3046.

Govt. of 18 Madras.

PUBLIC WORKS.

Dated

Recd. Encl.

G.O., 2nd April 1890 No. 466 R.
+ 466/A R

Chitravati Bridge

Madras Railway.

Highly appreciating the professional skill & energy exhibited by Mr. E. W. Stoney M. Inst. C.E. in the construction of the new bridge & a copy of the report on the bridge ordered to be forwarded to the Secy of S.

Chitravati Bridge
M. Ry.

Forwards copy of Resp on report of the C.E. for Rys on the new—

12

A No. 466 R of 2d April 1890.

Form No. 3.

C 2.4.90 / 1180

27.3.90.

Res 26 Mar ~~It gives~~ His Excellency the Governor in Council records with great pleasure ~~to record~~ his high appreciation of the professional skill and energy exhibited by ~~industry of~~ Mr. E. W. Stoney M. Inst. C. E., in the constn. of the new Chitravati bridge brought to the notice of Government by the Inspecting Officer in ~~his~~ the foregoing report ~~upon the Chittravati Bridge~~.

C. L. S.
23. 3. 90

R

2. A copy of these Progs: will be forwarded for the information of the Govt. of India.

H.E. No 466/A R of 2d April 1890
Forwarded.

Recd with plan 25/4/90

2.4.90
D. R

D
3/4

2

The Consulting Engr for Rys
" Ex Go Rjbcts

H.E. 28-3-90. R 2-4-90

P.W. Cr. No. 3046.

From

THE CONSULTING ENGINEER FOR RAILWAYS,

MADRAS,

No. 210

Dated 22d
Received 24 } March 1890

No. of Enclosures. 3 (+1 plan)

Subject.

Submitting for transmission to the Government of India, note on inspection of the new Chitravati Bridge, Madras Railway.

A

No. 466 R of 2d April 1890.

Statement of Progress of Sinkage at Chittravatti Bridge.

Month	Sinkage of Cylinders during month		Sinkage of Cylinders up to date		Sinkage of wells during month		Sinkage of wells up to date		Total sinkage of well and Cylinders during each month		Cylinders Bedded during month				Cylinders Bedded up to date	Wells Bedded each month No. of wells	Wells Bedded up to date No.	Remarks
1888																		
April	44′	6″	44′	6″					44′	6″	"							Cylinder Sinking was commenced on 23rd April 1888.
May	29′	3″	346′	9″					29′	3″	"							
June	202′	2″	542′	11″					202′	2″	"							
July	135′	3″	678′	2″					135′	3″	"							
August	244′	10″	923′	0″					244′	10″	1	7 Left			1			
September	181′	11″	1104′	11″					181′	11″	2	7 Right. 8 Left			3			
October	215′	3½″	1320′	2½″					215′	3½″	5	1L. 2R 1R 1L+4R			8			
November	84′	0″	1404′	2½″	18′	0″	18′	0″	105′	0″	4	4L 5L 8R 5R			12			
December	57′	1″	1461′	3½″	18′	4″	36′	4″	75′	5″	2	3L 3R			14			
1889																		
January	47′	2″	1511′	5½″	29′	8″	66′	0″	76′	10″	2	6R 6L			16			
February	32′	10″	1544′	3½″	42′	0″	108′	0″	74′	10″	"	"			"			
March	47′	1″	1591′	4½″	35′	0″	143′	0″	82′	1″	3	9R 12R 10R			19			
April	50′	2″	1641′	6½″	101′	9″	244′	9″	151′	11″	2	14R 9L			21			
May	43′	5″	1684′	3″														
June	22′	3″	1707′	2½″	17′	11″	332′	11″	40′	2″	2	15R. 16L	18L 10L 12L 18R 14L 16R. 15L.		28			
July	21′	11″	1729′	1½″	35′	3″	368′	2″	57′	2″	1	13R			30			
August	22′	9″	1751′	10½″	39′	4″	407′	6″	62′	1″	2	13L 17L			31	2	445	2
September	2′	7″	1754′	5½″	31′	9″	439′	3″	34′	4″	1	17R			33	1	3	3
October	1′	0″	1755′	5½″	1″	11″	441′	2″	2′	11″	"	"			34	2	447	5
November	6″	11″	1762′	4½″	4′	8″	445′	10″	11′	7″	1	11R			34	1	2	6
December	9′	9″	1772′	1½″	"	"	445′	10″	9′	9″	1	11L			35	1	1	7
															36			
	1772	1½			445. 10				2217	11½								

Major R. E.

for Executive Engineer for R.p.

Statement shewing total quantities of work done in the new Chitravaty bridge from 23rd April 1888 to 5th March 1890.

Description	Unit	Quantity	Total
C. I. work in Cylinders &c	Tons	2895	6211
W. I. work in girders & Bracing boxes		3316	
Cylinder sinking below river bed	C.ft	1772	
C.ft erected above river bed	"	541	
—Do— of wells below river bed	"	446	
Cylinders bedded		36	
Brick and cylinder wells bedded		7	
Concrete in Cylinders	C.yard	5359	6179
Do in North Abutment		582	
Do in South Abutment	"	40	
Do in Bracing boxes	"	198	
Masonry in Cylinders		2391	4497
—Do— in 3 wells North Abutment		442	
Do in Abutments		972	
Brick work 4 wells North Abutment	M	692	
Holes drilled for Bracing boxes	264	4752	5400
Do C. Caps	18	648	
No. of rivets in girders	11336	215384	222080
Do in Bracing boxes	372	6696	
Timber work of rail runners fixed in place	C.ft	2302	
Joists	C.ft	2586	
Teak wood planking	S.ft	23940	
Holes drilled in steel rails for bridge		5320	10640
Do Do Do in Rail runners		5320	
Girder Bearings fixed in place		76	
Rails loaded on Cylinders	No 39383	8752 Tons	Rails 117157 Tons 26034
Do unloaded from Cylinders	39383	8752	
Do Transferred	38385	8530	

Description	Unit	Quantity	Total
Total materials loaded and unloaded at Bridge works	Tons	21066	
Total shifts for sinking cylinders and wells		5342	
—do— Bedding —do—		1655	69 Hrs = 2790

Quantity of work done in the new Chitravati Bridge approaches &c from March 1877.

Description	Quantity	Total
New Bridge approaches. Length		1 mile 30 chs
Earthworks on Banks & cuttings	c. yds	43474
Rock cutting		1540 } 6307 3
Shak cutting		18059
Ballasting		4965
Excavation for minor Bridges		1739
Fencing		1 mile 17 chs
Laying Permanent way		1 mile 30 chs
Temporary Sidings		
Earthwork	cyds	7320
Ballast	"	1602
Laying		2 miles 78 chs
Bungalows and stores		
Masonry	cyds	2560
Thatching	sq yds	953
Tiling	"	162
Total area of Bungalows and stores		33479 sq ft

Average friction per sq. ft. of Surface below River Bed of cylinders	cwts	2.13.
Maximum —do— —do—		4.08
Minimum —do— —do—		1.29
Average friction as found from Sinking Pneumatic cylinders. 11R. 11L. & 13L.		2.66
Maximum —do— —do—		3.52
Minimum —do— —do—		2.32
Total depth of 12' cylinders in Wells sunk thro' Boulders		255'
No. of c. ft. of Boulders taken out		48613 = 1800 c. yds
Size of largest		5' long & 10 2/3 girth = 35 1/2 c. ft.
Total cost of Plant at starting		Rs 132,000
Weight of each girder		Tons 146. 12 cwt.
Total expenditure on new Chittravati Bridge inclusive of Engineers pay up to 1st February 1880		Rs 1469,540.

