

# HISTORICAL SURVEY OF HIGHWAY BRIDGE CONSTRUCTION WORK IN SRI LANKA

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## 1.0 Introduction and Scope

Dictionaries describe the word 'Bridge' as any structure of wood, stone, brick, iron or concrete raised over a river, pond, lake, road valley or the like for the purpose of convenient passage. However the connotation that has been given to this word by the Public Works Department is frequently used to distinguish a bridge from a culvert. According to the P. W. D. connotation a structure in a highway having a span higher than 10' is considered as a bridge while structures of shorter span are considered as culverts. This connotation has been accepted by the firm of Wilbur Smith and Associates, the United States Consultants who did a complete Traffic and Planning Study for the Sri Lanka Government in 1965.

According to this understanding of the word and based on returns received from Executive Engineers of the Highways Department, there are 3444 Highway Bridges on roads belonging to the Highways Department. However as there are bridges on roads belonging to the Land Development and Irrigation Departments as well as bridges belonging to several Municipalities and other local bodies, the actual total number of Road bridges in Sri Lanka should be around 4000.

In appendix 1 I have given the number of bridges falling within the different Administrative Districts according to three categories of overall length. I have also separated the total number of bridges into the various types and also given a list of bridges which are over 300' in overall length.

It is the construction of these 3444 bridges between about 1800-1981 that should form the subject matter of this paper. Any treatment of a subject of this magnitude in a short time is bound to be very sketchy and I make no apologies for it.

## 2.0 Search for Material

My task of writing this paper was made more difficult by the striking fact that during the 75 years history of the Engineering Association of Ceylon and the Institution of Engineers Sri Lanka. I could find only eight documented accounts about bridges constructed in Sri Lanka. They have ranged from mere

### APPENDIX 1 (A)

#### LIST OF BRIDGES Classified according to length

District	Length 10' to 100'	Length 101' to 300'	Length over 301'	Total No.
1. Amparai	38	06	02	46
2. Anuradhapura	91	05	01	97
3. Badulla	141	15	01	157
4. Batticaloa	85	13	03	101
5. Colombo	248	13	02	263
6. Galle	238	13	—	251
7. Gampaha	174	12	05	191
8. Hambantota	73	07	02	82
9. Jaffna	145	11	—	156
10. Kalutara	182	14	04	200
11. Kandy	176	11	01	188
12. Kegalle	216	12	01	229
13. Kurunegala	251	05	03	259
14. Mannar	23	—	01	24
15. Matale	119	06	—	125
16. Matara	141	05	—	146
17. Monaragala	35	03	—	38
18. Mullaitivu	58	05	—	63
19. Nuwara Eliya	147	05	—	152
20. Polonnaruwa	101	05	01	107
21. Puttalam	123	12	02	137
22. Ratnapura	335	18	02	355
23. Trincomalee	39	02	01	42
24. Vavuniya	34	01	—	35
Total	3213	199	32	3444

### APPENDIX 1 (B)

#### LIST OF BRIDGES.

#### Classified according to type

District	Steel bridges	R.C.C. bridges	P.S.C. bridges	Timber bridges	Arch. bridges	Total No.
1. Amparai	15	25	06	—	—	46
2. Anuradhapura	08	77	10	01	01	97
3. Badulla	42	84	21	—	10	157
4. Batticaloa	08	78	15	—	—	101
5. Colombo	13	203	47	—	—	263
6. Galle	23	181	47	—	—	251
7. Gampaha	18	133	40	—	—	191
8. Hambantota	08	58	16	—	—	82
9. Jaffna	18	113	10	—	15	156
10. Kalutara	19	153	28	—	—	200
11. Kandy	04	168	16	—	—	188
12. Kegalle	31	162	22	—	14	229
13. Kurunegala	23	211	25	—	—	259
14. Mannar	05	15	02	01	01	24
15. Matale	05	104	16	—	—	125
16. Matara	13	108	25	—	—	146
17. Monaragala	18	06	09	—	05	38
18. Mullaitivu	08	55	—	—	—	63
19. Nuwara Eliya	32	85	15	—	20	152
20. Polonnaruwa	11	71	25	—	—	107
21. Puttalam	09	106	20	01	01	137
22. Ratnapura	36	264	52	—	03	355
23. Trincomalee	08	25	09	—	—	42
24. Vavuniya	05	17	08	—	05	35
total	380	2502	484	03	75	3444

APPENDIX 1 (C)

