on the soil for sometimes, and soil became hard, the rate of removal by sluicing was reduced. The minimum was about ½ cubic foot per second.

In one hour the engine consumed four gallons of petrol. The cost of sluicing down the debris by means of the pumping set was not high and a large quantity of debris was removed every day. The places where the debris had been washed by the jet, did not give any trouble during the next rainfall as no slips occurred.

Check Dams. The streams in which debris moves out of all proportion to flood water, and caused devastation not only to bridges, and allied structures, but also destroys valuable land, can be controlled more or less effectively by a series of check Dams across these. A start has been at Chakki-Dalhousie Road, where heavy slips used to occur previously.

By construction of these Dams flow of debris has been considerably restricted and the road has been kept clear. It is proposed to treat worst cases in Kangra Provincial Division in the same manner.

The broad principles of design are to reduce the slope of the bed, so as to reduce velocity and momentum of water on which depends its capacity to move debris.

The Dam should however be designed as a fall, with apron on the downstream side to present damage in the bed by energy generated due to fall of water.

This method has been successfully employed in control of flood Debris in San Gabriel Area Los Angels described in the Indian Concrete Journal of September 1944. The attention of readers is invited to this article for further detailed information.

CHAPTER IV

Organisation of work costs, etc.

Immediately after the breaches were restored temporarily, by putting on diversions, a rough cost estimate amounting to Rs.18,92,700 (Original work Rs.13,86,250 and repairs Rs.5,06,450) was prepared for restoration of damages. This estimate provided for the following items :—

(*a*) Rebuilding bridges of increased span, so as to allow extra waterway.

(*b*) Construction retaining walls, etc., where roadside had been damaged.

(*c*) Provision of breast walls to prevent slips.

(*d*) A few additional culverts were provided for cross drainage.

(*e*) Restoration of damages to berms, tarred surface and reconsolidation of metal and tarring where road was washed away.

(*f*) Provision for removal of slips.

(*g*) Provision was also made for cost of tools and plant to carry out the work very expeditiously.

A Special Repairs Sub-Division was formed at Palampur and work from Nagrota to Mandi in a length of about 74 miles was entrusted to this Sub-Division. The total amount of works in three Sub-Divisions were as follows :—

		Rs.
Kangra Sub-Division	...	6,07,400
Palampur Sub-Division	...	10,31,100
Kulu Sub-Division	...	2,54,200
Total Rs.	...	18,92,700

Appointments of additional overseers were made and it was so arranged, where work was heavy, an overseer did not control a length of more than 15 miles. This was absolutely the maximum which an overseer could manage as he had not only to supervise the work of contractors, but also to give levels *nishans*, etc.

Simultaneously with the preparation of the rough cost estimate, a forecast of materials, *i.e.*, cement, steel, timber, etc., required for the works was prepared. The number of vehicles required for transport, and quantity of petrol required for these was also estimated.

The lists of these materials were forwarded to the Chief Engineer, for getting these released. By the time detailed estimates were prepared materials started arriving at site of works.

A contract was made with the Bridge Department of North Western Railway for fabrication and erection of steel girders.

Time table. Before starting work on each bridge, target dates were fixed by the Superintending Engineer, in consultation with the Deputy Chief Engineer, North Western Railway. The work on all bridges was completed according to the programme. This was as a result of close co-operation between P. W. D. contractors, the P. W. D. Staff, and the Bridge Department of North Western Railway.

The first batch of contracts was let out by end of December 1944 and and work was actually started in middle of January. Almost all bridges were completed by end of July 1945.

In important bridges, the times taken for various items of work are given as under :—

(1)	Excavation of foundation up to the design level, including pumping, etc....	1 to 1½ months
(2)	Laying of foundation concrete, construction of abutments up to girder level of springing of arches	1 month
(3)	Construction of staging for arches, etc. ...	15 days to 22 days.
(4)	Erection of plate girders including rivetting, etc.	1 week
(5)	Erection of steel work on Awa Khud Bridge from date of start including erection of staging ...	3½ months
(6)	Erection of steel work on Ban Ganga Bridge from date of start	4 months
(7)	Reinforced concrete slab including shuttering, fixing reinforcement, etc., on Ban Ganga, and Awa Khud Bridges was completed within one month after completion of erection by the Railway Staff.	

For bridges with plate girders it took about one month as construction of shuttering was a difficult affair.

A list of officers who worked on this project is given below :—

Chief Engineer : L. A. Freak, Esq., I.S.E.
H. A. Harris, Esq., I.S.E.

Superintending Engineer : R. L. Sondhi, Esq., I.S.E.
Executive Engineer : G. C. Khanna, Esq., P.S.E.
S. D. O. Kangra Sub-Division : N. U. Aslam, Esq.
S. D. O. Palampur Sub-Division : Abdul Aziz II, Esq.
S. D. O. Kulu Sub-Division : Saeed Ahmad, Esq., up to 11th July, 1945.
(Hans Raj Hurria, Esq., from 11th July, 1945).

Bridge Department of North Western Railway :

Deputy Chief Engineer Bridges	:	S. M. Johnson, Esq.
Executive Engineer Bridges	:	K. B. A. S. Faruqi.
Executive Engineer Bridges	:	L. H. Advani, Esq.
Assistant Engineer Bridges	:	R. M. Nawaz, Esq.

The cost of important bridges including cost per feet run and per sft. of waterway is given in Appendix V. The cost is high on account of higher rates of wages prevalent in the area due to war. The most expensive item has been construction of steel girders by railway who has charged Rs.800 to Rs.900 per ton for cost of steel work which is a very high rate.

APPENDIX I

STATEMENT SHOWING LIST OF NEW BRIDGES AND CULVERTS IN KANGRA DISTRICT

Amritsar-Pathankot-Kulu Road

Mile 81 furlong 2	Culvert 2½′ span (arch)
Mile 90 furlong 7	Culvert 2½′ span (arch)
Mile 114 furlong 6	Manjhi Bridge. Adding two spans 40′ and 10′ (girder)
Mile 117 furlong 1	Manooni Bridge, 2 spans 40′ and 20′ (girder)
Mile 131 furlong 7	Ran Khud Bridge, 30 ft. span (arch)
Mile 133 furlong 5	Soon Khud Bridge, 2 spans 28′ (arch)
Mile 134 furlong 7	Thakar Dawara Nulla, 10′ span bridge (arch)
Mile 135 furlong 2	Bhanjiar Nullah, 15′ span bridge (arch)
Mile 136 furlong 1	Jalbindi Nullah 20′ span bridge (girder)
Mile 136 furlong 2	Bhirl Khud bridge, 28′ span (arch)
Mile 139 furlong 2	Arch Bridge 10′ span.
Mile 139 furlong 6	Arch Bridge 10′ span.
Mile 141 furlong 2	Culvert 5′ span.
Mile 142 furlong 4	Awa Khud Bridge 120′ span (girder)
Mile 143 furlong 3	Culvert 5′ span (arch)
Mile 146 furlong 7	R. C. slab bridge 10′ span.
Mile 155 furlong 3	Culvert 5′ span (arch)
Mile 157 furlong 3	Bridge 20′ span (arch)
Mile 158 furlong 6	Causeway Cum Bridge 8′ span.
Mile 159 furlong 1	Bridge 20′ (arch)

Mile 162 furlong 1	Gugli bridge 3 spans 40′ each (girder)
Mile 165 furlong 1	Naira Bridge 40′ span (girder)
Mile 167 furlong 4	Culvert 5′ span (arch)
Mile 167 furlong 6	Culvert 5′ span (arch)
Mile 168 furlong 2	Causeway Cum Bridge 15′ (span)
Mile 168 furlong 7	Culvert 5′ span (arch)
Mile 170 furlong 3	Bridge 30′ span (arch)
Mile 176 furlong 3	Culvert 5′ span (arch)
Mile 177 furlong 7	Bridge 15′ span (arch)
Mile 178 furlong 2	Bridge 10′ span (arch)
Mile 178 furlong 8	Bridge 10′ span (arch)
Mile 179 furlong 6	Bridge 10′ span (arch)
Mile 180 furlong 1	Bridge 15′ span (arch)
Mile 180 furlong 4	(*i*) Bridge 20′ span (arch) (*ii*) Culvert 5′ span (arch)
Mile 180 furlong 6 & 7	(*i*) Culvert 5′ span (arch) (*ii*) Jobri Nullah bridge 20′ span (arch)
Mile 181 furlong 1	Bridge 5′ span (arch)
Mile 181 furlong 5	Bridge 10′ span (arch)
Mile 184 furlong 3	Culverts 5′ span (arch)
Mile 185 furlong 5	Culvert 5′ span (arch)
Mile 226 furlong 5	Causeway Cum Bridge 12′ span.
Mile 232 furlong 1	Timber bridges over Banjaura Khud (*i*) 3 spans 32′ each (*ii*) 2 spans 20′ each.
Mile 237 furlong 5 & 6	Timber bridges over Mohal Khud (*i*) 3 spans 25′ each (*ii*) 2 spaus 25′ each (*iii*) 3 spans 25′ each.

Jullundur-Hoshiarpur-Dharmsala Road

Mile 87 furlong 1	Ban Ganga Bridge, 150′ span.