Cost of Supervision up to 1st February '80

	Amount	Percentage on Outlay
Salaries &c of Engineer	20,300.	1.38
Do of Inspectors. Line Keepers Store Keepers and Engineer's office Establishments	19,500	1.33
Total Cost of Supervision	39,800	— 2.71.

Pneumatic work commenced in River	5th January 1889
Do Do ended	20th November 1889
Sinking two Boulders Piers 11-12 & 13. Total Time	10½ months
Date Girder erection began	3rd December 1888
Last Girder Riveting finished	12th February 1890
Total Time	14 months
Laying began from South Side 1 to 9th span	1st October 1889
Do finished do	11th January 1890
or 9 spans. Total Time	3 months
Date Laying began from North Side 1 to 19 spans	8th February 1890
Do finished	2nd March 1890
or 10 Spans. Total Time	23 days
Greatest load of Rails used in a cylinder	1120 = 249 Tons.
Do Do on Wells	1300 = 289 "
Greatest height water lifted by Pulsometer	64 ft=
Greatest number of feet Cylinders Sunk in a day by Priestman Dredgers	12'—6"
Average dredged by Priestmans in a day	5'—3"
Greatest No of lineal. ft: of Cylinders sunk in one day	16"—6"
Maximum load on any well or Cylinders	1300 rails = 289 Tons
Average Total Sinkage per day	May '88. 1'-6" June '88. 8"-0". August 9"-6"

	Ft:	Their own weight in Tons	Friction per sq. ft. in Tons
Average depth cylinders were Sunk without loads	19¼	31	.85
Maximum Do Do	27	25½	1.33
Minimum Do Do	10	33	.63

	Rails	Tons
Average Load used to Sink Cylinders in addition to their own weight	595	132.22.
Maximum do do	1120	248.88
Minimum do do	140	31.11.

Useful Notes and Memoranda of Works done at Chhitravati Bridge.

1st. Cylinder cutting edge fixed		23rd April 188
Dredging began		1st May 188
Do finished		6th June 18
Time occupied by Dredging		13 Months
Total Lft of Wells sunk by Dredging	332'-6"	
Do Do by Divers	35-1	146
Do excavated by Men	78-5	
Total Lft of Cylinders sunk by Dredging	1323'-0"	
Do Do by Pulsometer	111-6	
Do Do by Pneumatic	46-2	1772
Do Do by Divers	168-1	
Do excavated by Men sinking cutting edge	123-4	
Date Diving began		2nd June 1888
Do Do finished		24th November 188
Total time of Diving both for sinking and Redding		17 Months
Total shifts made for sinking and Redding Cylinders	5895	
Do Do Wells	102	6997
Do Do sinking Cylinders	4274	
Do Do Do Wells	1068	5342
Do Do Redding cylinders	1621	
Do Do Do Wells	34	1655
11 Right dredged to Boulders		5th March 1889
Do Do Redded		20th November 89
For sinking through Boulders Total time		8 Months +15 days
16 Left dredged to Boulders		28th December 1888
Do Redded		13th December 1889
For sinking through Boulders Total Time		11½ Months.

Form No. 1.

OFFICE OF CONSULTING ENGINEER FOR RAILWAYS,

PUBLIC WORKS DEPARTMENT.

Madras, 22nd March 1890.

Note on inspection of the new Chitravati bridge, North West Line, Madras Railway.

No. 210

Government.

SUBMITTED. to Government for transmission to the Government of India.

2. The following useful information compiled by Mr. Storey is appended, as being of great interest and likely to prove of value ~~[illegible]~~ in the design and construction of future works of this description.

MADRAS RAILWAY COMPANY

REGISTER No. 357
FILE No.

Enclosure to A.g's No. 6621/304 9.9.

P.W. Enc 2
3046/9

No. E 28.

Revised. Statement shewing result of tests of Bridges on Madras Railway, Inspected on 6th March 1890.

New Chitravati Bridge

6

100—25-9-89.

Name or Number of Bridge.	Mileage. Miles.	Mileage. Tel. posts.	Particulars of Water-way. No. of spans.	Particulars of Water-way. Length of span in feet.	Description of Girder.	Particulars showing position in which test was applied. No. of span counting from	Right or Left Girder.	Top or bottom Boom.	Point at which deflection and oscillation were taken.	First test. Deflection. In inches.	First test. Deflection. In terms of span.	Second test. Deflection. In inches.	Second test. Deflection. In terms of span.	Third test. Deflection. In inches.	Third test. Deflection. In terms of span.	Third test. Oscillation in inches.	Permanent set	Remarks.
						1		Bottom		.44	1/3709	.43	1/3795	.44	1/3709	.12	.05	
					Whipple	2		"		.43	1/3795	.38	1/4294	.49	1/3330	.15	.04	The following loads were
					Murphy	3		"		.44	1/3709	.42	1/3885	.48	1/3400	.19	.05	used in testing the New
					with double	4		"		.45	1/3626	.42	1/3885	.47	1/3472	.19	.05	Chitravati Bridge
					system of	5		"		.45	1/3626	.44	1/3709	.56	1/2914	.24	.04	Live Load.
					Lattice Bars	6		"		.45	1/3626	.41	1/3990	.47	1/3472	.21	.03	2 H.B. Engines with Tons. Cwts. Qrs.
					139'. 8" Long	7		"		.44	1/3709	.43	1/3795	.51	1/3200	.16	.03	Tenders fully loaded 139. 2. 0
					18. 0 wide	8		"		.45	1/3626	.42	1/3885	.52	1/3138	.17	.03	Tons Cwts Qrs each 66. 11. 0
					Centre to Centre	9		"		.46	1/3547	.46	1/3547	.49	1/3330	.15	.03	2 R. O. G. Wagons
					of Booms effective	10		"		.43	1/3795	.44	1/3709	.45	1/3626	.16	.02	loaded with 66
					depth 11'. 6" weight	11		"		.45	1/3626	.42	1/3885	.58	1/2815	.20	.02	20 feet rails each 44. 11. 3
					146 Tons	12		"		.43	1/3795	.42	1/3885	.52	1/3138	.18	.04	Tons Cwt Qrs 22. 5. 3½
New Chitravati Bridge			19		Rails Carried	13		"		.45	1/3626	.43	1/3795	.50	1/3264	.24	.02	Total live load. 177. 13. 3
					by trough rail	14		"		.42	1/3885	.41	1/3986	.56	1/2914	.24	.03	Tons Cwt Qrs equal to 1. 6. 1 per foot run
					bearers supported	15		"		.45	1/3626	.43	1/3795	.49	1/3330	.14	.04	
					on Cross	16		"		.45	1/3626	.44	1/3709	.45	1/3626	.18	.05	Dead Load.
					girder 8'. 0"	17		"		.44	1/3709	.42	1/3885	.45	1/3626	.15	.03	Tons Cwt Qrs
					apart from	18		Bottom		.46	1/3547	.44	1/3709	.49	1/3330	.16	.04	Girders 146. 12. 0
					Centre to	18		Top		.47	1/3472	.48	1/3400	.48	1/3400	.19	.02	Rails & Timber 12. 6. 2
					Centre.	19		Bottom		.43	1/3795	.44	1/3709	.47	1/3472	.24	.03	Total dead load 159. 8. 2
						19		Top		.45	1/3626	.44	1/3709	.47	1/3472	.24	.03	Tons Cwt Qrs equal to 1. 3. 2 per foot run
									Total	9.34		9.02		10.34		3.90	.72	Tons Cwt Qrs Total Load 337. 1. 5
									average	.44	1/3709	.43	1/3795	.49	1/3330	.19	.03	equal to 2. 9. 3 per foot run
									maximum	.47	1/3472	.48	1/3400	.56	1/2914	.24	.05	Note. the span used in all the
									minimum	.42	1/3885	.38	1/4294	.44	1/3709	.12	.02	Calculations is that from Centre to
																		Centre of bearings viz 136 feet.
5	3	2	3	3	12-wheel	3	3	1	5	3	5	3	5	3	5	3	3	