BRIDGES OVER 300 FEET IN LENGTH

<i>C. E's Division</i>	<i>E. E's Division</i>	<i>Location of Road</i>	<i>No. of spans Lengths</i>	<i>Total Length</i>	<i>Carriage way width</i>	<i>Type</i>
1. Batticaloa	Batticaloa	268/1, C. R. W. B. Road	06/158' 6"	951 ft.	5' 6"	Steel bridge
2. Matale	Polonnaruwa	50/4, Maradankadawela-Habarana-Valaichchenai Road	06/158'	948 ft.	15' 6"	Steel
3. Colombo	Colombo	1/1, Southern approach to NKB A special (New Kelaniya Bridge)	1/67, 3/84, 1/107, 3/108 1/70, 1/83	930 ft.	29' 0"	R.C.C. and P.S.C. beam
4. Chilaw	Puttalam	62/2 Colombo-Puttalam Road	04/197	788 ft.	14' 0"	Steel bridge
5. Colombo	Colombo	3/4, Colombo-Puttalam Road	07/108	756 ft.	24' 0"	Steel bridge
6. Badulla	Koslanda	148/5, C. R. W. B. Road	05/147	735 ft.	25' 0"	Steel bridge with R.C.C. deck
7. Galle	Kalutara	27/1, Colombo-Galle Road	06/107	642 ft.	20' 5"	Steel bridge
8. Galle	Kalutara	27/2, Colombo-Galle Road	06/107	642 ft.	20' 5"	Steel bridge with R.C.C. deck
9. Galle	Kalutara	Colombo-Galle Road (Egoda Uyana Bridge)	10/62' 6"	625 ft.	40' 0"	P.S.C. beam
10. Galle	Kalutara	13/1, Colombo-Galle Road	08/78	624 ft.	18' 0"	Steel
11. Chilaw	Chilaw	52/4, Colombo-Puttalam Road	05/120	600 ft.	24' 0"	P. S. C.
12. Batticaloa	Kalmunai	1/1, Pottuvil-Panama Road	04/125	500 ft.	22' 0"	Concrete deck on R.S.J.
13. Batticaloa	Amparai	35/4, Siyambalanda-Damana-Amparai Road	15/33	495 ft.	27' 0"	R.C.C.
14. Batticaloa	Amparai	25/1, Karativu-Ampara/Inginiyagala Road	14/32	468 ft.	20' 0"	R.C.C.
15. Kandy	Kandy	5/2, Kandy-Jaffna Road (Katugastota Bridges)	06/69	414 ft.	24' 0"	Steel bridge with R.C.C. deck
16. Matara	Hambantota	141/4, Colombo-Galle-Hambantota-Wellawaya Road	04/98	392 ft.	25' 0"	P.S.C.
17. Batticaloa	Kalmunai	2/1, Akkarapattu-Varapathan Chenai Road	12/32' 6"	390 ft.	24' 0"	R.C.C.
18. Ratnapura	Kalawana	1/1, Idangoda-Ayagama Road	3/88, 3/37	375 ft.	24' 6"	R.C.C.
19. Kegalle	Rambukkana	3/9, Karadupae-Rambukkana Road	12/30	360 ft.	15' 0"	Concrete deck on R.S.J.
20. Mannar	Mannar	4/4, Murunkan-Chilavathurai Road	05/70	350 ft.	23' 0"	P.S.C. beams
21. Matara	Tangalle	45/2, Pelmadulla-Madampe-Nonagama Road	07/49' 9"	348 ft.	48' 3"	P.S.C. beams
22. Colombo	Dompe	1/1, Hanwella-Urappola Road	2/86, 2/87' 6"	347 ft.	24' 0"	P.S.C.
23. Kurunegala	Polgahawela	2/2, Polgahawela-Kegalla Road	1/19, 3/29' 6" 2/58' 6", 1/29 1/27' 6", 1/28	327' 6"	17' 6"	Steel bridge with R.C.C. deck
24. Ratnapura	Ratnapura	64/8, Galeboda-Ratganga Road	03/108"	324 ft.	27' 0"	P.S.C.
25. Colombo	Negombo	2/3, Mankaduwa-Madalgama Road	2/29' 6", 4/66	323 ft.	24' 0"	P.S.C.
26. Colombo	Negombo	13/4, Tudella-Pamunugama-Talahena-Negombo Road	9/19' 6" 4/41' 6", 1/20 2/27' 9"	317 ft.	19' 3"	R.C.C.
27. Colombo	Negombo	27/4, Colombo-Puttalam Road	2/29, 4/64	314 ft.	24' 0"	Steel
28. Anuradhapura	Nochchiyagama	1/1, Lion Pillar, Sri Maha Bodhi Road (Malwathu Oya bridge)	05/62' 6"	313 ft.	45' 0"	P.S.C. beams
29. Colombo	Nittambuwa	1/1, Veyangoda-Ruwanwella Road	03/102	306 ft.	15' 6"	Steel
30. Trincomalee	Trincomalee	13/1, Trincomalee-Pulmoddai Road	06/50	300 ft.	22' 0"	P.S.C. beams
31. Kurunegala	Wariyapola	49/3, Katugastota-Kurunegala-Puttalam Road	11/27' 3"	300 ft.	17' 0"	Steel
32. Kurunegala	Polgahawela	42/1, Ambepussa-Kurunegala-Trincomalee Road	03/100	300 ft.	18' 0"	Steel bridge with R.C.C. deck

3 page accounts to a 66 page account of the construction of new Kelani Bridge in 1960, by Mr. Chandrasena and K. A. Rasaratnam. This latter document is by far the most comprehensive description about a bridge constructed in Sri Lanka. I am heavily indebted to all these authors for some of the technical information presented in this paper.

In the transactions of the Institution of Civil Engineers (London), there are bound to be a few articles about bridges constructed in Sri Lanka, by the British Engineers. However as copies of these transactions pertaining to the 19th century were not available at the Peradeniya Campus, I was not able to include them in my search for material.

While I was able to have discussions with an officer of the Department of Archaeology, relating to bridges that existed in Sri Lanka before the Colonial era and refer to some of the Annual Reports of the Archaeological Department, lack of time prevented me from getting into touch with the Government Archives.

Even though no technical information is available about the Bridges in Sri Lanka of the Pre Colonial period, I have included some historical information pertaining to this period in an attempt to give at least a sketchy picture of the Bridges of this era.

As writers of History are fond of breaking up History into various periods, I too shall treat the subject under 3 distinct periods, which I shall call.

- |                                 |               |
|---------------------------------|---------------|
| (1) Pre British Colonial period | Prior to 1796 |
| (2) British Colonial period     | 1796 - 1948   |
| (3) Post Colonial Period        | 1948 - 1981   |

### 3.0 Pre British Colonial Period

From the very early Anuradhapura period the necessity for the construction of bridges would have been felt when the transport of animals or agricultural produce, or the movement of armies from place to place and other similar requirements were encountered. In most cases the early Sri Lankans of this era, would have satisfied this need by the construction of bridges comprising of relatively short spans using either rock or timber as their construction material. They were familiar with the possibilities as well as limitations of these two construction materials and bridges of long spans were not attempted even though the loads that had to be catered for, were small indeed compared to axle loads of today. As a result we have a large number of place names ending in 'tota' the Sinhala word for

ferry, viz: Katugastota, Weragantota, Anguruwatota, Gintota, Bentota, Ambalantota, etc. where ferries have operated for the passage of human beings animals and ox-drawn carts, etc. across relatively wide rivers.

Archaeological remains of rock bridges have been found at Anuradhapura, Polonnaruwa, Tiriyaya in Trincomalee District, Vavuniya and Sigiriya in Matale District, etc. The oldest of these rock bridges is the "Gal Palama" at Anuradhapura the archaeological remains of which is found about 3 miles away from the Sri Maha Bodhi. This bridge spanned the Malwatu Oya and was having an overall length of about 200' with a road width of only 8'. It is believed that this bridge was constructed during the time of King Devanampiyatissa about 2 centuries B.C. It is also believed that this bridge was specially constructed for the arrival of the 'Sri Maha Bodhi' sapling which was brought by Sangamitta, the daughter of King Asoka The Great of India. However from the present archaeological remains it is not possible to give a diagrammatic sketch of the bridge as it existed at that time.

It is not surprising that no remains have been come across of timber bridges of this early period. However a timber bridge believed to belong to either the Gampola period or the Kandy period has been found at Bogoda in Badulla District. The remarkable feature about this bridge is that it had a tiled roof above it to protect the timber work of the deck. This bridge has hitherto been completely restored to its earlier lines and levels by the Archaeological Department.