APPENDIX II

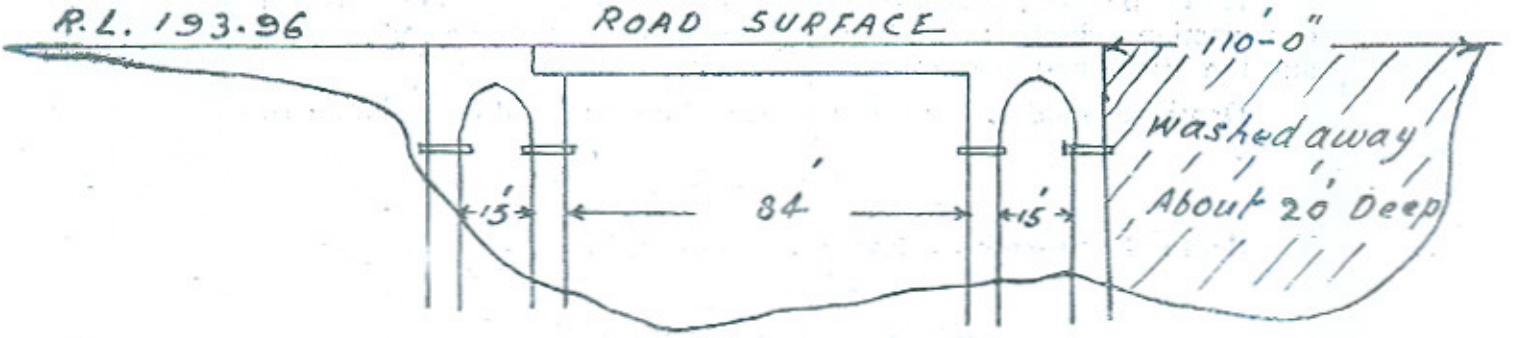
STATEMENT SHOWING VELOCITIES, DISCHARGES OF IMPORTANT STREAMS IN KANGRA PROVINCIAL DIVISION

Serial No.	Name of Bridges.	Mileage.	Catchment area.	Waterway at H.F.L.	Total opening of the bridge.	Bed slope	Velocity	Discharge	Length of Bridge.	Remarks.
1	Chakki Bridge 24 spans of 40', 10 spans of 59½, 2 spans of 50' and one span of 53' respectively ...	74/1	270·0	17,760	23,000	1 in 195	12·8	230.000	1,513	(1) The H. F. L. assumed in 1933, w 4 spans of Chakki Bridge w washed away. The velocity disch etc., was calculated by Col. L Adlard the then Executive Engin
2	Camloh Nullah Bridge 4 spans of 15' each	77/1	1·5	360	420	1 in 28	17·0	6,120	60	
3	Grail Khud Bridge 6 spans of 25' each ...	79/4	26·0	1,567	1,992	1 in 130	14	21,938	150	(2) The H. F. L. has been assumed t up to springing of arch. Actu water may not have reached level. Therefore figure seems hi
4	Bodh Khud Bridge 2 spans of 25' each ...	80/4	3·2	425	458	1 in 128	12	5,100	50	
5	Grail Khud Bridge 1 span of 84 ft. ...	89/1	6·0	850	1,498	1 in 50	18	15,300	84	
6	Dehri Khud Bridge 2 spans of 92' each ...	95/7	67·0	67	2,816	1 in 100	18	50,688	184	(6) This bridge was overtopped in 19 The discharge must have been u than calculated.
7	Baraal Khud Bridge 1 span of 83½ feet ...	98/6	54·0	2,158	2,545	1 in 100	32	47,476	84	
8	Bhali Khud Bridge 1 span of 61 feet ...	99/3	2·5	360	900	1 in 200	20	7,200	61	
9	Khauli Bridge 1 span of 82½ feet ...	107/7	25·0	1,400	1,476	1 in 30	*32	44,800	83	*(9) The velocity as worked out Manninge's formulae seems excess Back water slope must have b reduced due to afflux velocity co not be more than 25'/sec. In calculations slope of 1 in 30 been assumed which is bed slope.
10	Chambi Nullah Bridge 3 span of 40' each	110/3	11·1	1,480	1,480	1 in 50	20	29,600	120	
11	Guj Nullah Bridge 2 spans of 86' each ...	112/7	36·0	2,720	2,720	1 in 100	18	49,960	172	
12	Banoye Nullah Bridge 1 span of 84 feet ...	113/2	7·0	900	1,260	1 in 45	18	16,200	84	
13	(i) Large Manjhi Bridge 5' spans (14', 84', 14', 40' and 10') ...	114/6	30	2,300	3,000	1 in 32	22	50,600	228	(13) Very small quantity of water n passes through small Manjhi.
	(ii) Small Manjhi Bridge 3 spans of 21⅛ feet each ...	114/7								
14	(i) Manuni Khud Bridge 2 spans of 40' and 20' ...	117/1	22·0	1,600	2,800	1 in 30	22	35,200	123	(14) The area has been worked out both bridges.
	(ii) Manuni Khud Bridge 2 spans 22' and 28½' ...	117/2								
15	Baner Khud Bridge 1 span of 158 feet ...	121/5	48·0	2,700	2,700	1 in 50	26	70,200	158	(15) Water touched the grider and floati twigs were entangled in steel work
16	Nigal Khud Bridge 1 span of 140 feet ...	131/4	45·0	2,120	4,800	1 in 25	30	63,600	140	
17	Awa Khud Bridge 1 span of 120 feet ...	142/4	14·5	1,600	2,700	1 in 32	22	35,200	120	(16 and 18) The velocity seems hi when the water got headed up d to afflux, back water slope must ha been considerably reduced. T actual velocity could not be m than about 25 feet per second H.F.L.
18	Binwan Khud Bridge 1 span of 124 feet ...	148/2	69·0	3,000	4,000	1 in 50	34	75,000	124	
	JULLUNDUR-HOSHIARPUR DHARMSALA ROAD									
19	Ban Ganga Bridge one span of 150 feet ...	87	77·0	4,400	4,460	1 in 85	22	96,800	150	(19) The bridge was overtopped August, 1944. When it was ov topped the slope behind the brid was reduced considerably, therefo bed slope is not the criterion. T velocity in a bed like this cannot more than 22 feet.

APPENDIX III

Manjhi Bridge Mile 115

Calculations for waterway, depth of foundations, etc.



Catchment Area = 26 square miles.

Waterway to be provided as per Dun's table page 177 M.E.S. Hand-Book = 1,300 square feet.

Actual area of openings of the bridge before flood = 1,675 square feet.

The bridge was overtopped by flood before it was outflanked, therefore waterway was small. Cross section of the nala immediately downstream and upstream of the bridge cannot give true value of the discharge, that actually occurred at H. F. L. Due to obstruction, the level at bridge site was raised and when finally the approach road was breached, the quantity of water which flowed was much greater than the water actually flowing in the nala during the highest flood.

An examination of a number of cross sections shows that :

Average waterway = 2,000 square feet.

Wetted perimeter = 220 sft.

$R = \text{H. M. D.} = \frac{2000}{220} = 9$ feet

slope S = 1 in 31.

Velocity by Mannimge's formula

$$= \frac{1{\cdot}4856}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

= 22 feet/second.

where n = ·05 torrential streams encumbered with detritus and big boulders. If we add a span of 50 feet, total width of waterway

= 164 feet.

Total waterway provided with 12·5 depth of water = 2,050 sft.

as against 2,000 sft. required for maximum flood.

This gives an average clearance of 2 feet which is considered ample

maximum discharge during the flood of August 1944. } = 2,000 × 22 = 44,000 cubic feet per second.

It may be stated that during flood of 1892, when bridge was under construction a discharge of about 28,000 cusecs passed through the nala and the bridge had to be raised.

Depth of foundations :—The average intensity of flood per foot run

$$= q = \frac{(44000)}{164} = 268 \text{ cusecs.}$$

The depth of non-scouring flow can be obtained from Lacey's formula

$$R = 0{\cdot}9\left(\frac{q^2}{f}\right)^{\frac{1}{3}} = 21{\cdot}6 \text{ feet.}$$

where f = 6 for shingle and boulder bed.

By Kennedy's formula

$$D = \left(\frac{VO}{m}\right)^{1{\cdot}56}$$

VO = 22 feet per second.

m = 3·5 for gravel and boulder bed as per page 40 of M. E. S. Hand-Book.

D = 17·5 feet.

To allow for scour and provide for a factor of safety the foundation should be taken $\frac{1}{3}$ D more *i.e.*, 17·5 + 5·8, *i.e.*, 23 feet below H. L. F.

As the average depth-water during H. F. L. = 12·5 feet.

depth of foundation below bed level = 8 feet accordingly to Lacey and 10·5 feet according to Kennedy. Foundation must be taken to a level lower than this, so that they are absolutely safe. The foundations of the existing bridge are 12 feet below the present bed level. Foundation of the extension to the bridge will be taken to the same depth.

Awa Khud Bridge

Catchment Area	=	14·5 square miles.
Average area of waterway during highest flood level	=	1,575 square feet.
Water perimeter	=	165
Hydraulic mean depth	=	$\frac{1,575}{165}$ 9·5 feet.

slope = 1 in 33

Velocity by Mannimge's formula

$$V = \left(\frac{1{\cdot}4856}{n} R^{\frac{2}{3}} S^{\frac{1}{2}} \right)$$

V = 23 feet per second

where n = ·05

Maximum discharge during the flow of August 1944 = 36,000 cusecs

Waterway provided up to bottom of girder = 2,700 square feet.

This gives a clearance of about 8 feet.