Chief Engineer's Office
18th March 1890

(Signed) J. W. Stoney
Engineer for Chitravati Bridge

C. J. Smith Colonel R.E.
Consulting Engineer for Railways

(True Copy)
A. W. P. Carter
Chief Engineer R.D.

16

Report on the Inspection of the new Chitravati Bridge North west Line, Madras Railway.

The inspection was made on March 6th 1890, in company with the Agent and Manager, the Chief Engineer, Mr Stoney the Engineer in charge of the work, and other Engineers of the railway.

The bridge consists of 19 spans of 131 feet clear waterway: The girders are of the Whipple Murphy type, with a double system of lattice bars, by which the adjacent

adjacent panels are connected. The total length of the girders is 139' 8", the distance between the bearings being 136 ft, the effective depth 16 ft, and the width from center to center of booms 18' 0". The rails are carried on longitudinal timbers fixed in trough rail bearers, which are supported on cross girders at 8' 0" central interval. In consequence of the camber being taken up by the longitudinal baulks the overhead clearance varies about 3", the minimum headway being 14 ft 6". The abutments have splayed

wing walls, and are built of fine flat bedded lime stone. The masonry of the south abutment is reported to be built on rock at a depth of 17 feet below ground. The body of the north abutment is founded on 3 cast iron cylinders 12' in diameter lined with masonry and filled with portland cement concrete. There are two similar 12' cylinders under each of the wing walls. These cylinders are taken down to a maximum depth of 66 ft and are cut off 6 ft below the river bed and arched over to carry the masonry superstructure

structure. The 18 piers are each formed of a pair of cast iron cylinders 12 ft in diameter, placed 18 ft apart from center to center transversely. They extend from the bottom rock to about 10 ft below the river bed, where their diameter is reduced to 9 ft by a conical taper piece 7' 6" high. From the top of this the cylinders are 9 ft in diameter for the full height, being finished by an adjustable sliding cap, and connected by massive prought iron bracing boxes firmly bolted and

The quality of the work in this bridge is much superior to that of any I have seen in this Presidency, and as regards "cost" and "time occupied in completion" (taking into consideration the delay due solely to the difficulty in forcing Nos 11 piers through the boulder formation), it beats any record, at least in Southern India. The work from commencement to finish was in sole charge of Mr E. W. Stoney, M. Inst. C.E., who has not only added to his already high reputation as an able

Engineer

ad
Engineer, but with his
wer
usual indefatigable
of
industry has placed on
di
record for the service of
be
his profession a most
ef
valuable collection of facts,
th
illustrating the cost of
c
each operation in detail,
p
and the frictional re-
sistances to be overcome
in cylinder sinking, which
will supply a want
long-felt in this country,
and cannot fail to be
of inestimable value to
those who may hereafter
have to design or build
bridges of similar cha-
racter.

I bring Mr. Stoney's
services to the special

40

notice of Government know-
ing that the Chief Engineer
entertains the same opinion
of that officer's high quali-
fications as that above
expressed.

The bridge was tested
as laid down in enclosure
to P. W. D. circular No 19R,
dated 30th August 1883, the
results, which were highly
satisfactory, are embodied
in the usual statement
and are attached to this report.

The testing load consisted
of 2 K B_2 Engines each
weighing 16 tons 11 cwts
0 qrs and 2 loaded rail
wagons each weighing 22
tons 5 cwts 3 qrs. The

testing

testing load applied together with the dead load of the bridge did not produce a strain in any part of the material beyond the stresses specified by the Government of India.

Under the authority given in circular N° 4, dated 25th October 1887, embodied in G.O. N° 852R, dated 17th November 1887, I authorised the opening of the new Chitravati Bridge without restriction as to speed on 6th March 1890.

C.F. Smith Col. R.E.,
Consg. Engr. for Rys.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Railway.

Read the following paper:—

From the Consulting Engineer for Railways, dated Madras, 22nd March 1890, No. 210.

Report on the Inspection of the new Chitrávati Bridge, North-West Line, Madras Railway.

The inspection was made on 6th March 1890, in company with the Agent and Manager, the Chief Engineer, Mr. Stoney, the Engineer in charge of the work, and other Engineers of the railway.

2. The bridge consists of 19 spans of 131-feet clear waterway. The girders are of the Whipple-Murphy type, with a double system of lattice bars, by which the adjacent panels are connected. The total length of the girders is 139 feet 8 inches, the distance between the bearings being 136 feet, the effective depth 16 feet, and the width from centre to centre of booms 18 feet. The rails are carried on longitudinal timbers fixed in trough rail bearers, which are supported on cross girders at 8 feet central interval. In consequence of the camber being taken up by the longitudinal baulks the over-head clearance varies about 3 inches, the minimum headway being 14 feet 6 inches. The abutments have splayed wing walls, and are built of fine flat bedded limestone. The masonry of the south abutment is reported to be built on rock at a depth of 17 feet below ground. The body of the north abutment is founded on three cast-iron cylinders 12 feet in diameter lined with masonry and filled with Portland cement concrete. There are two similar 12-feet cylinders under each of the wing walls. These cylinders are taken down to a maximum depth of 66 feet and are cut off 6 feet below the river-bed and arched over to carry the masonry superstructure. The eighteen piers are each formed of a pair of cast-iron cylinders 12 feet in diameter placed 18 feet apart from centre to centre transversely. These extend from the bottom rock to about 10 feet below the river-bed, where their diameter is reduced to 9 feet by a conical taper piece 7 feet 6 inches high. From the top of this the cylinders are 9 feet in diameter for the full height, being finished by an adjustable sliding cap, and connected by massive wrought-iron bracing boxes firmly bolted and filled with concrete. The quality of the work in this bridge is much superior to that of any I have seen in this Presidency, and as regards "cost" and "time occupied in completion," (taking into consideration the delay due solely to the difficulty in forcing No. 11 pier through the boulder formation), it beats any record, at least in Southern India. The work from commencement to finish was in sole charge of Mr. E. W. Stoney, M. Inst. C.E., who has not only added to his already high reputation as an able Engineer, but with his usual indefatigable industry has placed on record, for the service of his profession, a most valuable collection of facts, illustrating the cost of each operation in detail, and the frictional resistances to be overcome in cylinder sinking, which will supply a want long felt in this country, and cannot fail to be of inestimable value to those who may hereafter have to design or build bridges of similar character.

3. I bring Mr. Stoney's services to the special notice of Government, knowing that the Chief Engineer entertains the same opinion of that officer's high qualifications as that above expressed.