A British Civil Servant has recalled that in the early 19th century the Colombo-Galle Road was unbridged except for the existence of a wooden bridge at Mahamodera, Galle. This bridge which had been built on wooden piles has had a cadjan roof over it to protect the timber planks of the deck from the elements. This bridge at Mahamodera, Galle too may be belonging to the same period as the Bridge at Bogoda in Badulla District.

It is very likely that both Portuguese and the Dutch may have built a few bridges in the maritime areas. They would certainly have been prompted by military considerations, rather than by considerations of communication or trade. As these two historical periods were also before the industrial revolution in Britain they would have used timber rock or brick as their construction material, as the technology for the manufacture of Cast-iron members for bridge purposes, was not yet known at the time.

#### 4.0 Macroscopic view of trends

Before I embark on a discussion of the particular types of bridges that were constructed during the British Colonial Period, I shall attempt to give the reader a macroscopic view of the historical trends in certain selected factors pertaining to bridge construction during the British Colonial and the subsequent Post Colonial periods.

For this purpose the five factors that I have selected are :

- (1) Historical growth of Road mileages maintained by the Government.

Year	Mileage	Year	Mileage
1884	2,673	1952	11,046
1900	3,588	1955	11,171
1920	4,225	1960	11,600
1947	5,600	1980	15,719
1950	6,556		

- (2) Historical growth in the Number of Highway bridges in Sri Lanka.

Year	Number of Highway Bridges
1900	800-1,000
1960	2,009
1981	3,444

- (3) Historical Survey of Departments and Agencies responsible for bridge construction in Sri Lanka

Period	Agency primarily responsible for Bridge construction	Other Agencies that were involved in the construction
1796-1815 ..	Quartermaster General's Department	Royal Engineers
1815-1842 ..	Civil Engineer and Surveyor-General's Department sometimes also referred to as Colonial Engineer and Land Surveyor's Department	Royal Engineers Ceylon Pioneer Lascars Later called the Military Corps of Pioneers.
1842-1845 ..	Civil Engineer and Surveyor-General's Department	Pioneer Corps
1846-1851 ..	Commissioner of Roads Civil Engineer's Department	Pioneer Corps
1851-1862 ..	Civil Engineer and Commissioner of Roads Department	Pioneer Corps and Government Factory (from 1858)
1863-1876 ..	Public Works Department	Pioneer Corps Government Factory
1877-1938 ..	Public Works Department	Government Factory (Pioneer Corps ceases to exist in 1877)
1938-1968	Public Works Department	Formation of a Bridges Organisation under C.E. (Bridges) in 1938 Government Factory C. E. Bridges
1968-1971 ..	Highways Department	Government Factory State Development and Construction Corporation
1971-1978	Territorial Civil Engineering Organisation and Highways Department	Newly formed Bridges Organisation under a Deputy Director Bridges
1978 - to date	Highways Department	S. D. & C. C.

- (4) Historical Survey of Materials used for Bridge Construction.

Period	Material	Predominant Types of Bridges
Prior to beginning of 19th century	Rock, Timber	Simply supported Beams on Columns with Timber planks or Rock slabs forming the deck
From 1800 to 1920	Rock, Brick Cast Iron Wrought Iron Steel	Rock and Brick Arch bridges Lattice Girder bridges Bowstring Girder bridges Plate Girder bridges Rolled beam Girder bridges
1920 to 1951	Wrought iron Steel Reinforced concrete	Wrought iron or steel truss and girder bridges as above R/F concrete slab bridges R/F concrete beams and slab bridges
1951 to date	Reinforced concrete Prestressed concrete	R/F concrete slab bridges R/F concrete beam and slab bridges Prestressed beam bridges P. S. C. beams lengthened with end blocks by Post-tensioning Post tensioned P. S. C. Beams

- (5) Historical Survey of Costs of bridge Construction in Sri Lanka.

Year	1900	1935	1960	1965	1972	1975	1979	1981
Cost per sq. ft. of Deck	Rs. 25	Rs. 50	Rs. 100	Rs. 150	Rs. 400	Rs. 500	Rs. 1000	Rs. 1800

#### 5.0 British Colonial Period

##### 5.01 General scene in road transportation

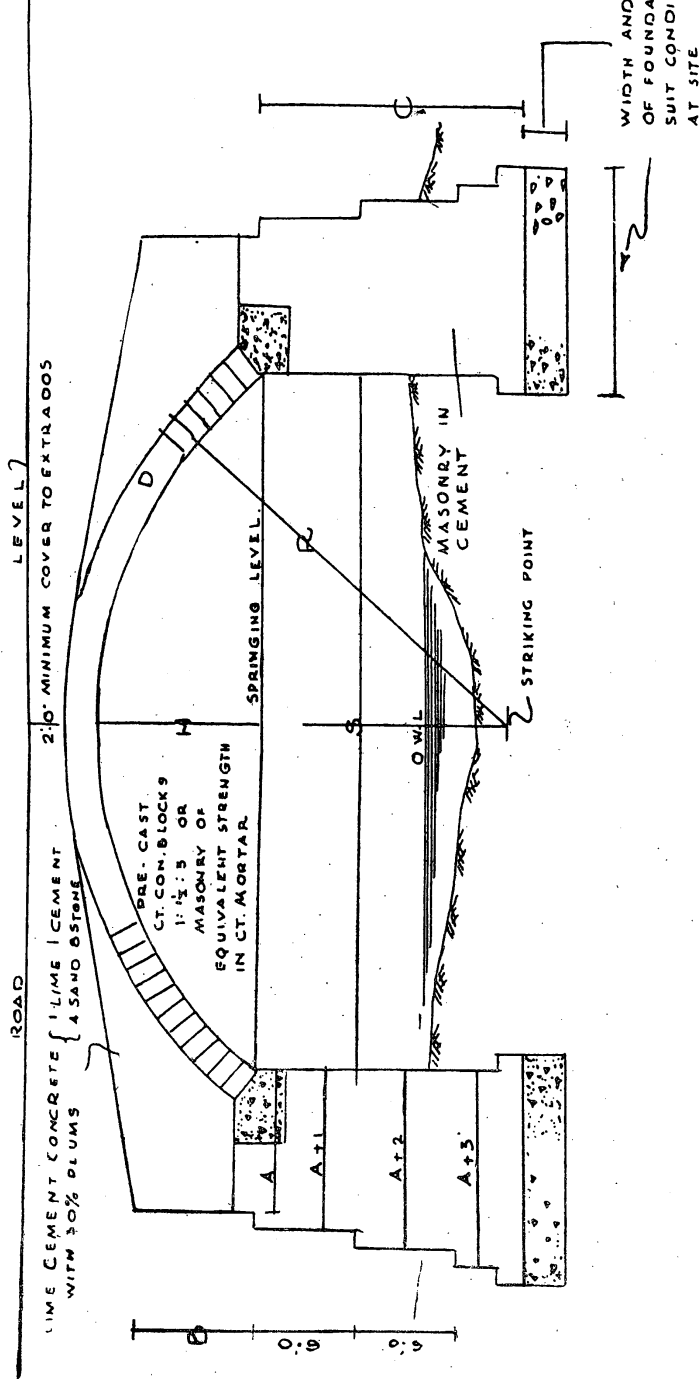
According to the recorded history of the P. W. D. the first road to be built by the British complete with all bridges was the Colombo-Kandy road. This road was called the Military Road as it was built by the Royal Engineers under the command of Captain Dawson in whose honour the imposing Dawson Tower at Kadugannawa has been built. This Military Road was constructed between 1820-1833 and completed with the completion of the Peradeniya Bridge which has often been referred to as "the graceful satinwood bridge without a nail or bolt in it". It is mentioned that there is a model of this bridge in the South Kensington Museum. It is also on record that 1200 labourers worked in the raising and forming of the approaches of this bridge. This satin wood bridge was replaced in 1906 by the open-spandrel arch bridge that stands today.