Depth of foundations :—

$$q = \left(\frac{36000}{120} \right) = 300 \text{ cusecs/st.}$$

$$R = 0{\cdot}9 \left(\frac{q^2}{f} \right)^{\frac{1}{3}} = 21{\cdot}6 \text{ feet.}$$

where f = 6 for shingle and boulder bed.

As the maximum depth during H. F. L. average had level will be 13 feet.

Depth of foundation below bed level = 21·6 − 13 = 8·6 feet.

According to Kennedy's formula depth works out to be 18 feet. To allow for factor of safety the design depth should be 24 feet. Depth of foundation below bed level = 24 − 13 = 11 feet.

The depth of foundation below the lowest bed level is about 8·5 feet, while below the average level is about 12 feet. At the site of foundation the depth is about 15 feet below the corresponding bed level. This is considered ample.

APPENDIX IV

Analysis of working pumping sets

Type of sets

"A" Sets with diesel oil Engines :— (Stove start)

		Rs.	a.	p.
K. Oil for starting Engine = $\frac{1}{6}$ gallon @ Rs. 1-14	...	0	5	0
Diesel Oil consumed 6 gallons per 12 hrs. @ Rs. 1-8	...	9	0	0
Mobil Oil consumed 1/4 gallon per 12 hrs. @ Rs. 4	...	1	0	0
Grease Oil consumed $\frac{1}{4}$ lbs. per 12 hrs. @ As. 10	...	0	2	6
Cotton waste, etc. (Miscellaneous) @ Re. 1	...	1	0	0
Mechanic and driver = 89 per mensem	...	3	0	0
Cooly for keeping water in circulation tank filled = 1 per 12 hrs. @ Rs. 1-8	...	1	8	0
Total	...	15	15	6

Cost of working per hour Rs. 1-5-3

"B" Sets with Diesel Oil Engines :— (Cold Start)

As analysis "A" above loss cost of K. Oil per hour

Cost of working per hour = Rs. 1-4-9

"C" Sets with K. Oil Engines :— (Petrol Start)

		Rs.	a.	p.
Petrol for starting = $\frac{1}{6}$ gallon @ Rs. 2-11	...	0	7	0
K. Oil consumed 4 gallons per 12 hrs @ Rs. 1-12-6	...	7	2	0
Mobil Oil consumed $\frac{1}{4}$ gallons per 12 hrs. @ Rs. 4	...	1	0	0
Graese consumed $\frac{1}{4}$ lbs. per 12 hrs. @ As. 10	...	0	2	6
Cotton Waste, etc. (Miscellaneous) @ Re. 1	...	1	0	0
Mechanic Driver 1 = Rs. 89 per mensem	...	3	0	0
Total	...	12	11	6

Cost of working per hour Rs.1-1-0

In the above analysis, cost of transport of pumping sets, repairs, depreciation, etc., have not been taken. As the sets are costly and wear and tear is great on account of shifting working in open, etc., the cost of depreciation, repairs and cost of transport can be taken at about Rs.12 to Rs.15 per day.

The total cost per day should be doubled. The figures in Column 11 require to be doubled.

APPENDIX IV

		PRIME MOVER					PUMP					
1	2	3	4	5	6	7	8	9	10	11	12	13
No.	Make	Type	Horse Power (h.p.)	Speed (r. p. m.)	Type of starting.	Type of coupling.	Dia. of suetion and suct : Head.	Dia. of delivery and Deli- very Head.	Discharge (Galls HR)	Cost of working set per hour. Rs. a. p.	Reference to analysis of cost.	Remarks.
1	Crossley	Diesel Oil Engine	8 h. p.	750	Stove Start	Belt	4″/11′	4″/1¾′	16,000	1 5 3	(A)	Motor Engine need heating to start it. Pump speed = 1,150 r.p.m.
2	Tangye	,,	6 h. p.	670	,,	,,	4″/14′	3″/2′	14,500	1 5 3	(A)	Motor Engine need heating to start it Pump speed = 1,000 r.p.m.
3	National	,,	5 h. p.	550	Cold Start	,,	4″/11′	3″/2′	10,200	1 4 9	(B)	A later type of moto Requires no heati to start it. Pump speed = 850 r.p m.
4	National	,,	5 h. p.	550	,,	,,	4″/ 8′	3″/1¾′	10,500	1 4 9	(B)	A later type of moto Requires no heati to start it. Pump speed = 850 r.p.m.
5	Prestwitch	Kerosene Oil Engine	6 h. p.	1,400	Petrol Start	Shaft	3″/15′	3″/2′	20,000	1 1 0	(C)	Pump speed = 1,400 r.p m.
6	Prestwitch	,,	5 h. p.	1,400	,,	,,	2½″/13′	2″/2′	17,500		(C)	Pump speed = 1,400 r.p.m.
7	Jaeger	,,	4 h. p.	1,400	,,	,,	2″/9′	2″/1½′	8,700		(C)	Pump speed = 1,400 r.p.m.

APPENDIX V

STATEMENT SHOWING COSTS OF BRIDGES CONSTRUCTED IN KANGRA PROVINCIAL DIVISION

Serial No.	Name of bridges	Total probable cost of bridge	Cost of steel girders incurred by Railway Department	Cost of abutment Piers and R. C slabs, etc.	Length of bridge in Rft.	Cost per ft. length	Waterway	Cost per Sft.	Remarks
1	Thakar Dawara bridge 10′ span in mile 131/7 of A. P. K. Road	7,000	...	...	10	700	60 Sft.	117	(a) Water-way been worke up to the spri of arch or le 2 ft. or more board.
2	10′ span bridge in mile 139/6 ..	17,000	...	...	10	1,700	200 ,,	85	
3	Bhanjar Nullah bridge 15′ span in mile 135/2 ...	15,000	...	...	15	1,000	165 ,,	91	(2) The bridge is 24 ft. in heig
4	20′ span bridge in mile 157/3 ...	16,000	...	...	20	800	260 ,,	62	
5	Bhiral Khud bridge 28′ span in mile 136/2 ...	30,000	...	...	28	1,071	504 ,,	60	(9) The cost is hig account of tective bund, additional pi
6	Ran Khud bridge 30′ span in mile 131/7 ...	24,000	...	...	30	800	300 ,,	80	
7	30′ span bridge in mile 170/3 ...	24,000	...	...	30	800	300 ,,	80	
8	Naira bridge 40′ span in mile 165/1 ...	32,000	13,000	19,000	40	800	720 ,,	44	
9	Manjhi bridge 2 spans (40′ and 10′) in mile 1 4/6	60,000	13,000	47,000	50	1,200	625 ,,	96	
10.	Manuni bridge 2 spans (40′ and 20′) in mile 117/1	52,000	20,000	32,000	60	867	600 ,,	87	
11	Awa Khud bridge 120′ span in mile 142/4 ...	1,60,000	1,11,500	48,000	120	1,333	2,880 ,,	56	
12	Gugli bridge 3 spans 40′ each in mile 162/2 ..	1,15,000	50,000	65,000	120	958	1,660 ,,	68	
13	Bana Ganga bridge 150′ span in mile 87/1 of J.H.D. Road ...	1,60,000	1,13,000	47,000	150	1,067	4,800 ,,	33	(13) The area of w way has greatly incre therefore cos sft. is low on bridge.

