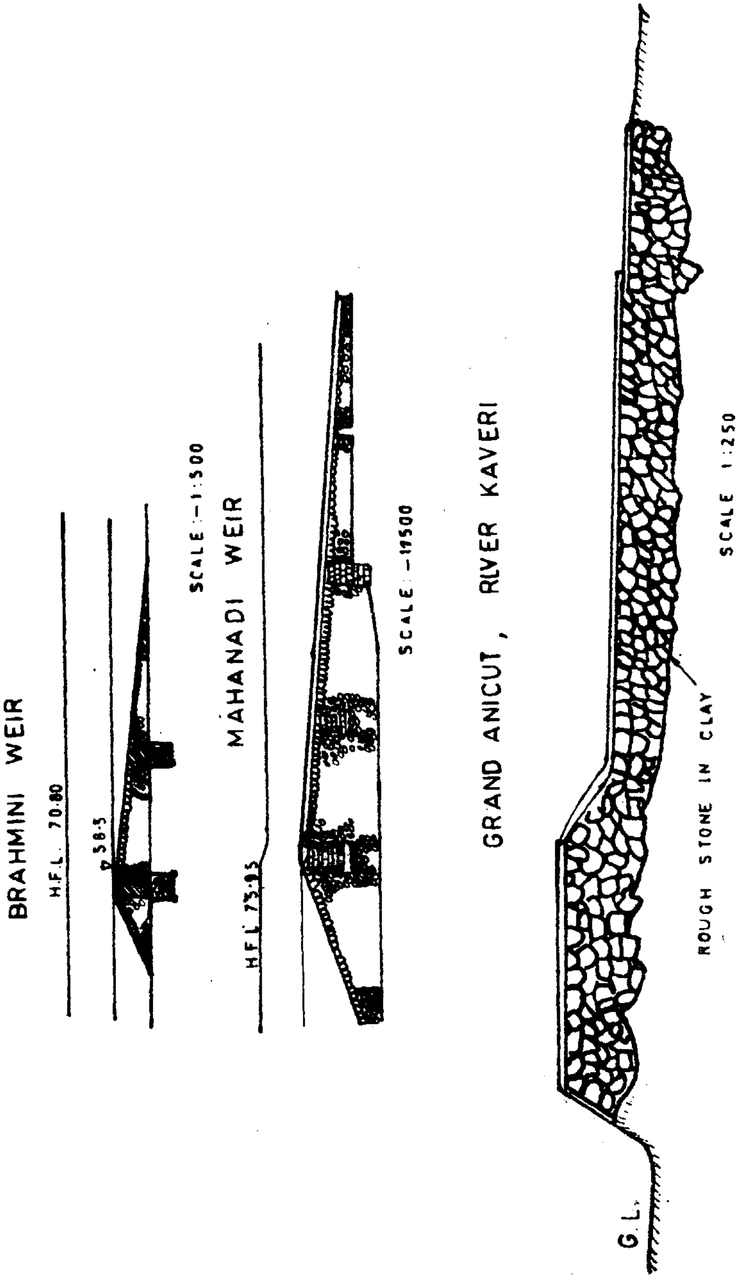

FIG. 7 Cross-sections of masonry weirs (Ref. 12, 13).

by British engineers. It may be noted that almost all these dams have served well without any mishap but their sections are found to be inadequate according to the modern theories.

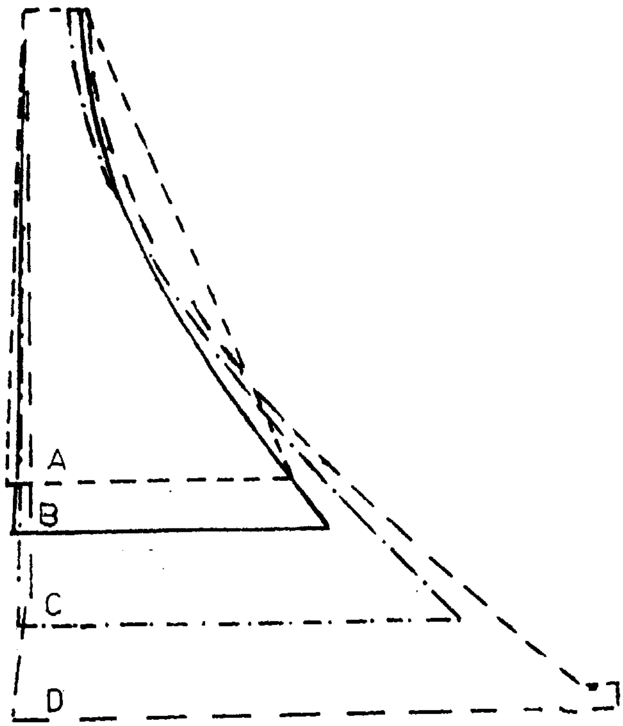

FIG. 8 Cross-sections of masonry dams.

	height.	
(*a*) Khadakwasla Dam	30 m	
(*b*) Bhatgar Dam	33 m	
(*c*) Tansa Dam	40 m	
(*d*) Periyar Dam	45 m	(Ref. 12)

Advances in Irrigation Engineering Brought by British Engineers

The British engineers advanced the knowledge of irrigation engineering in following aspects.