4. The bridge was tested as laid down in enclosure to Public Works Department Circular No. 19 R., dated 30th August 1883; the results, which were highly satisfactory, are embodied in the usual statement and are attached to this report. The testing load consisted of 2 K. B_2 engines each weighing 66 tons 11 cwts. and two loaded rail wagons each weighing 22 tons 5 cwts. 3 qrs. The testing load applied, together with the dead load of the bridge did not produce a strain in any part of the material beyond the stresses specified by the Government of India.

5. Under the authority given in Circular No. 4, dated 25th October 1887, I authorised the opening embodied in G.O., No. 852 R., dated 17th November 1887, I authorised the opening of the new Chitrávati bridge without restrictions as to speed on 6th March 1890.

(Signed) C. J. SMITH, Colonel, R.E.,
Consulting Engineer for Railways.

ENCLOSURES.

NEW CHITRAVATI BRIDGE.

REVISED STATEMENT showing result of tests of bridges on Madras Railway, inspected on 6th March 1890.

Name or number of bridge.	Mileage. Miles.	Mileage. Telegraph posts.	Particulars of Waterway. Number of spans.	Particulars of Waterway. Length of span in feet.	Description of girder.	Particulars showing position in which test was applied. Number of span counting from	Right or left girder.	Top or bottom boom.	Point at which deflection and oscillation were taken.	First test. Deflection. In inches.	First test. Deflection. In terms of span.	Second test. Deflection. In inches.	Second test. Deflection. In terms of span.	Third test. Deflection. In inches.	Third test. Deflection. In terms of span.	Oscillation in inches.	Permanent set.	Remarks.
New Chitrávati bridge.	South abutment 211 miles 70·40 chains.				Whipple-Murphy with double system of lattice bars 139 feet 8 inches long, 18 feet wide centre to centre of booms, effective depth 16 feet, weight 146 tons. Rails carried by trough rail bearers supported on cross girder 8 feet apart from centre to centre.	1	Right girder.	Bottom.	Centre of each span.	·44	1/3,709	·43	1/3,795	·44	1/3,709	·12	·05	The following loads were used in testing the new Chitrávati bridge:—
	North do. 212 ,, 30·70 ,,					2		Do.		·43	1/3,795	·38	1/4,294	·49	1/3,330	·15	·04	
						3		Do.		·44	1/3,709	·42	1/3,885	·48	1/3,400	·19	·05	
						4		Do.		·45	1/3,626	·42	1/3,885	·47	1/3,472	·19	·04	
						5		Do.		·45	1/3,626	·44	1/3,709	·56	1/2,914	·24	·03	
						6		Do.		·45	1/3,626	·44	1/3,980	·47	1/3,472	·21	·03	
						7		Do.		·45	1/3,626	·41	1/3,795	·51	1/3,200	·16	·03	
						8		Do.		·44	1/3,709	·43	1/3,885	·52	1/3,138	·17	·03	
						9		Do.		·45	1/3,626	·42	1/3,547	·49	1/3,330	·15	·03	
						10		Do.		·46	1/3,547	·46	1/3,709	·45	1/3,626	·16	·02	
						11		Do.		·43	1/3,795	·44	1/3,885	·58	1/2,813	·20	·02	
						12		Do.		·45	1/3,626	·42	1/3,885	·52	1/3,138	·18	·04	
						13		Do.		·43	1/3,795	·42	1/3,795	·50	1/3,264	·24	·02	
						14		Do.		·45	1/3,626	·43	1/3,986	·56	1/2,914	·24	·03	
						15		Do.		·42	1/3,885	·41	1/3,795	·49	1/3,330	·14	·04	
						16		Do.		·45	1/3,626	·43	1/3,709	·45	1/3,626	·18	·05	
						17		Do.		·45	1/3,626	·44	1/3,885	·45	1/3,626	·15	·03	
						18		Do.		·44	1/3,709	·42	1/3,709	·49	1/3,330	·16	·04	
						18		Do.		·46	1/3,547	·44	1/3,400	·48	1/3,400	·19	·02	
						19		Bottom.		·47	1/3,472	·48	1/3,709	·47	1/3,472	·24	·03	
						19		Top.		·43	1/3,795	·44	1/3,709	·47	1/3,472	·24	·03	
								Bottom.		·45	1/3,626	·44						
								Top.										
									Total ..	9·34	..	9·02	..	10·34	..	3·90	·72	
									Average.	·44	1/3,709	·43	1/3,795	·49	1/3,330	·19	·03	
									Maximum.	·47	1/3,472	·48	1/3,400	·56	1/2,914	·24	·05	
									Minimum.	·42	1/3,885	·38	1/4,294	·44	1/3,709	·12	·02	
			19	Clear waterway of each, span 131 feet. 19 × 131 = 2,489 Linear feet. Total do. do.														

Live Load.

	Tons.	Cwts.	Qrs.
2 K B_2 engines with tenders fully loaded, each 66 tons 11 cwts.	133	2	0
2 R. O. G. wagons loaded with 66 20-feet rails, each 22 tons 5 cwts. 3½ qrs.	44	11	3
Total live load	177	13	3

equal to 1 ton 6 cwts. 1 qr. per foot run.

Dead Load.

	Tons.	Cwts.	Qrs.
Girders ..	146	12	0
Rails and timber. ..	12	16	2
Total dead load	159	8	2

equal to 1 ton 3 cwts. 2 qrs. per foot run.

	Tons.	Cwt.	Qrs.
Total Load ..	337	1	5

equal to 2 tons 9 cwts 3 qrs. per foot run.

NOTE.—The span used in all the calculations is that from centre to centre of bearings, viz., 136 feet.

(Signed) H. R. P. CARTER,
Chief Engineer, Madras Railway.

(Signed) C. J. SMITH, Colonel, R.E.,
Consulting Engineer for Railways.

18th March 1890.

Submitted to Government for transmission to the Government of India.

2. The following useful information compiled by Mr. Stoney is appended, as being of great interest and likely to prove of value in the design and constructions of future works of this description:—

Useful Notes and Memoranda of work done at Chitrávati Bridge.

1st Cylinder cutting edge fixed	23rd April 1888.
Dredging began	1st May 1888.
Do. finished	6th June 1889.
Time occupied by dredging	Thirteen months.

	Ft.	In.
Total lineal feet of wells sunk by dredging	332	6
Do. do. by divers	35	1
Do. excavated by men	78	5
	446	0
Total lineal feet of cylinders sunk by dredging ...	1,323	0
Do. do. by pulsometer ...	111	6
Do. do. by pneumatic ...	46	2
Do. do. by divers	168	1
Do. excavated by men sinking cutting edge	123	4
	1,772	1

Date diving began	2nd June 1888
Do. finished	24th November 1889.
Total time of diving both for sinking and bedding ...	Seventeen months.
Total shifts made for sinking and bedding cylinders...	5,895
Do. for wells	1,102
	6,997
Total shifts made for sinking cylinders	4,274
Do. for sinking wells	1,068
	5,342
Total shifts made for bedding cylinders	1,621
Do. for bedding wells	34
	1,655