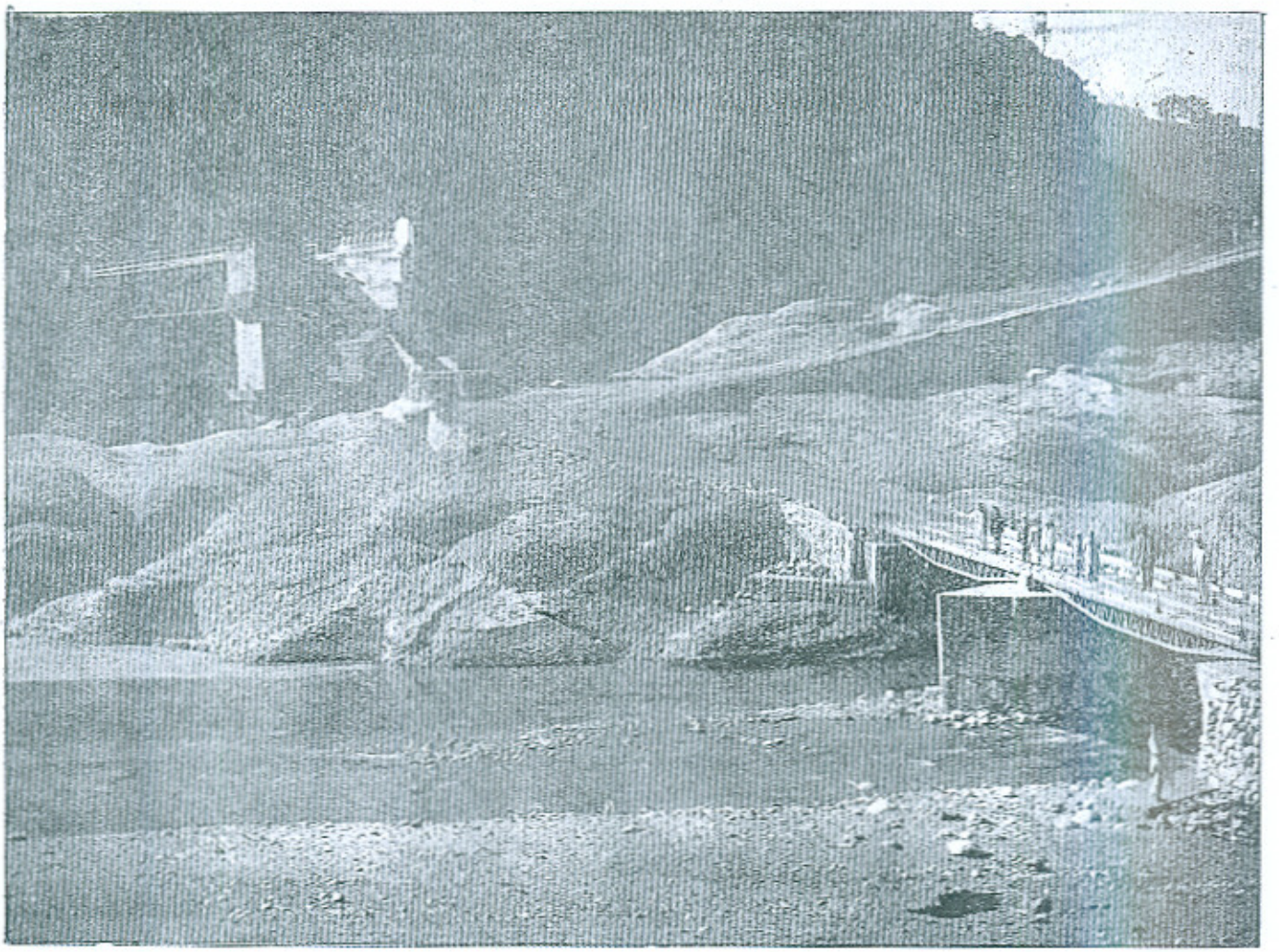


Photo No. 1.

BANGANGA BRIDGE.

In Mile 87/1 of Jullundur-Hoshiarpur-Dharmsala Road

The Photograph shows the Washed-Away Wings and Approach Road on the Right Bank (Kangra Side) The New Temporary Bridge and Diversion are also shown.

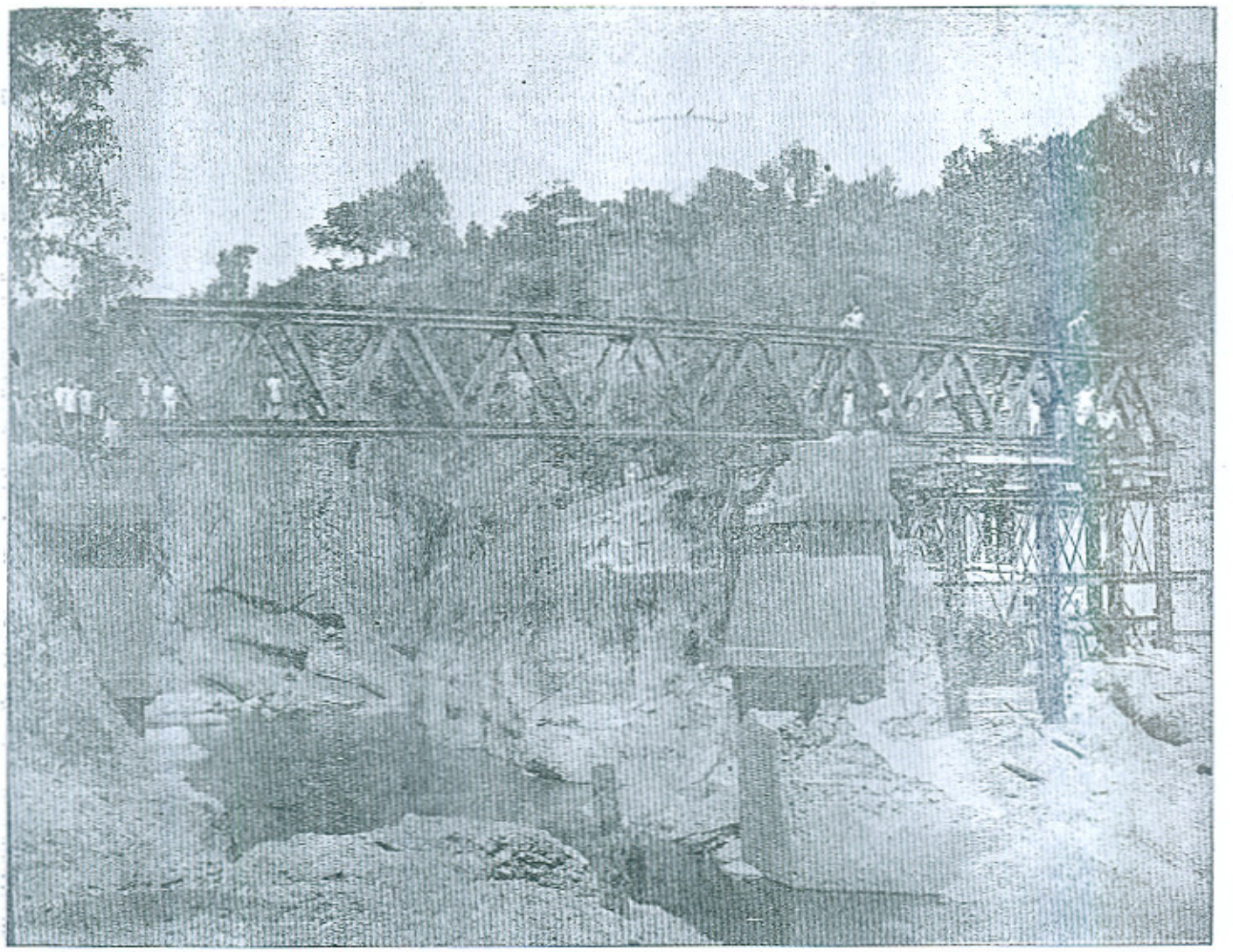


Photo No. 2.

BANGANGA BRIDGE SPAN 150 FEET.

On Jullundur-Hoshiarpur-Dharmsala Road Mile 87/1. Another view of Banganga Bridge. The old Abutment on the Right will be Dismantled after Final Erection of the Bridge.

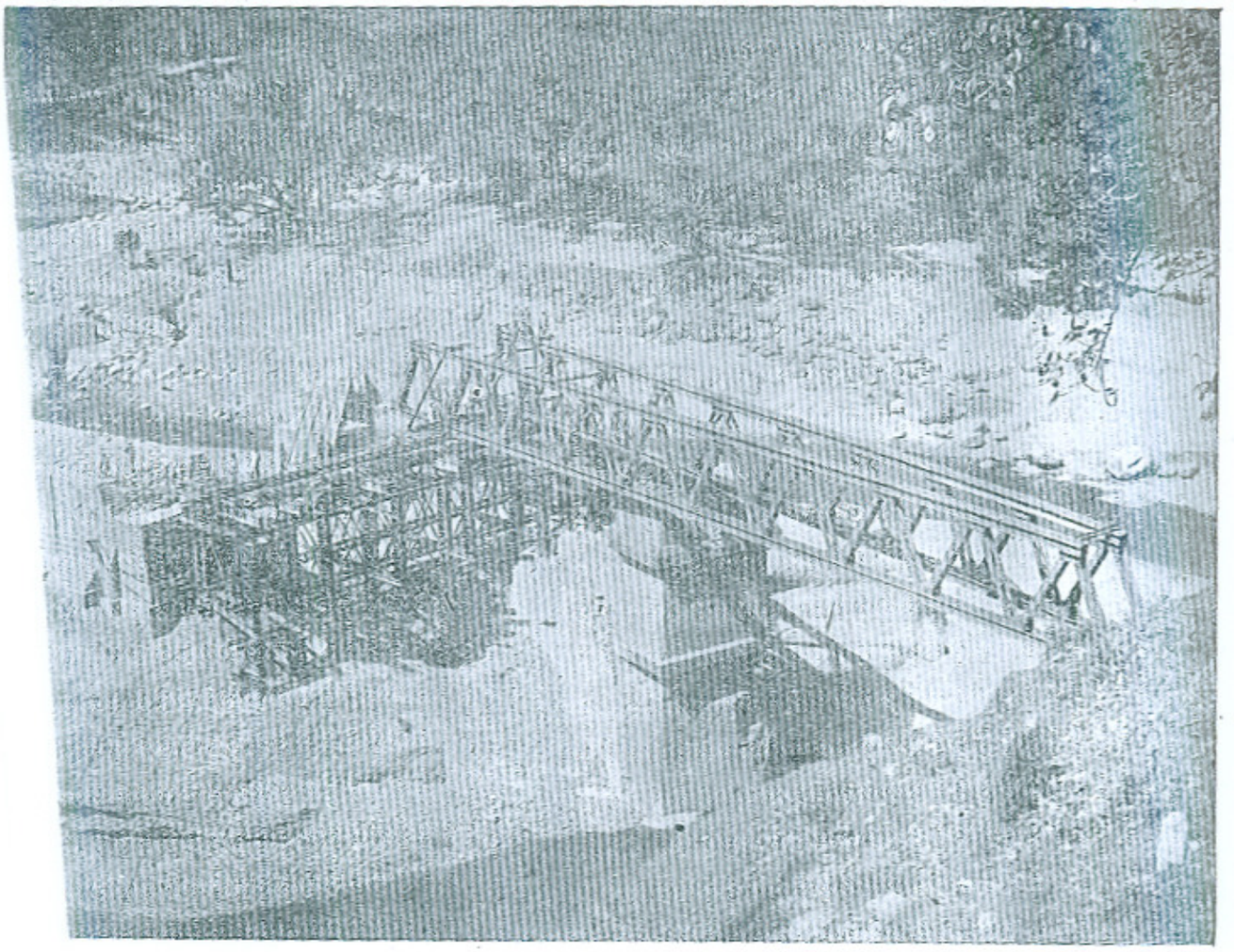


Photo No. 3.