Colomb-Galle road was unbridged at the time except for Mahamodera Timber Bridge which I referred to earlier. All carts and pedestrians had to be ferried across the several rivers and lakes in 'padda' boats.

Somewhere around the middle of the 19th century, a two-horse Mail Coach has started operating between Colombo and Kandy and this is believed to be the first of its kind that ran in Asia. The Mail Coach left Colombo at 6.00 p.m. and reached Kandy at 6.00 a.m. the following day. Seating accommodation was 4 inside and 2 outside and the fare was £ 2 10s. for a ticket. This service was run by a syndicate of Europeans and most of the drivers too were Europeans.

# KEY DIAGRAM AND TABLE OF DIMENSIONS

## ARCH BRIDGES



SPAN S	RISE H	RADIUS R	DEPTH OF ARCH D	ABUTMENT AT SPRINGING LEVEL A	HEIGHT OF HAUNCHES B	HEIGHT OF ABUTMENT C *
5'-0"	1'-3"	3'-1/2"	1'-1"	2'-9"	1'-4"	5'-6"
10'-0"	2'-6"	6'-3"	1'-3"	3'-6"	2'-0"	7'-0"
15'-0"	3'-9"	9'-4 1/2"	1'-5"	4'-3"	2'-8"	8'-6"
20'-0"	5'-0"	12'-6"	1'-6"	5'-0"	3'-4"	10'-0"
25'-0"	6'-3"	15'-7 1/2"	1'-8"	5'-9"	4'-3"	11'-6"
30'-0"	7'-6"	18'-9"	1'-9"	6'-6"	4'-8"	13'-0"
40'-0"	10'-0"	25'-0"	2'-0"	8'-0"	6'-0"	16'-0"
50'-0"	12'-6"	31'-3"	2'-3"	9'-6"	7'-4"	19'-0"
60'-0"	15'-0"	37'-6"	2'-6"	11'-0"	8'-8"	22'-0"

\* NOTE  
 IF HEIGHT OF ABUTMENT EXCEEDS VALUES SHOWN IN TABLE, THE SECTION OF ABUTMENT MUST BE STRENGTHENED TO RESIST EARTH PRESSURE.

The expenditure incurred on the construction of the Colombo-Kandy road was only £422,915, about 4½ million rupees according to the exchange rate at that time. However the toll revenue from this road during the period 1841-1866 has amounted to £572,362. Estimated number of carts that have used Colombo-Kandy Road during 1841-1866 is 2½ million. The tolls on Peradeniya Bridge were annually sold by the G. A., Kandy and the revenue in 1866 had been Rs. 64,250/-

In the middle of the 19th century Kandy had been a very busy place, being the centre of a booming Coffee trade and many British firms had their branches in Kandy.

The Katugastota Bridge which was first constructed during the period 1858-1860 had been opened for traffic by Sir Henry Ward. 250 guests had been invited for the ceremonial dinner. The ceremonies have ended with a ballroom dance on the bridge in which His Excellency, Sir Henry Ward, had participated. The first road Bridge at Katugastota was built at a cost of £35,000.

In the year 1904, some of the diagnosis of the Lattice were found to be bucked slightly and a traffic count was taken on the bridge, in June 1904.

The results of the count were as follows :

18 Single horse carriages

12 Rickshaws

5 2-wheeled horse carriages

5 Bicycles

9 Hackery buggies

1 Hackery

48 Double bullock carts (Loaded)

30 Double bullock carts (un loaded)

10 Single bullock carts (Loaded)

6 Single bullock carts (un loaded)

6 Horses

34 Oxen and 1 buffalo

6525 Pedestrians.

As a remedial measure it is on record that the following regulations were enforced :

- (a) More than 3 carriages or carts must not proceed over the bridge at one and the same time.
- (b) More than 50 persons must not proceed over the bridge at one and the same time.
- (c) Wheeled traffic must not stop on the bridge.
- (d) Crowds of persons must not congregate on the bridge.
- (e) All traffic must proceed at a walking pace.
- (f) The passage of elephants over the bridge was prohibited.

This should give some idea of the traffic on a major bridge around Kandy at the beginning of this century.

A Toll bridge appears to have been constructed by the carpenters of Kalutara who undertook to construct a wooden bridge across the Kalu-ganga receiving as compensation, the proceeds of the bridge toll for a period of 10 years. It is not on record whether the investors got a good return on their investment by following this procedure.

### 5.1 Bridges constructed during the British Colonial Period

The predominant types of bridges constructed during the British Colonial period are :

- (1) Rock and Brick arch bridges
- (2) Lattice girder bridges
- (3) Bowstring girder bridges
- (4) Plate girder bridges
- (5) Rail-iron trussed girder bridges
- (6) Rolled beam girder bridges
- (7) Reinforced concrete bridges.

Of the above types, the choice between rock and brick arches, Rail iron trussed girders, Rolled beam girders and Reinforced concrete, is available for short span bridges while the other types are generally more suitable for bridges of longer span. The final choice was made on consideration of site conditions, comparative costs and aesthetic suitability.