11 Right dredged to boulders	5th March 1889.
Do do. bedded	20th November 1889.
For sinking through boulders, total time	Eight months and fifteen days.
11 Left dredged to boulders	28th December 1888.
Do. do bedded	13th December 1889.
For sinking through boulders, total time	Eleven-and-a-half months.
Pneumatic work commenced in river	5th January 1889.
Do. do. ended	20th November 1889.
Sinking through boulders piers 11, 12 and 13, total time	Ten-and-a-half months.
Date girder erection began	3rd December 1888.
Last girder rivetting finished	12th February 1890.
Total time	Fourteen months.
Laying began from south side 1st to 9th span ...	1st October 1889.
Do. do. finished do. or 9 spans...	11th January 1890.
Total time	Three months.
Date laying began from north side 10 to 19 spans ...	8th February 1890.
Do. do. finished or 10 spans ...	2nd March 1890.
Total time	Twenty-three days.
Greatest load of rails used in a cylinder	1,120 = 249 tons.
Do. do. on wells	1,300 = 289 ,,

	Ft.	In.
Greatest height water lifted by pulsometer	64	0
Greatest number of feet cylinder sunk in a day by Priestman's dredger	12	6

Useful Notes and Memoranda of work done at Chitrávati Bridge—*cont.*

	Ft.	In.
Average dredged by Priestman's in a day	5	3
Greatest number of lineal feet of cylinders sunk in one day	16	6
Maximum load on any well or cylinder	1,300 rails = 289 tons.	
Average total sinkage per day	May 1888, 10 feet 6 inches; June 1888, 8 feet; August, 9 feet 6 inches.	

	Feet.	Their own weight in tons.	Friction per square foot in cwts.
Average depth cylinders were sunk without loads ...	19¼	31	·85
Maximum do. do. ...	27	25⅓	1·33
Minimum do. do. ...	10	33	·63

	Rails.	Tons.
Average load used to sink cylinders in addition to their own weight	595	132·22
Maximum do. do. ...	1,120	248·88
Minimum do. do. ...	140	31·11

	Cwts.
Average friction per square foot of surface below river-bed of cylinders	2·13
Maximum do. do. ...	4·08
Minimum do. do. ...	1·29
Average friction as found from sinking pneumatic cylinders 11 R., 11 L. and 13 L.	2·66
Maximum do. do. ...	3·52
Minimum do. do. ...	2·32

Total depth of 12-feet cylinders in wells sunk through boulders	255 feet.
Number of cubic feet of boulders taken out	48,613 = 1,800 cubic yards.
Size of largest	5 feet long 10⅔ feet girth = 35½ cubic feet.

	Rs.
Total cost of plant at starting	1,32,000

	Tons.	Cwts.
Weight of each girder	146	12

	Rs.
Total expenditure on new Chitrávati bridge inclusive of Engineer's pay up to 1st February 1890 ...	14,69,540

	Amount. Rs.	Percent on outlay.
Cost of supervision up to 1st February 1890—		
Salaries, &c., of Engineer	20,300	1·38
Salaries, &c., of Inspectors, Time-keepers, Store-keepers and Engineer's office establishments ...	19,500	1·33
Total cost of supervision ...	39,800	2·71

Statement showing total quantities of work done in the new Chitrávati bridge from 23rd April 1888 to 5th March 1890.

Description.	Unit.	Quantity.	Total.
C. I. work in cylinders, &c.	Tons.	2,895	6,211
W. I. work in girders and bracing boxes	,,	3,316	
Cylinder sinking below river-bed	L. feet.	1,772	
Lineal feet erected above river-bed	,,	541	
Do. of wells below river-bed	,,	446	
Cylinders bedded	...	36	
Brick and cylinder wells bedded	...	7	

Statement showing total quantities of work done in the new Chitrávati bridge from 23rd April 1888 to 5th March 1890—*cont.*

Description.	Unit.	Quantity.	Total.
Concrete in cylinders ...	C. yards.	5,359	
Do. in north abutment ...	...	582	
Do. in south abutment ...	...	40	
Do. in bracing boxes ...	...	198	6,179
Masonry in cylinders ...	...	2,391	
Do. in three wells north abutment ...	...	442	
Do. in abutments ...	...	972	
Brick work, four wells, north abutment ...	...	692	4,497
Holes drilled for bracing boxes ...	264	4,752	
Do. for C. caps ...	18	648	5,400
Number of rivets in girders ...	11,336	215,384	
Do. do. in bracing boxes ...	372	6,696	222,080
Timber work of rail runners fixed in place ...	C. feet.	2,302	
Joists ...	"	2,586	
Teak-wood planking ...	Sq. feet.	23,940	
Holes drilled in steel rails for bridge ...	...	5,320	
Do. do. in rail runners ...	...	5,320	10,640
Girder bearings fixed in place ...	...	76	
	NO.	TONS.	RAILS.
Rails loaded on cylinders ...	39,383	8,752	117,151
Do. unloaded from cylinders ...	39,383	8,752	TONS.
Do. transferred ...	38,385	8,530	26,034
Total materials loaded and unloaded at bridge works ...	...	21,065	
Total shifts for sinking cylinders and wells ...	...	5,342	
Do. bedding do. ...	...	1,655	6,997 Hours. = 27,988

QUANTITY of work done in the new Chitrávati bridge approaches, &c., from March 1877.

Description.	Unit.	Quantity.	Total.
New bridge approaches ...	Length.	1 mile 30 chains.	
Earthworks on banks and cuttings ...	C. yards.	43,474	
Rock cutting ...	...	1,540	
Shale cutting ...	...	18,059	63,073
Ballasting ...	...	4,965	
Excavation for minor bridges ...	...	1,739	
Fencing ...	...	1 mile and 17 chains.	
Laying permanent-way ...	...	1 mile and 30 chains.	
Temporary sidings—			
Earthwork ...	C. yards.	7,320	
Ballast ...	"	1,602	
Laying ...	...	2 miles 78 chains.	
Bungalows and stores—			
Masonry ...	C. yards.	2,560	
Thatching ...	Sq. yds.	953	
Tiling ...	"	162	
Total area of bungalows and stores ...	Sq. feet.	33,479	

STATEMENT of progress of sinkage at Chitrávati bridge.