BANGANGA BRIDGE SPAN 150 FEET.

On Jullundur-Hoshiarpur-Dharmsala Road Mile 87/1. The Photograph shows the erection of Steel Girders on the Original Abutments. The Steel Girders will be shifted (Slewed) to their Final Position on Temporary Staging and will Rest on the Abutment shown on the left of the Picture. The temporary Bridge used for Diversion can be seen at the Rear of the Staging.

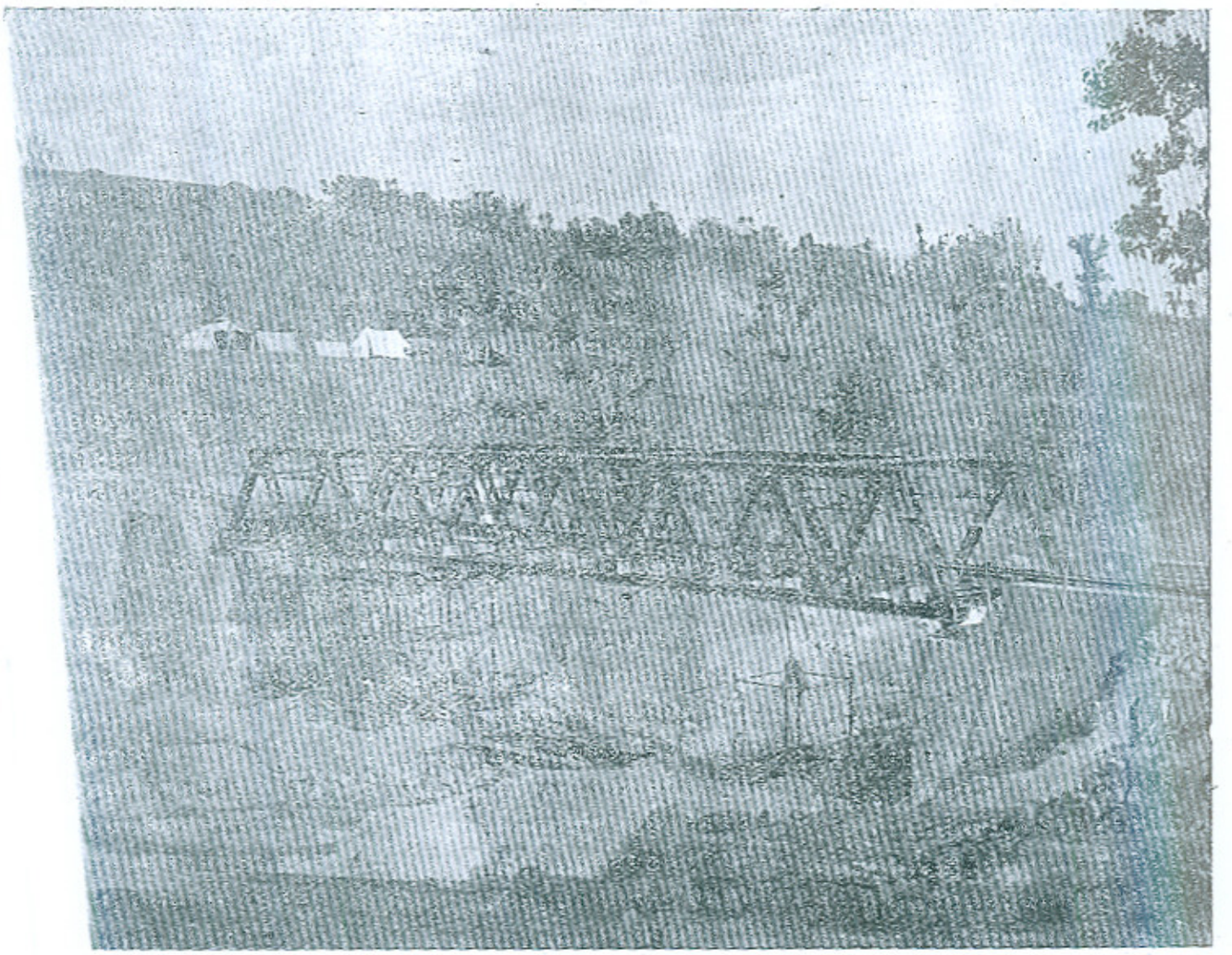


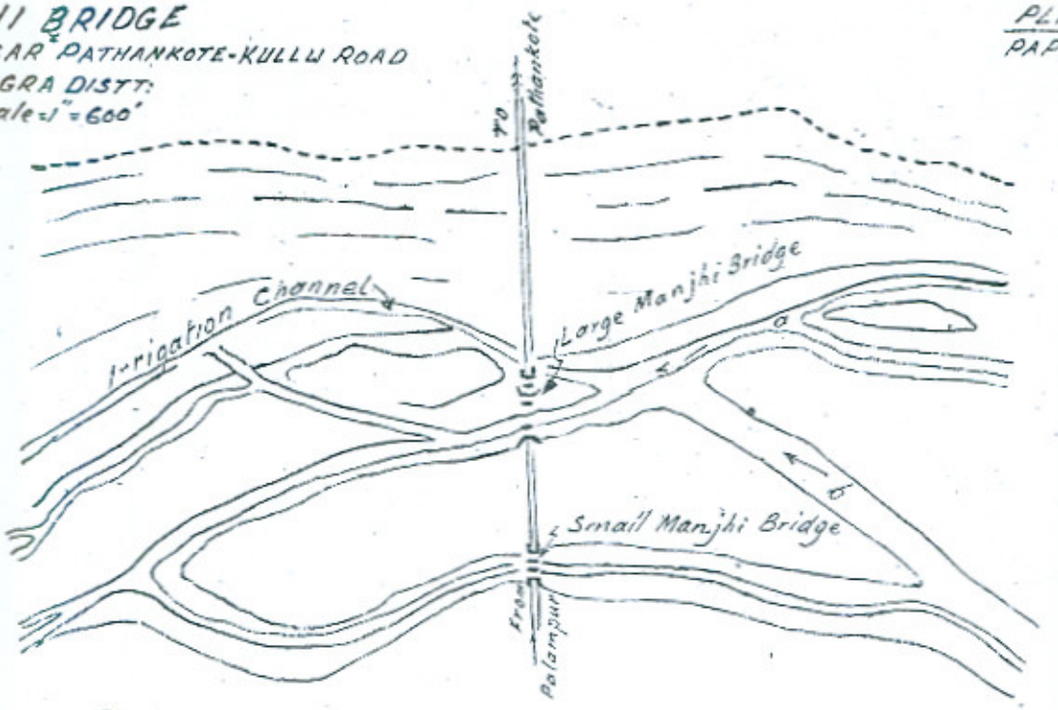
Photo No. 4.

AWA-KHUD BRIDGE SPAN 120 FEET.
On Amritsar-Pathankot-Kulu Road Mile 142/4.
The Steel Girders have been erected.
Temporary Staging has been Partly Dismantled.

MANJHI BRIDGE

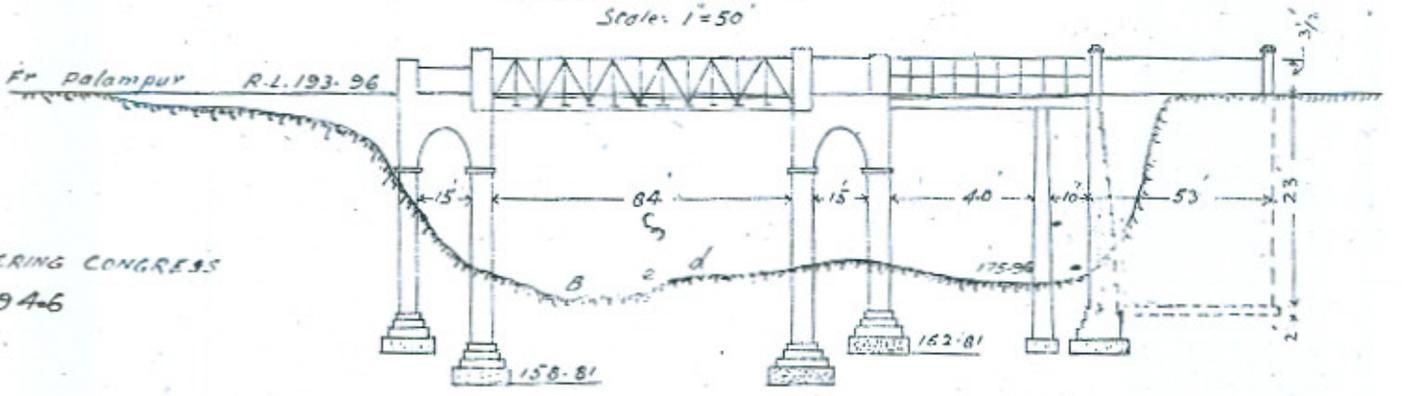
14/6, AMRITSAR-PATHANKOTE-KULLU ROAD
KANGRA DISTT:
Scale: 1" = 600'