An all out study of different aspects of hydraulic engineering including meteorology was started by the British. Systematic measurements of rainfall, gauging of rivers, measurements of silt load in North Indian rivers were taken, assembled and processed by them. They understood the importance of meteorological studies and done it for each district. It is the British engineers who had drawn contours of rainfall for entire India. The inundation canals in Punjab and Sind provinces were abandoned by Indians when they were blocked by silting. British engineers studied the hydrodynamic aspects of silting and constructed large head works with arrangements for desilting and made a success of it.

Lindley derived formula relating velocity, bed width and depth of water for standard silt in lower Chenab, Stawell derived relationship between velocity and depth for fine sand for Shwebo canal, Burma. Kennedy had developed relationship between these two parameters for fine sand-silt for Punjab canals.

Formulae were developed by Inglis, Dicken, Talbot, Kuichling, McMath, Lloyd-Davis, Elliot, Barkli-Zeiglor etc. for the determination of quantity of flood runoff of a river from the knowledge of rainfall and characteristics of catchment area. These are purely impirical relationships applicable for particular rivers with known characteristics of catchment area. A very painstaking careful experimentation work has to be carried out for a large number of years to arrive at these formulae.

Chezy, Bazin, Kutter and many others have developed formulae for calculating discharge of open channels. Very well planned large scale experiment were carried by them to determine the coefficient of rugosity of different materials like soil, rubble masonry, concrete lining etc. forming the sides and bed of canals.

All of the above research workers may not be British but the British engineers developing irrigation works in India had such a background of scientific knowledge which Indian engineers totally lacked.

In 1836 Arthur Cotton, one of the most celebrated English engineers, built a new dam on the Coleroon. Cotton followed closely the style of the ancient dam, namely the grand anicut. The Coleroon dam is of interest because its unsatisfactory performance drew attention for the first time to the phenomenon of piping, the process by which water percolating under a dam has sufficient pressure and velocity to erode the foundations, often to the extent that the dam is undermined. Similar failures of other Indian river dams eventually led to the first experimental investigations of seepage under masonry dams, and the work of Beresford and Clibborn in the 1890's was able to predict the failure in 1898 of the Narora weir on the river Ganges.

The industrial revolution started in England in 18th century. The advances in mechanical engineering skills were fruitfully used by British engineers for construction of dams. The idea of progress in mechanical engineering by the end of 19th century can be had from different types of machinery used at the time of construction of Periyar[21] dam (Appendix 1).

It may be noted that diverting water of river Periyar through a tunnel to river Vaigai could not be thought of by Indian engineers as they were ignorant of development of mechanical engineering. It is the British engineers who acquainted Indians to the use of different types of machines.[22]

British engineers were far ahead of their Indian counterparts so far as electrical engineering is concerned. The water diverted from Periyar river falls about 1,200 ft. in the first mile from the mouth of the tunnel. British engineers knew that from this fall of water electric power of 60,000 H.P. could be generated. A complete report of power generation was ready by 1893. Unfortunately there was no immediate need for this power.[23]

The details of Cauvery transmission scheme[24] are given in Appendix 2. It gives an idea of the state of knowledge of generation of hydel electricity by the close of the 19th century.

IRRIGATION ADMINISTRATION

The administration of irrigation water including the basic procedure of levying of the tax for use of irrigation water as followed by British engineers by the close of 19th century was essentially same as described in *Kauṭilīya Arthaśāstra* (3rd to 4th century B.C.) which is probably the earliest treatise in which this subject is dealt with.

According to *Arthaśāstra*[25], it is the duty of the Administrator (*Samaharta*) to keep record of the number of fields in villages. The fields are to be grouped as dry or wet fields, vegetable gardens, their boundaries, names of owners as well as whether a tax is to be levied from the owner or not.