### 5.2 Brick and Rock Arch Bridges

A good example of a brick arch bridge constructed during the early British period is the bridge at Mawanna on the Colombo-Kandy Road. Another is found at Pilimalawa over the Nanu Oya near the Railway level crossing. Both these bridges are in a remarkably good condition and are quite capable of carrying the very heavy axle loads of present day traffic. The dimensions of typical brick arch bridges are given in Appendix 2.

From the key-diagram and the accompanying table it can be seen that when the span of an arch bridge is fairly high, the width of the abutments increase proportionately in order to cater to the increased horizontal thrusts coming from the arch. This factor makes it uneconomical to have arches of very large span where naturally occurring rock is not available at the abutments.

### 5.3 Lattice Girder Bridges

This is by far the most common type of bridge for longer spans. Cross girders transmit the dead and live loads of the deck to the node points in the Lattice thereby transmitting the stress to the members of the Lattice.

Usually Lattice girders are placed on good rocker and roller bearings so that no temperature stresses will be generated in the members of the lattice due to changes in temperature. It is very important to periodically inspect these rocker and roller bearings to ensure their effectiveness.

#### 5.4 Bowstring girder Bridges

Two examples of Bowstring girder bridges can be given from around Kandy one of which is actually an inverted bowstring. The bridge at Pillimalawa on the Pillimalawa-Menikdiwela Road is a Bowstring girder bridge while that on Ulapane-Udapussellawa Road (called Ulapane Bridge) is an inverted bowstring girder. In this type, the lower members at deck level are suspended from the curved, upper boom by vertical hangers. Although a parabolic outline is theoretically advantageous for the upper boom there is little loss of efficiency when the curved member is segmental. This type is seldom used for spans of less than 100'. As the rise to span ratio is generally 1 : 5 and as there are generally wind bracings between the curved members it is not practicable to use bowstring girders for spans shorter than 120'. For shorter spans however an inverted bowstring could be utilised.

#### 5.5 Plate girder Bridges

With the commencement of production in 1857 of heavy wrought iron plates for industrial purposes, the building of plate girder bridges came into being. Using these heavy plates, girders of varying depths could be built up according to the requirement of span and loading conditions. It has been recognised that very graceful lines can be achieved for bridges using built up plate girders. An impression of a shallow arch can be achieved by using two plate-girders cantilevering towards midspan as in Bolgoda Bridge on the 5th mile of Panadura-Nambapana Road.

#### 5.6 Rail-iron trussed girder bridges

This type, which is built up of rail-iron sections can be used for only short spans.

#### 5.7 Rolled beam girder bridges

Even this type of bridge can be used only for short spans as the main load carrying members are Rolled Beams (R. S. JJ.) Depending on the span and loading conditions one can decide whether to have buckle plates spanning between the R. S. JJ. carrying the deck load, or whether one should have a concrete slab spanning between the R. S. JJ.

The compression flange of the R. S. JJ. could be embedded in the deck concrete up to the Neutral Axis giving the advantage of a composite section. The tension flangs of the R. S. JJ. too are often encased

in a weak concrete to protect the steel from speedy weathering.

#### 5.8 Reinforced concrete bridges

It is believed that the first Reinforced concrete bridge was constructed in Lancashire, England in the year 1902. This bridge had a span of 43' 7". It is also believed that the first Reinforced concrete bridge in Sri Lanka was constructed around 1920 and thereafter Reinforced concrete beams became very popular as a suitable construction material at least for the bridges of short and medium span.

For short spans, the deck of the bridge could be designed as a simply supported slab or where the bridge comprises of several spans, the deck slab could be designed as a continuous slab over the piers. For longer spans, the deck could be designed as T beams sometimes also referred to as a 'beam and slab' deck.

Reinforced concrete has the following advantages as a bridge construction material :

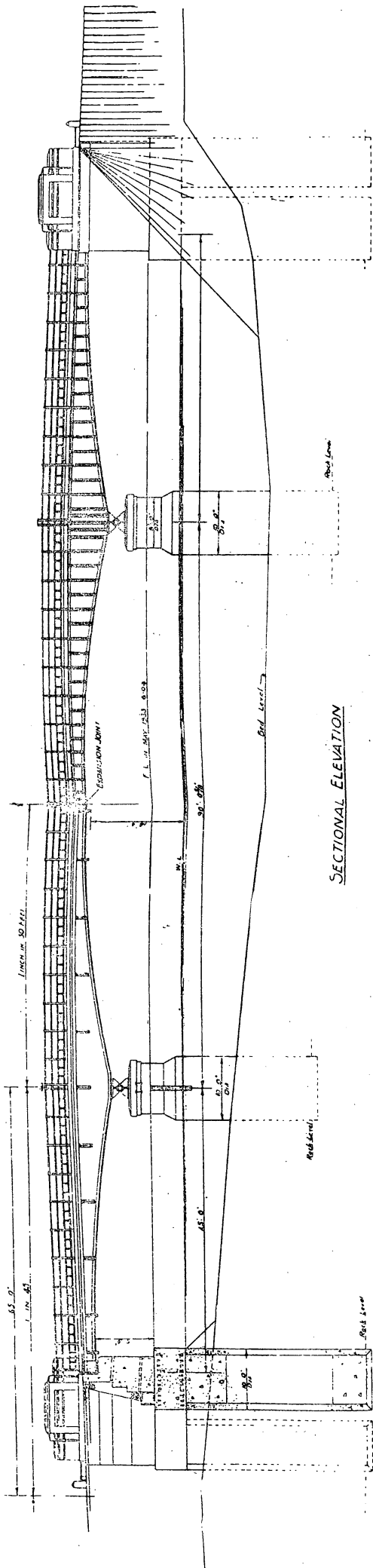
- (1) Technology required for the production of reinforced concrete was of a lower level than that required for the assembly of steel girders and trusses.
- (2) Concrete uses less of imported steel, and uses the bulk of raw materials which are locally available.
- (3) Resistant to attacks from salt-water spray and hence more suitable for work in maritime areas.
- (4) Needs no surface treatment of any kind under normal circumstances.

Building of Bridges was virtually the monopoly of the Government Factory until the use of reinforced concrete was started. This gave rise to the formation of a Bridges Organisation under a Chief Engineer Bridges who was mainly responsible for building of concrete bridges.