PLATE 1
PAPER 281



BRIDGE AS REBUILT

Scale: 1" = 50'



VGINEERING CONGRESS
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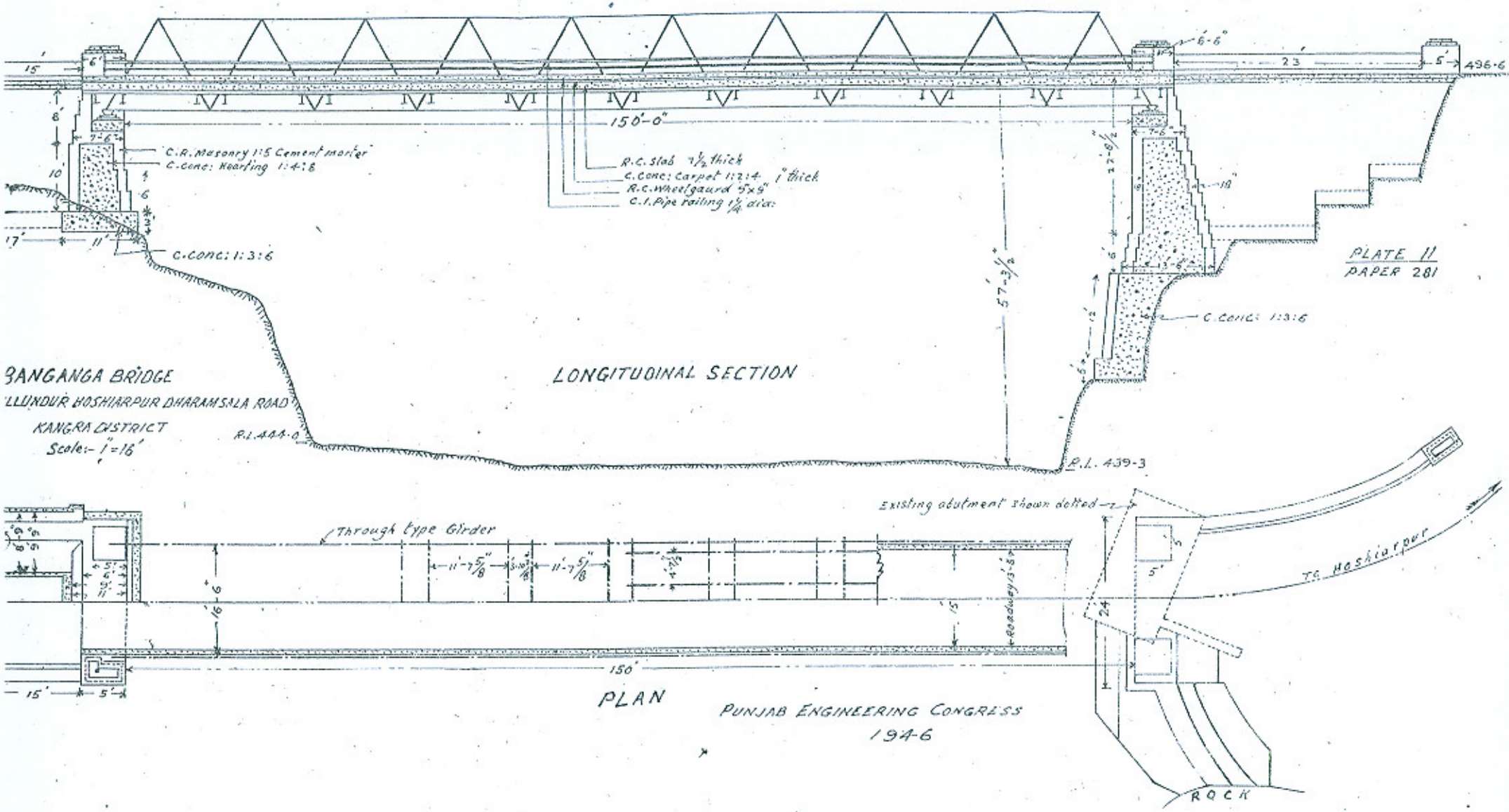
C.R. Masonry 1:5 Cement mortar
C. Conc: Hearting 1:4:8
C. Conc: 1:3:6
R.C. Slab 7½ thick
C. Conc: Carpet 1:2:4 1" thick
R.C. Wheelgaurd 5"x9"
C.I. Pipe railing 1¼ dia:
150'-0"
496-6
P.L. 444-0
P.L. 439-3
57'-3½"
C. Conc: 1:3:6
PLATE II
PAPER 281
BANGANGA BRIDGE
LLUNDUR HOSHIARPUR DHARAMSALA ROAD
KANGRA DISTRICT
Scale:- 1"=16'
LONGITUDINAL SECTION
Through type Girder
Existing abutment shown dotted
To Hoshiarpur
Roadway 13'-5"
ROCK
PLAN
PUNJAB ENGINEERING CONGRESS
1946