Month.	Sinkage of cylinders during month.	Sinkage of cylinders up to date.	Sinkage of wells during month.	Sinkage of wells up to date.	Total sinkage of wells and cylinders during each month.	Cylinders bedded during month.		Cylinders bedded up to date.	Wells bedded each month. Number of wells.	Wells bedded each month. Well numbers.	Wells bedded up to date.	Remarks.
	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	NO.						
1888.												
April ..	44 6	44 6	..	..	44 6	..	......	..	..	..	..	Cylinder sinking was commenced on 23rd April 1888.
May ..	296 3	340 9	..	..	296 3	..	......	..	..	..	..	
June ..	202 2	542 11	..	..	202 2	..	......	..	..	..	..	
July ..	135 3	678 2	..	..	135 3	..	......	..	..	..	..	
August ..	244 10	923 0	..	..	244 10	1	7 left ..	1	..	..	..	
September ..	181 11	1,104 11	..	..	181 11	2	7 right and 8 left	3	..	..	..	
October ..	215 3½	1,320 2½	..	..	215 3½	5	1 left, 2 right, 1 right, 1 left and 4 right.	8	..	..	..	
November ..	87 0	1,407 2½	18 0	18 0	105 0	4	4 left, 5 left, 8 right and 5 right ..	12	..	..	..	
December ..	57 1	1,464 3½	18 4	36 4	75 5	2	3 left and 3 right ..	14	..	..	..	
1889.												
January ..	47 2	1,511 5½	29 8	66 0	76 10	2	6 right and 6 left ..	16	..	..	..	
February ..	32 10	1,544 3½	42 0	108 0	74 10	..	......	..	..	..	..	
March ..	47 1	1,591 4½	35 0	143 0	82 1	3	9 right, 12 right and 10 right ..	19	..	..	..	
April ..	50 2	1,641 6½	101 9	244 9	151 11	2	14 right and 9 left ..	21	..	..	..	
May ..	43 5	1,684 11½	70 3	315 0	113 8	7	18 left, 10 left, 12 left, 18 right, 14 left, 16 right and 15 left.	28	..	..	..	
June ..	22 3	1,707 2½	17 11	332 11	40 2	2	15 right and 16 left ..	30	2	4 and 5	2	
July ..	21 11	1,729 1½	35 3	368 2	57 2	1	13 right ..	31	1	3	3	
August ..	22 9	1,751 10½	39 4	407 6	62 1	2	13 left and 17 left ..	33	2	6 and 7	5	
September ..	2 7	1,754 5½	31 9	439 3	34 4	1	17 right ..	34	1	2	6	
October ..	1 0	1,755 5½	1 11	441 2	2 11	..	......	34	1	1	7	
November ..	6 11	1,762 4½	4 8	445 10	11 7	1	11 right ..	35	..	..	..	
December ..	9 9	1,772 1½	..	445 10	9 9	1	11 left ..	36	..	..	..	
Total ..	1,772 1½	..	445 10	..	2,217 11½	..	......	..	..	..	..	

ORDER—dated 2nd April 1890, No. 466 R., Public Works.

His Excellency the Governor in Council records with great pleasure his high appreciation of the professional skill and energy exhibited by Mr. E. W. Stoney, M. Inst. C.E., in the construction of the new Chitrávati bridge brought to the notice of Government by the inspecting officer in the foregoing report.

2. A copy of these Proceedings will be forwarded for the information of the Government of India.

(Here enter No. $\frac{466}{A}$ R., dated 2nd April 1890.)

(True Extract.)

(Signed) SIDNEY SMITH, Major, R.E.,
Under-Secy. to Govt., P.W.D.,
Railway Branch.

To the Consulting Engineer for Railways.
" Examiner, Guaranteed Railway Accounts.
To Mr. E. W. Stoney.

ENDORSEMENT—dated 2nd April 1890, No. $\frac{466}{A}$ R., Public Works.

Forwarded.

(True Extract.)

(Signed) SIDNEY SMITH, Major, R.E.,
Under-Secy. to Govt., P.W.D.,
Railway Branch.

Exd. A. Aubert.
Spare Copies

RAILWAY.

Govt. of {1890} Madras.

PUBLIC WORKS.

Dated April, 2nd.

Recd. *Encl*

G.O., 2nd Apr. 1890, No. $\frac{466}{A}$ R.

APRIL.

Chitravati Bridge, Madras Railway

Forwarding copy of Proceedings on report of the Consulting Engineer for Railways on the new —.

II.—Inspection and sanction to opening under the Act are compulsory in the cases of—

(*a*) Bridges or viaducts which are added to the line or have been built to replace others which have been damaged, destroyed, or taken down, if the span exceeds 40 feet.

(*b*) Similar bridges of any span if a type of girder or structure is used which has not already been tested on the line.

(*c*) Additional spans to existing bridges when they exceed 40 feet clear span, or when they are of a type not previously tested on the line.

(*d*) Any new permanent line outside station limits, such as a second line added to an existing single one.

III. In the case of all important new works, additions, or alterations, or any alterations whatever which infringe standard dimensions, the Agent or Manager shall be bound to give the Inspecting Officer notice, in due time, of the probable date of completion of the work, so that if desired an inspection prior to opening may be made, and no such works are to be opened until the permission of the Inspecting Officer has been received.

IV. The same rule will apply to temporary diversions and new sidings over which passenger trains are to be run.

Nos. 786, 787 and 788 R.-C., dated 12th April 1884.
No. 37 R.-C., dated 10th January 1885.
No. 285 R.-C., dated 18th March 1887.

3. In supersession of the orders contained in the letters noted in the margin, and now read again, the Governor-General in Council is pleased, under the authority conveyed in section 5 B (2) of Act IV of 1879 as amended by Act IV of 1883, to confer upon all Inspecting Officers appointed under the Act power to sanction the opening to passenger traffic of—

(*a*) Any temporary diversion, including bridges and approaches ;

(*b*) New bridges on a line already opened ;

(*c*) Extensions of existing bridges on open line ;

(*d*) New sidings added for passenger traffic ;

and the re-opening for traffic of—

(*e*) Portions of main line which have been closed for repairs, including bridges and other works,

if on inspection in each case it is found that the opening of the same would not be attended with danger to the public, and subject to the matter being reported in full detail to the Governor-General in Council in due course for the purpose of record.

4. Similar power is vested in Inspecting Officers in the case of minor works for which special inspection is not considered necessary, if they are otherwise satisfied that the opening of such work will not be attended with danger to the public.

The Governments of Madras, Bombay, Bengal and the North-Western Provinces and Oudh.
The Chief Commissioners of the Central Provinces, Assam and Burma.
The Resident at Hyderabad.
The Agents to the Governor-General for Rajputana and Central India.
The Consulting Engineers to the Government of India for Railways.
The Director-General of Railways.

ORDER.—Ordered, that this Resolution be communicated to the Governments, Administrations and officers named in the margin for information and guidance.

Also to the Government of the Punjab, the Agent to the Governor General for Baluchistan and the Accountant General, Public Works Department, for information.

PUBLIC WORKS SECRETARIAT OOTACAMUND

R. C. B. PEMBERTON, Colonel R.E.,
Secretary.

B

G. C. Press, Simla.—No. 708 P. W. D.—31-10-87.—1,300.

No. 1032 Rd 17th November/87
Commd: to the Con: Engr: for Ryo: for information & guidance with reference to Progs No 1045 R d/28th Septr/83

[*General Distribution.*]

Circular No. 4 Railway.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

RAILWAY CONSTRUCTION.

INSPECTION OF NEW WORKS, AND RENEWALS ON RAILWAYS PREVIOUSLY OPEN FOR TRAFFIC.

Powers of Inspecting Officers.

Simla, October 25, 1887.

Read again—

Act IV of 1883.
Public Works Department Circular No. 19 Railway, dated 30th August 1883.
Letter to Consulting Engineer for Railways, Madras, No. 273½ R.-C., dated 12th April 1884.
Letter to Secretary to Government of Bombay, Public Works Department, No. 786 R.-C., dated 8th September 1884, and endorsement thereon, Nos. 787 R.-C. and 788 R.-C. of date.
Letter from Consulting Engineer, Lucknow, No. 056, dated 22nd September 1884.
Letter to Consulting Engineer, Lucknow, No. 37 R.-C., dated 10th January 1885.
Letter to Secretary to Government of Bombay, Public Works Department, No. 306 R.-C., dated 20th April 1886.
Letter to Secretary to Government of Bombay, Public Works Department, No. 284 R.-C., dated 18th March 1887.

Read also—

Letter from Director General of Railways, No. 530 C., dated 17th June 1887.
Letter from Consulting Engineer, Calcutta, No. 1646, dated 30th June 1887.