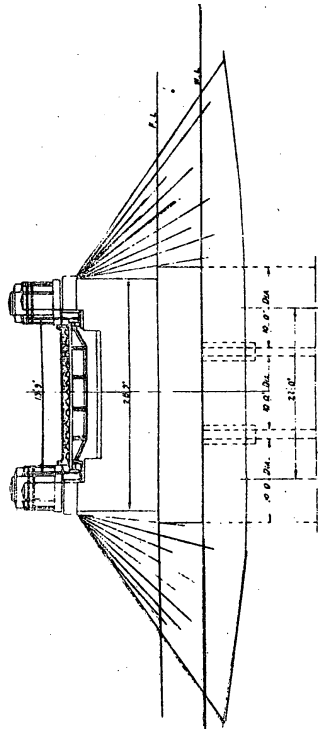
#### 6.0 Post Colonial Period (1948-to-date)

At the beginning of the Post-Colonial period one still found that the Public Works Department was responsible for a large number of activities, some of them being :

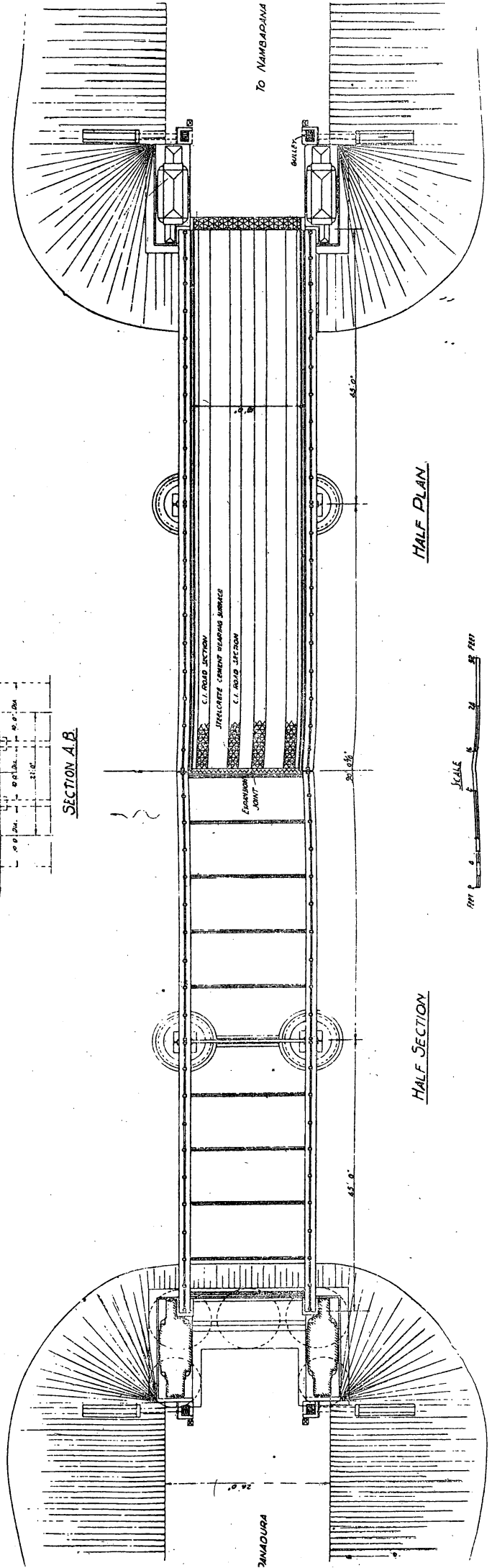
- (a) Highways and Bridge Construction and maintenance.
- (b) Construction and maintenance of airports.
- (c) Construction and maintenance of public buildings.
- (d) Construction and maintenance of water-supply schemes for the major urban areas.
- (e) Acting as Civil Engineering consultants to several other Departments such as Education, Land Development, etc.



SECTIONAL ELEVATION



SECTION A.B.