PLATE III
PAPER 281

GRAPH SHOWING RELATION BETWEEN DISCHARGE AND CATCHMENT AREA OF VARIOUS BRIDGES ON KANGRA VALLEY

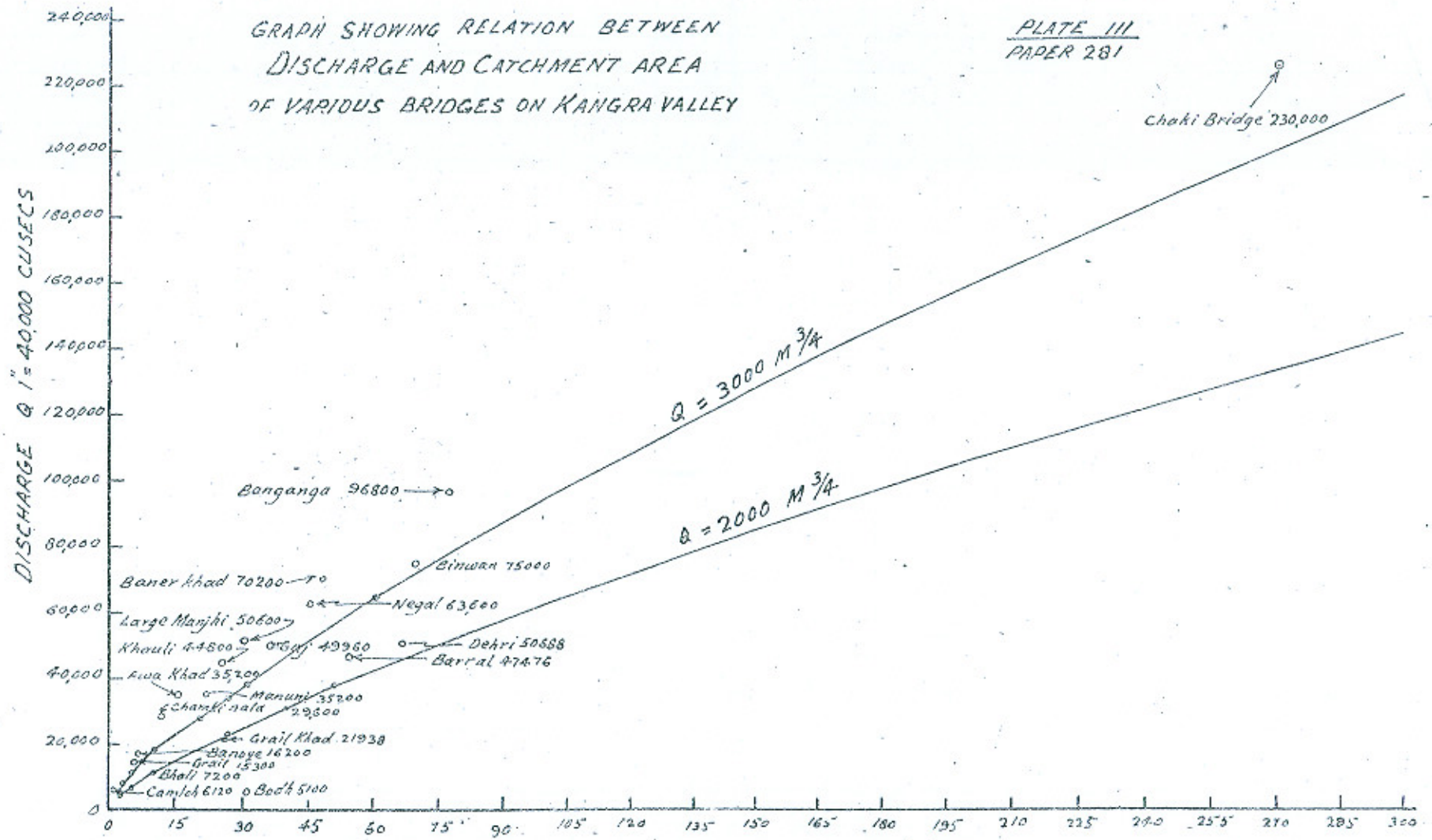

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PLATE IV
PAPER 281

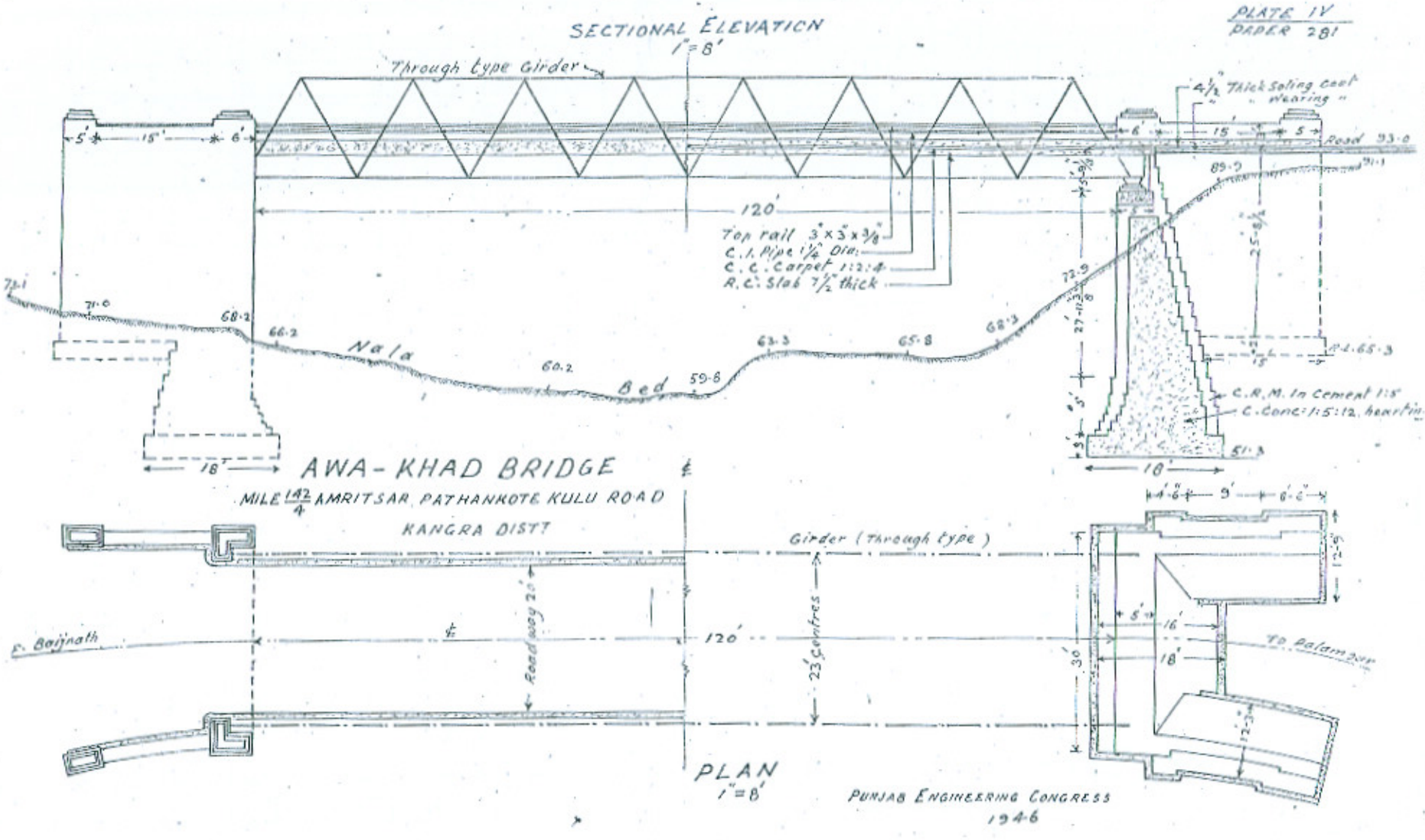

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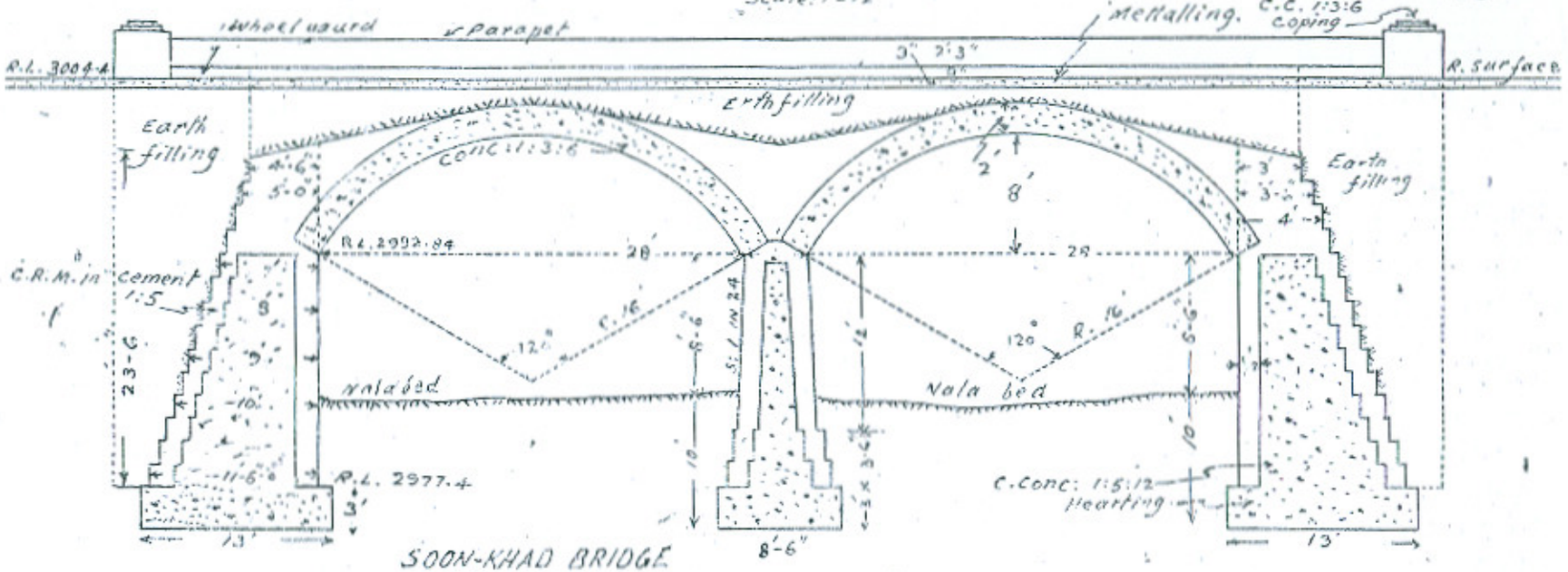
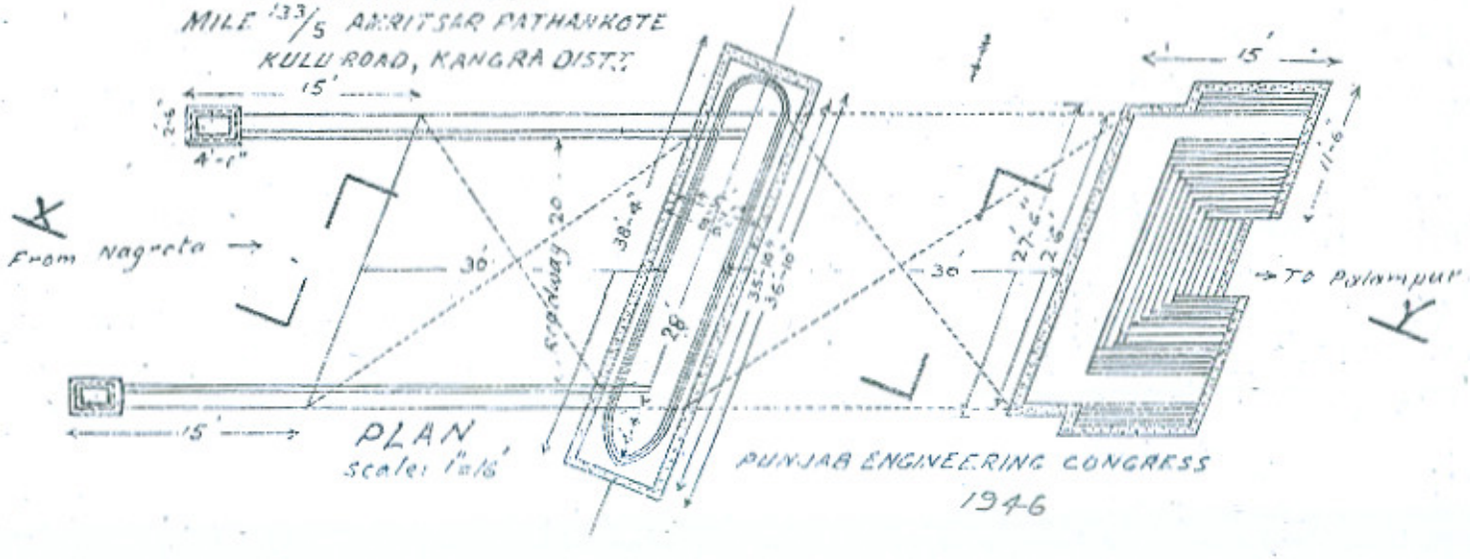
PLATE V
PAPER 281

SEC: ON X.Y.
scale: 1"=12'



SOON-KHAD BRIDGE
MILE 133/5 AMRITSAR PATHANKOTE
KULU ROAD, KANGRA DIST.