OBSERVATIONS.—In the two letters read above, questions are raised as to whether inspections are required under Act IV of 1883 in the case of new bridges built in place of others which have failed, and in other cases which, it is contended, do not fall within section 5 of the Act IV of 1879, as amended by Act IV of 1883, which refers to "A Railway, or portion or extension of, or addition to, a Railway;" or section 5 C., which refers only to a portion of open line which has been "so altered by the Railway Administration as to cause damage to, or affect the safety of, passengers carried thereon;" or section 5 F. which refers only to "a Railway or portion of a Railway" which "has been closed under section 5 E."

2. The Railway Act is now under revision, and care will be taken that any ambiguity which may be thought to exist with regard to the points named above shall be removed in the new bill, but the Governor-General in Council is pleased to lay down the following rules for the present guidance of Inspecting Officers and Managers or Agents of State or Guaranteed Railways, with regard to inspections of works of reconstruction or repairs or additions on open lines:—

I.—An Inspecting Officer under the Act has power to prohibit the opening to traffic of any portion of line which has been renewed or altered in any way whatever, until it shall have been inspected by him and its opening duly sanctioned under the Act.

CCh 8126/83

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

RAILWAY CONSTRUCTION.

To

Circular No. 19 Railway.

Dated August 30, 1883.

Received

G. S. C. Hy 3/3

P.W. 483/69

466
466 R
A

B No 1045 R 28/9/83

2 copies with compl. enclos. given to R.O.(?) 26/1/87

3 ~~copies for As. of 28/2/87~~

3 copies for As. of 1/3/87

Communicated to the Cons: Engr for Rys (Sd) C. J.

Rules for the Inspection of Railways prior to opening for passenger traffic.

G. I. C. P. O.—No. 329 P. W. D.—11-12-86—100.

[*General Distribution.*]

Circular No. 19 Railway.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

RAILWAY CONSTRUCTION.

Simla, August 30, 1883.

Rules for the Inspection of Railways prior to opening for passenger traffic.

Read again—

Public Works Department Circular No. 23 Railway, dated 11th November 1875.
" " " " " 1 Railway, dated 15th January 1878.
" " " " " 16 Railway, dated 19th June 1878.
" " " " " XVII Railway, dated 16th February 1881.
" " " letter " 325 R.C., dated 29th April 1881, to the Consulting Engineer for Guaranteed Railways, Calcutta.

Read also—

Letter No. 243G., dated 31st January 1883, from the Consulting Engineer for Guaranteed Railways, Lahore.

OBSERVATIONS.—Under Section 5 of Act IV of 1883, no railway, nor portion or extension of, nor addition to, a railway, can be opened for the public conveyance of passengers until the Railway Administration has given to the Governor General in Council notice in writing of the intention of opening the same, nor until the Governor General in Council has, by order, sanctioned the opening of the same.

And, under Section 5B, a necessary preliminary to this sanction is the report, to the Governor General in Council, by an Inspecting Officer duly appointed under the Act, that the opening of the line would not, in the opinion of the Inspecting Officer, be attended with danger to the public using it.

RESOLUTION.—With a view to carrying out the above provisions, the Governor General in Council is pleased to direct that notice of intention to open for passenger traffic a section of railway shall be communicated to the Government of India, through the usual channel, at least one month previous to the date approximately fixed for such opening.

2. After this notice has been given, the Railway Administration may call upon the officer appointed for the purpose to carry out the inspection of the line, supplying him with all necessary information regarding the section to be inspected, as provided in the annexed Rules. The Inspecting Officer will then make arrangements for the inspection in communication with the Agent, Manager or Engineer-in-Chief, who is in direct charge of the line.

3. The inspection should be carried out in accordance with the rules herewith circulated for the guidance of all concerned, and the Inspecting Officer should submit his report for the orders of the Governor General in Council as

soon as possible after the completion of the inspection. The details of construction and other information, prescribed in Section III of the Rules, which are required for purposes of record by the Government of India, should accompany his report.

4. The Inspecting Officers appointed under the Act, and their circles of inspection, as at present constituted, are detailed in Public Works Department Circular No. X Railway, dated 4th May 1883.

5. The Agent, Manager or Engineer-in-Chief will be held responsible for seeing that the Inspecting Officer is not called upon to undertake the inspection before the section of the line to be inspected is complete in all essential particulars. As a rule certificates by the Engineer-in-Chief to the effect that the works considered necessary for the safe working of the line will be completed, or be in working order, on some future date, will not be accepted, and the opening of the line will not be authorised unless such works are completed to the satisfaction of the Inspecting Officer at the time of his inspection.

ORDER.—Ordered, that this Resolution, and the Rules referred to, be communicated to the Governments, Administrations, and Officers named in the margin for information and guidance, in supersession of all previous orders on the subject.

The Governments of Madras, Bombay, Bengal, the North-Western Provinces and Oudh, and the Punjab.
The Chief Commissioners of the Central Provinces, Assam, and British Burma.
The Residents, Hyderabad and Mysore.
The Agents to the Governor General for Rajputana, Central India, and Biluchistan.
The Consulting Engineers to the Government of India for Guaranteed Railways.
The Director General of Railways.

Also to the Accountant General, Public Works Department, for information.

By order,

R. A. SARGEAUNT, Major, R.E.,

Offg. Under Secretary

Documents accompanying.

Rules for Inspection of Railways prior to opening for passenger traffic, and Appendices A and B.

Enclosure to Public Works Department Circular No. 19 Railway, dated 30th August 1883.

Rules for the Inspection of Railways by an independent officer prior to the opening of any Section or Sections for passenger traffic.

I.—Duties of Inspecting Officer.
II.—Rules for Manager.
III.—Information to be furnished.
IV.—Certificates by Manager.
V.—Points for observation.
VI.—Tests.
VII.—Forms.

Throughout these rules the term "Manager" means the responsible officer in charge of the Railway at the time of the inspection, whether Agent, General Manager, Engineer-in-Chief or other officer.

Section I.—Duties of the Inspecting Officer.

1. As these inspections are made for the particular object of assuring the Government of the condition of the line, it is desirable that the Inspecting Officer should confine his report to points directly affecting the safety and welfare of the travelling public and of the railway servants, and should not introduce into his report any irrelevant matter.

2. He should be as concise as possible in his recommendations, stating briefly, but clearly, the grounds on which they are made. It will be assumed that any points on which he has made no remark do not, in his opinion, affect the safety or welfare of the travelling public or railway servants.

3. He may recommend that the railway be opened either unconditionally, or subject to certain restrictions, or he may recommend a postponement of the opening.

4. The Inspecting Officer should investigate all questions affecting the safety of the public, but his attention is particularly directed to the following points:—

(1) To the general formation of the line, and the necessity for increasing widths, flattening slopes, or preventing slips.

(2) To the existence of sharp curves or gradients in dangerous positions.

(3) To the general character and condition of the rails and fastenings, sleepers and ballast.

(4) To the strength and quality of all structures above ground.

(5) To the waterways of the bridges and culverts, so far as to ascertain that they have been fully investigated by the proper officers.

(6) To the provision of parapets or hand-rails, where necessary, on bridges and viaducts.

(7) To the means of escape of railway servants in long viaducts or tunnels.

(8) To any infringement of the standard dimensions of fixed structures.

(9) To the protection of bridge platforms from fire.

(10) To the character and condition of the fencing.

(11) To the proper arrangements for level-crossings.

(12) To the provision of proper gradient posts and mile marks.

(13) To the character and condition of the points and crossings.