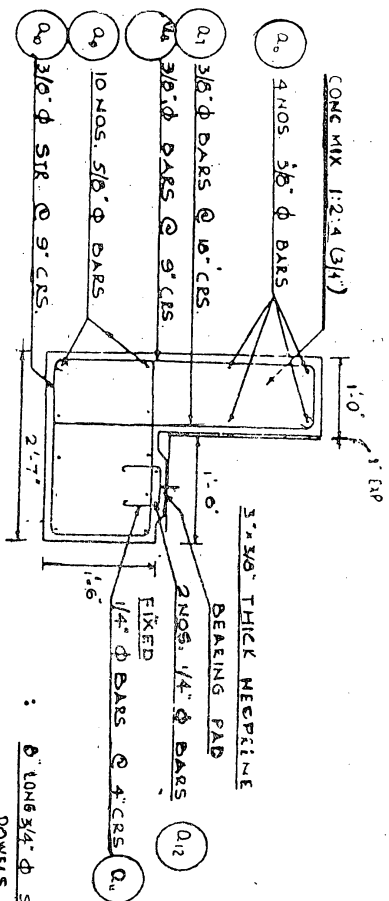
HALF PLAN

HALF SECTION

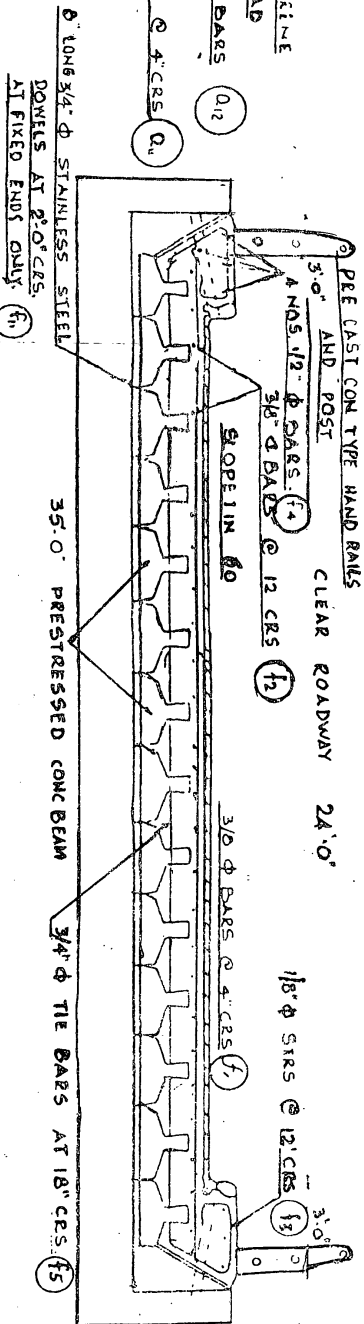


TO NAMBADANA

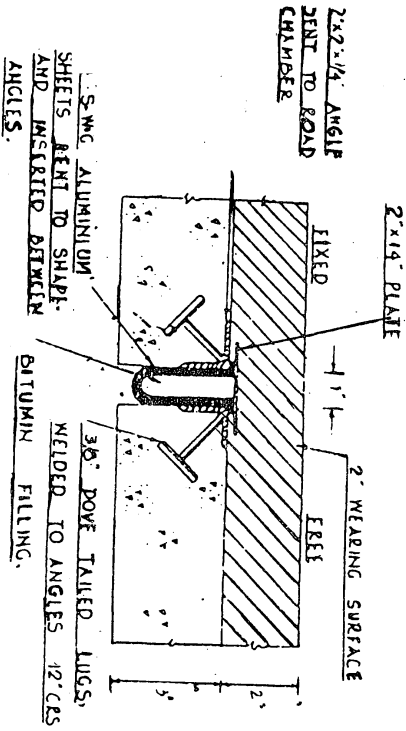
ZANADURA



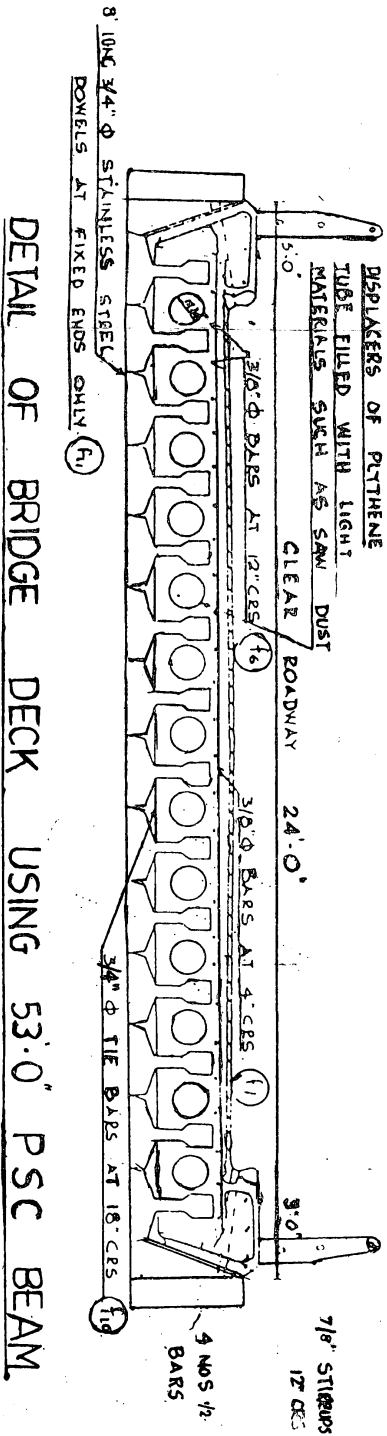
**ABUTMENT CAPPING**  
SCALE - 2 FEET TO AN INCH



**DETAILS OF BRIDGE DECK USING 35.00' PSC BEAMS**

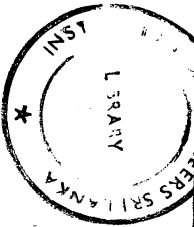


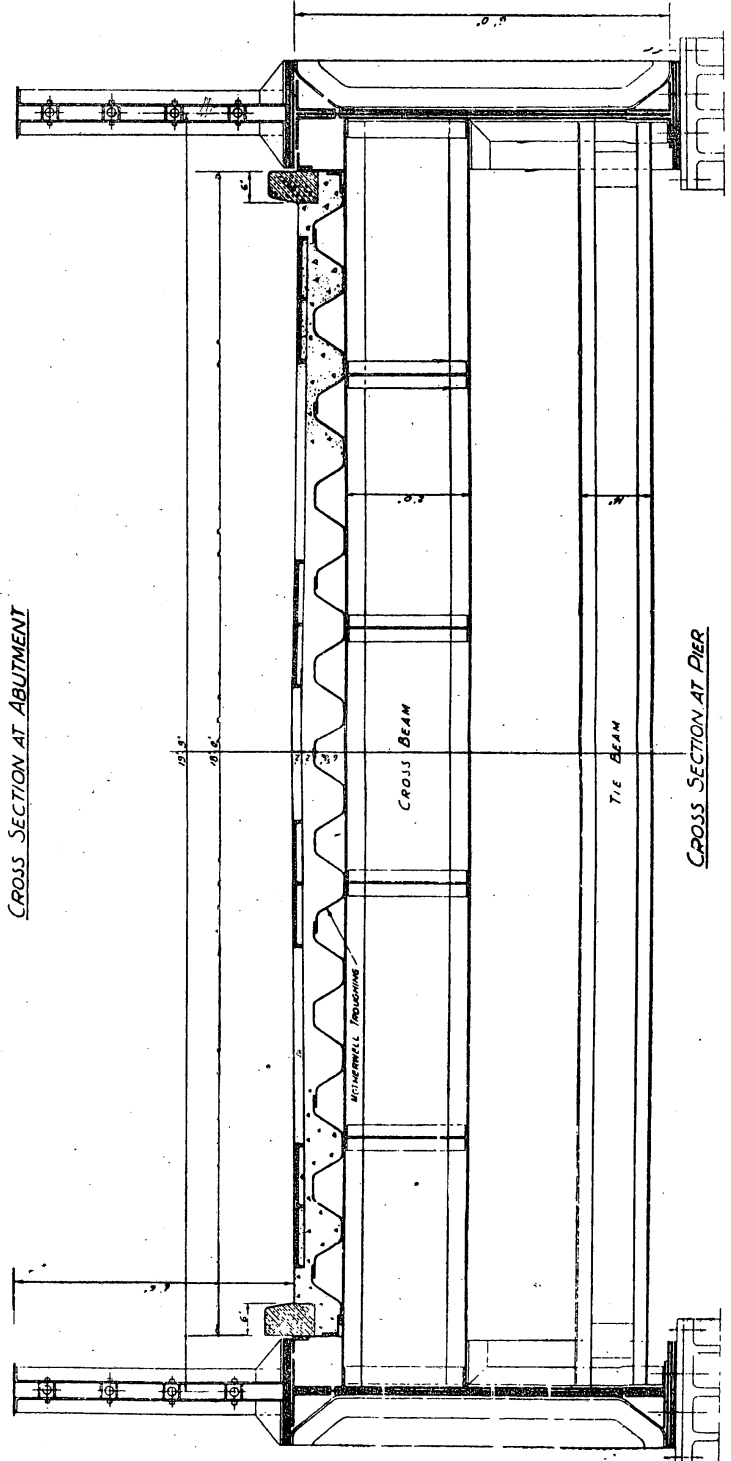
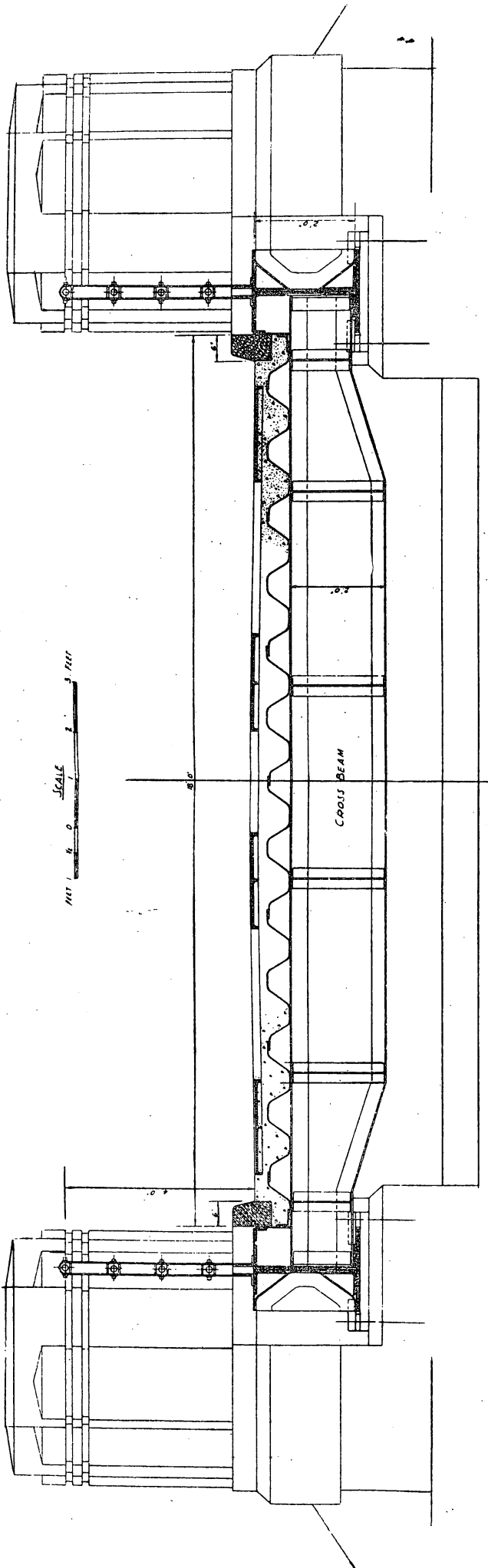
**EXPANSION JOINT**