PLAN
scale: 1"=16'

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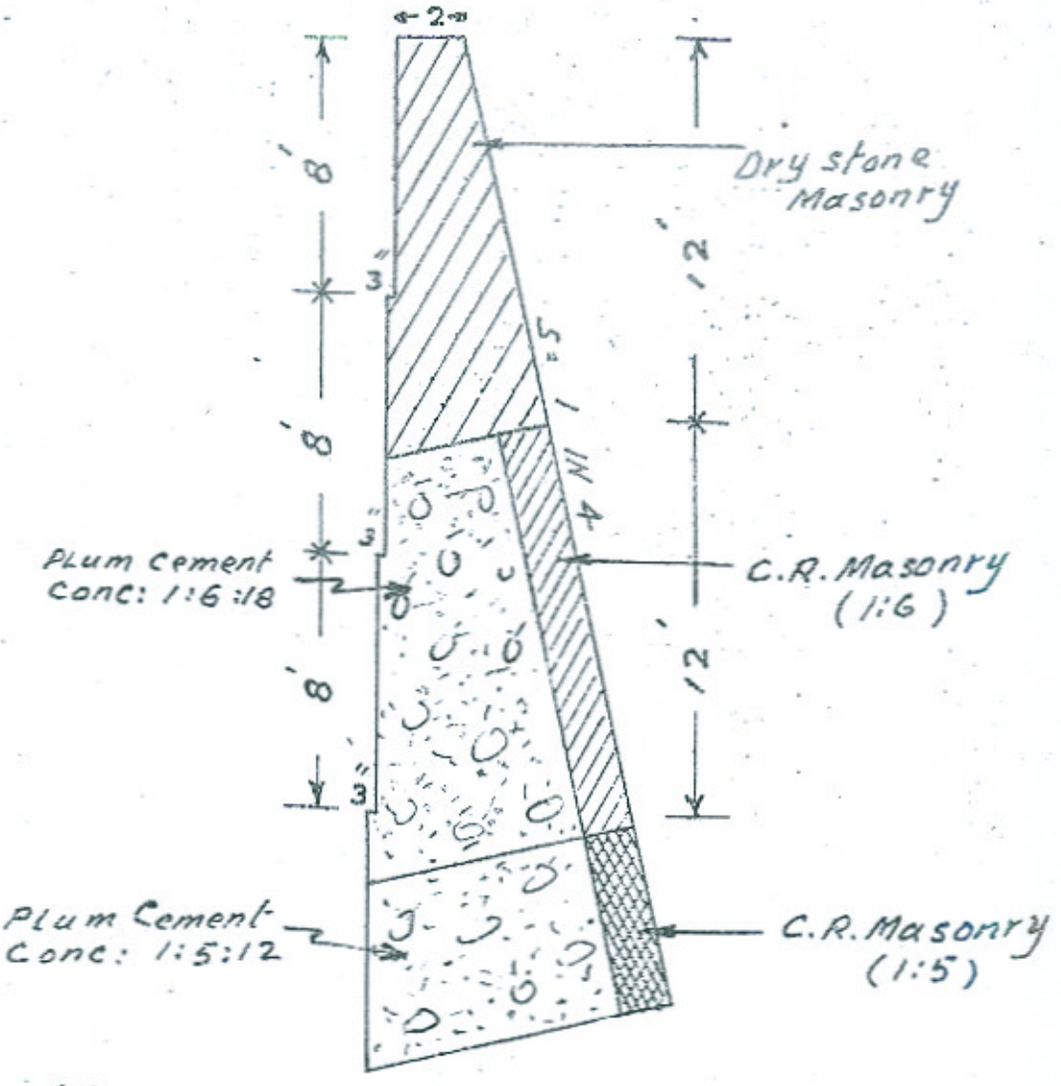
PLATE VI
PAPER 281

TYPE SECTION OF RETAINING WALL

Scale 1" = 8'



Note:-

1. Upper 12' to be C. R. Masonry laid dry.
2. From 12' to 24' Down plum cement concrete 1:6:18 with face masonry in cement 1:6 1½' thick.
3. Below 24' Plum cement conc: 1:5:12 with face masonry in cement 1:5 1½' thick.

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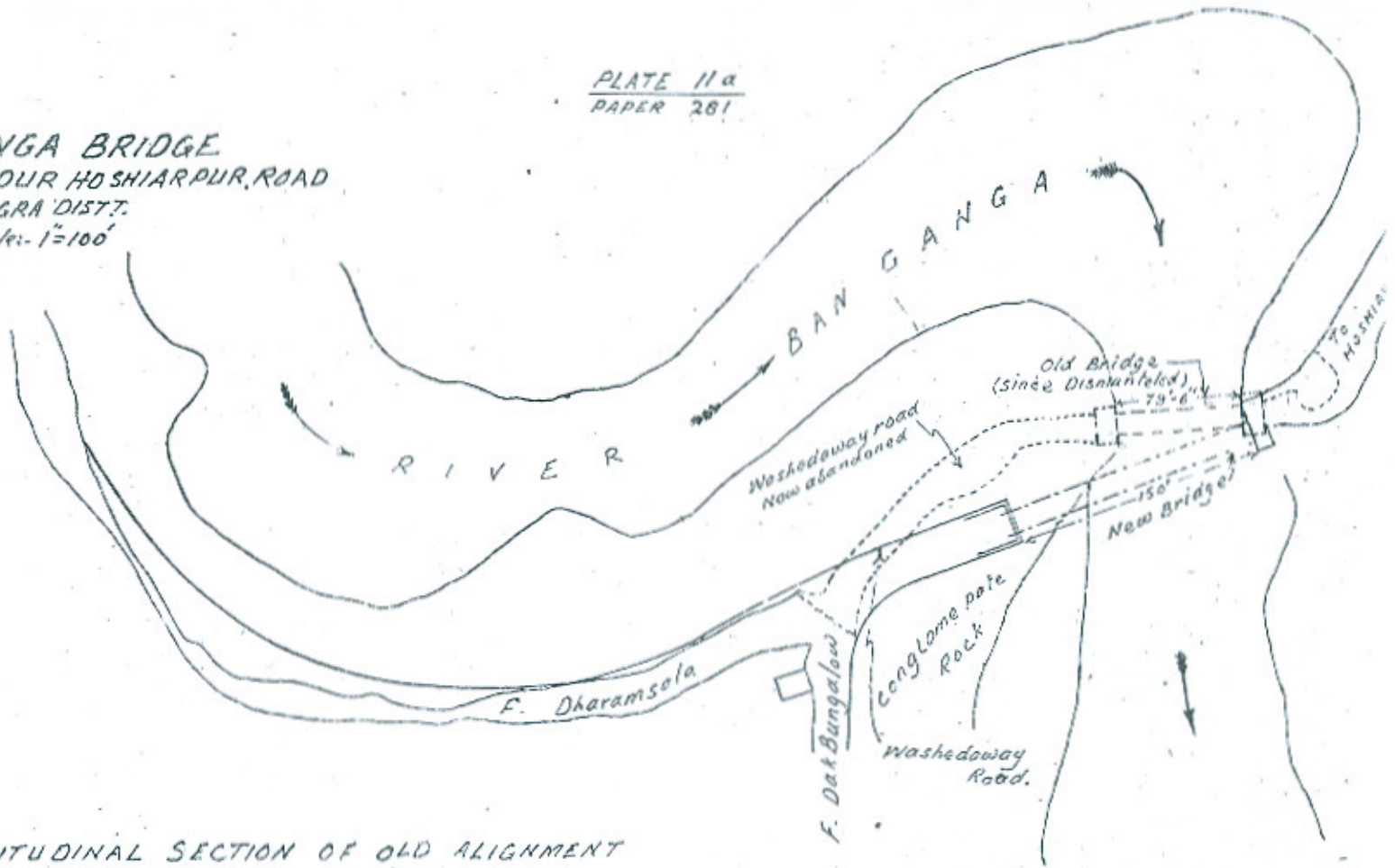
PLATE 11a
PAPER 281

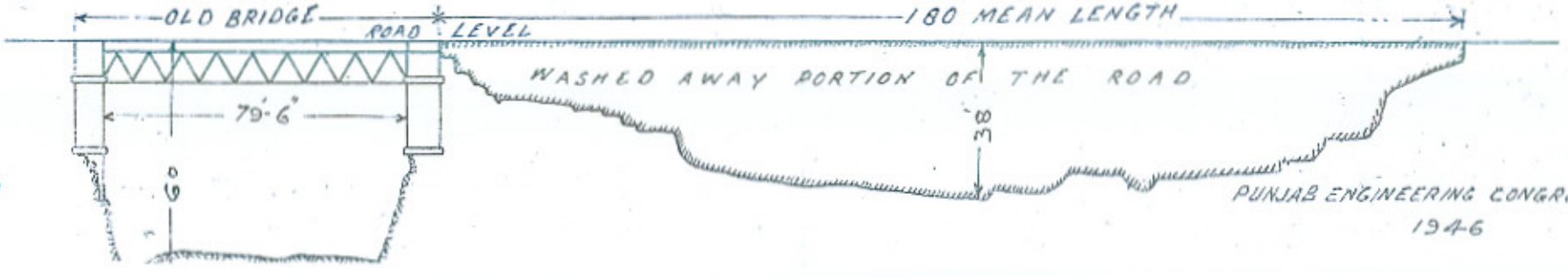
BAN GANGA BRIDGE

MILE 87/1 JULLUNOUR HOSHIARPUR ROAD
KANGRA DIST.T.
Scale:- 1"=100'



LONGITUDINAL SECTION OF OLD ALIGNMENT

Scale:- 1"=40'



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