Kauṭilya mentioned the types of crops that are grown on irrigated lands. These are, "Flower-gardens, fruit-orchards, vegetable gardens, wet crop fields and sowings of roots".[26]

The water-cess is to be levied in proportion to the quantity of water used and also in proportion to the yield of the crop. There was no equipment available at that time to measure the quantity of canal water. The amount of tax to be levied was, therefore, varying according to the contrivance by which irrigation water was fed to the fields. The tax was one-third of the yield of crop when the field was irrigated from channels by a mechanism. It was one-fourth when lifted from rivers, lakes, wells etc. In case the water is used from their own waterworks the farmers were required to pay one-fifth water rate.[27] In order to know the quantity of yield of crop, the record of type of crop and the area in which it is sown is kept by the Administrator. It is further mentioned that spies in the guise of traders should find out the quantity of crops grown so that there is a separate check on the crops grown.[28]

Kauṭilīya Arthaśāstra does not give the information about the way in which irrigation is worked from the channel water. The method used in Khandesh (Dhule and Jalgaon districts) before the advent of British may be supposed to be representative for other parts of India. The area irrigated is divided into several plots and each irrigator has his share in these plots. The different plots are sown wholesale in a regular rotation of crop. Thus, in the first year, one plot would be all sugarcane, the next all rice, the third wheat and so on. In the next year according to rotation, the first plot would be laid down in wheat, the second in rice and the third in sugarcane. This arrangement is very convenient for the distribution of water and is economical.[29]

The irrigation administration followed by British in the 19th century was essentially same to that described in *Kauṭilīya Arthaśāstra* with some variations in detail.

The revenue officers prepare maps showing configuration of each field. They are numbered. Information regarding the owner, occupancy or cultivating tenant, area, soil etc. is kept in a register. Copies of maps and registers are supplied to irrigation engineers. Then the type of crop is noted and the area actually irrigated is measured and the water rates are calculated on this basis. An idea of the water rates levied depending upon the type of crop and the area irrigated may be had from the table given below.

These rates are for irrigation by flow; lift rates are half these figures:[30]

Class	*Crops*	*Water rates per acre* Rs.
1	Sugarcane	7.50
2	Rice	6.25
3	Orchards, gardens, tobacco, vegetables etc.	5.00
4	Cotton, fibres, oil seeds etc.	3.75
5	All hot weather crop other than those of class 1 to 4	2.50
6	Single watering to plough, not followed by a crop	1.25

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[20]Strange, "Reservoirs in India" as quoted by Buckley R. B. (1905), ref. 12, p. 91.
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[26]Ibid (2.6.5).
[27]Ibid (2.24.18).
[28]Ibid (2.35.11).
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APPENDIX 1

Machinery used at Periyar Dam[21]

A 200 H.P. turbine working on hydropower was used to provide necessary power to different types of machines. The water for supplying the turbine was led from the waste weir with its crest 25 ft. above datum giving a work load of about 20 ft.

The machines operating on this power were:

(*a*) Six stone breakers to break stones for concrete.

(*b*) A wire ropeway for conveying materials from the workshops to the dam.

(*c*) Disintegrators for grinding lime and surki.

(*d*) Mortor and concrete mixers.

(*e*) Air compressors, six in numbers.

Other machines:

(*a*) A self-acting tramway for conveying stones from quarries to stone breakers.

(*b*) Steam operated stone breakers.

A tunnel was dug for diverting water of periyar to Waghai river. The tunnel was 90 sq. ft. in sectional area. The length being 8,337 ft.

The machinery used was:

(*a*) Rock drills driven by compressed air. The air compressors, 2 in Nos., being worked by a turbine.

(*b*) Air compressors were also run by steam generated by boilers fed by fire wood.

APPENDIX 2

Cauvery Transmission Scheme[24]

It was decided to supply power of the Cauvery falls to operate the mining machinery on the Kolar Gold Fields in the year 1898. The sheer drop of water is only about 180 ft. but allowing for the minor falls and rapids above and below, a head of 406 ft. is available. Water is taken from river Cauvery about 2 miles above the falls and is carried in two canals $3\frac{1}{3}$ miles in length to three penstocks, each of which feeds two turbines in the generator house. The turbine requires 181 cusecs of water with an effective head of 387′-7″ to supply 5,970 H.P. to the generators which produce current at 2,200 volts. The current is carried to the step up transformer station and is transformed to 30,000 volts for transmission along lines. After a distance of $91\frac{1}{5}$ miles near Kolar field, it is step-down by transformer to 2,300 volts. The current is distributed to 31 motors ranging from 5 H.P. to 400 H.P. The motors operate 12 air compressors, 11 stamp mill batteries, 2 quartz dressing plants, 5 hoists and one pump, the total capacity being 4,285 H.P.

The contractors were General Electric Co. of America.