**DETAIL OF BRIDGE DECK USING 53.0' PSC BEAM**

**TYPICAL CROSS SECTION OF BRIDGE DECK USING P.S.C BEAMS (PRESTRESSED)**





CROSS SECTION AT ABUTMENT

CROSS SECTION AT PIER

Few could have imagined that the P. W. D., which was the oldest Department in the Island, known at its commencement in 1815 as the Civil Engineer and Surveyor General's Department, was destined to disintegrate rapidly and cease to exist by 1969. On the separation of the Building and Highway functions of the P. W. D. into the Buildings Department and the Highways Department respectively, the P. W. D. ceased to exist.

In 1971, two years later, the Bridge Organisation which was under the Chief Engineer (Bridges) separated out from the Highways Department and formed the crux of the State Development and Construction Corporation. At this stage even the functions of construction and maintenance of Roads and Bridges became the responsibility of the Territorial Civil Engineering Organisation resulting in a drastic curtailment of the functions of the Highways Department. This rather anomalous situation was again rectified in 1978 when the Highways Department got back unshared responsibility for all Highway activity. These structural changes were of far-reaching influence which only history can evaluate later on.

### 6.1 Prestressed concrete Bridges

Even after the commencement of construction of Reinforced concrete Bridges, the construction of long span bridges was still the monopoly of wrought iron or steel. (Lattice girders, plate girders, bowstring girders and spandrel arches of wrought iron or steel monopolised the domain of long span bridges.) This was to be so only until the advent of prestressed concrete into the field of bridge construction. This happened somewhere in the 1950s and thereafter there was almost an immediate change over from steel to prestressed concrete for the long-span bridges.

Even though for short spans, prestressed concrete does not have any advantage over reinforced concrete with regard to costs, the use of factory produced prestressed concrete beams has become popular for bridges of even short span. The State Development and Construction Corporation which has the monopoly in producing prestressed beams, are producing beams ranging from 11' to 53' in length. These beams are produced by pretensioning techniques.

A beam of 62'.6" in length can be made out of specially produced 53'.0" pretensioned beams by the attachment of 2 end blocks and post-tensioning. This technique was used on the recently constructed Malwatu Oya Bridge and several other bridges where spans of 62'.6" had been adopted.

For spans longer than 62'.6", prestressed beams using post-tensioning techniques can be used, with

great advantage. With this advance in technology wrought iron or steel girders are seldom used today even for long span bridges. Due to this reason, the post Colonial period can be truly called the era of Prestressed concrete Bridges.

### 7.0 Concluding remarks and Acknowledgements

Two other factors which have had a tremendous impact on the subject of bridge construction are :

- (a) Refinements in the various codes of practice and design methods.
- (b) Advances in the subject of Soil Mechanics and Foundation Engineering.

For example, the earlier designers of wrought iron and steel girder bridges have used a factor of safety of 5 in their designs. With reinforcements in the codes of practice and other design methods later designers would have used much lower factors of safety coming closer to 2.

Similarly with advances in the field of Soil Mechanics and foundation engineering, the earlier tendency to take the bridge foundations right down to rock, was abandoned and more and more bridges are being founded on suitable load bearing soils other than rock. I have not attempted to trace these trends with time mainly due to lack of documented information.

I must thank Mr. M. R. Fernando, Director of Highways for his permission to present this paper and Mr. E. F. M. Perera, Deputy Director (Bridges) for his encouragement during its preparation. I owe a debt of gratitude to the staff of my office who helped in various ways in the preparations made for this paper.

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