(14) To arrangements for preventing the escape of vehicles from sidings in stations, either by gravity on an incline, or by force of the wind.

(15) To the character, condition and position of the signals.

(16) To the width of the platforms, and their proper ramping at the ends.

(17) To the sufficiency of the accommodation for passengers at stations especially with regard to latrine arrangements.

(18) To the weight and dimensions of the rolling stock, and its limitation to the standards prescribed.

(19) To the provision of cow-catchers on an unfenced line.

(20) To the sufficiency of space and ventilation in the passenger carriages.

(21) To the provision of some proper and efficient arrangement for turning engines at the terminus of the section about to be opened.

(22) To the establishment of a proper and sufficient block system, or other approved mode of working the traffic.

5. The character of the tests of iron bridges is given in Section No. VI.

6. The Inspecting Officer should furnish to the Government of India a record of the deflection and oscillation of all girder bridges of large span, and of at least one of each type of small spans, under the test loads. Spans of about 40 feet and over are to be considered "large spans."

7. The Inspecting Officer should during his inspection intimate, as far as practicable, to the "Manager" the general tenor of the recommendations he intends to make, in order to afford that officer the opportunity of discussing with him the various points raised. He may furnish the officer in question with a copy of his report, or extracts therefrom, making it clear at the same time that the line cannot be opened without proper sanction in accordance with the terms of the Railway Acts.

8. The report of the Inspecting Officer, with his recommendation, and the information required under Section III, is to be sent to the Government of India, who will issue such instructions thereon as may appear to be desirable.

Section II.—"Rules for the Manager."

1. As soon as the "Manager" can fix approximately the date for opening the railway, he will give notice of the intention to open through the usual channel to the Government of India.

2. After this notice has been given he may call upon the Government Inspector, within whose circle the railway lies, to inspect the line, sending to him, at the same time, the details of construction prescribed in Section III of these rules.

In the case of State lines, with the permission of the Controlling Administration.

3. These particulars should reach the Inspecting Officer at least one month before the date proposed for opening, to enable him to make himself acquainted with the circumstances of the line before his visit of inspection.

4. The Inspecting Officer will then fix a date for the inspection, and arrange the character of the tests required and other necessary details in communication with the "Manager."

5. The "Manager" of the Railway, or such officer as he may delegate for the purpose, must accompany the Inspecting Officer in his inspections, afford him all information and assistance, and provide all instruments and arrangements necessary for applying such tests as he may require. The Manager should be accompanied during the inspection by the Engineer-in-Chief, or in his unavoidable absence, by an Engineer of the Railway, who can afford to the Inspecting Officer such technical information as he may require.

6. The Manager will give to the Inspecting Officer, in writing, certificates that he will comply with any restriction that may be imposed by the Inspecting Officer. Should the Manager demur to any restriction so imposed, he may refer the question to the Government of India, but pending final decision the restriction must be observed. The responsibility of any infringement of the certified conditions will rest on the Manager.

Section III.—Information to be furnished.

The following information and details of construction should be supplied by the Manager to the Inspecting Officer at least one month before the date proposed for opening, and should, subsequently, accompany the report of the inspection sent to the Government of India.

1. A small index plan and section of the line, on which must be drawn all curves gradients, cuttings, and embankments, the position of large bridges, level-crossings, stations, mileage, &c.

Note.—The scale of the plan and section should be about 1 inch = 1 mile horizontal, and 1 inch = 100 feet vertical, with enlargement of detail, wherever the scale is too small to afford the prescribed information.

2.	A table of curves		see Form	A,	Section VII.
3.	„	gradients	„	B,	„
4.	„	ballast	„	C,	„
5.	„	important waterways	„	D,	„
6.	„	abstract of „	„	E,	„
7.	„	large bridges	„	F,	„
8.	„	stations	„	G,	„
9.	„	station machinery	„	H,	„
10.	„	„ buildings, staff quarters, &c.	„	I,	„
11.	„	level-crossings	„	K,	„

12. Drawings of any class of permanent-way (including points and crossings) not in ordinary use in India.

13. Drawings of girders other than those of Government standard type with calculation of strains.

14. Sections of tunnels.

Note.—If the Government of India lithographed types have been adopted in any case, it will be sufficient to refer to the type, giving the dates of the lithographs.

Section IV.—Certificates and Engagements.

The following certificates and engagements, duly signed by the Manager, are to be handed to the Inspecting Officer before he commences his inspection. These certificates must subsequently be sent to the Government of India and placed on record:—

1. Certificate that no structure infringes the limits of the standard dimensions prescribed by the Government of India.

2. Certificate that no engine or other vehicle exceeds the maximum moving dimensions prescribed by the Government of India.

3. Engagement that no infringement of the standard dimensions, either in structures or moving bodies, will be made without the consent of the Government of India, in writing, to each case of infringement.

4. Certificate that not more than two engines shall ever be allowed at one and the same time on any one track of a bridge.

5. Engagement that no alteration shall be made in the rolling-stock or its loads which will involve live loads in excess of those which may from time to time be prescribed* by the Government of India for each gauge respectively.

---

* The live loads at present prescribed are given in type drawings—
Metre gauge I. B. No. A., dated 3rd June 1881. } Printed as Appendix B to these rules.
5′ 6″ I. B. No. A., dated 3rd June 1881. }

Section V.—Points for observation.

The attention of Inspecting Officers and Managers is particularly requested to the following points:—

1. The provisional list of standard dimensions to be followed as far as practicable: this list will be subject to alteration from time to time as found necessary.

2. Rails to be fished at the joints.

3. With flat-bottomed rails, the rails on both sides of the joints should be supported on bearing plates, double spiked outside.

4. Gate-keepers, provided with huts, should be posted at all gates capable of closing across the line. Gates closing across the line should be provided with signal boards and lamps which can be clearly seen by those on the approaching train.

5. Mile and quarter-mile marks should be provided, and gradient posts for all gradients exceeding 300 yards in length.

6. Stations and junctions should be properly protected by main and distant signals.

7. Arrangements should be made to avoid shunting over a junction. And when two lines meet, the junction should, in ordinary cases, be formed as a double line junction.

8. Level-crossings not commanding a clear view of the line on both sides should be protected by semaphore signals. Level-crossings in towns, or on populous thoroughfares, may require special protection by distant signal, electric bell or telegraph.

9. All signals worked by wire should be weighted so as to fly to 'Danger' on the fracture of the wire. (General Rule No. 25.)

10. Tunnels and long viaducts should be provided with facilities which will enable workmen to escape from an approaching train without difficulty.

11. The descents at the ends of platforms should be by ramps, not steps.

12. Facing points should be kept locked as far as practicable.

13. High level platforms, overbridges and other structures requiring this protection should be walled or railed in to prevent accidents to passengers.

14. Stations should not be on gradients steeper than 1 in 250. When they are unavoidably on steeper gradients, proper catch sidings should be provided to prevent runaway wagons from descending the gradient. Catch sidings may, under certain circumstances, be required at the foot of steep inclines.

15. Clocks at stations should be placed where they can be seen by the drivers and guards.

16. The block system, or some other system approved by the Government of India, will be adopted for the working of the traffic (see General Rules).

Section VI.—Tests.

System of testing iron bridges on Railways in India.

The Government of India do not approve of the system of testing iron bridges to an extent far in excess of the maximum loads they will have to carry in practice.

2. If tested too heavily, a faulty portion is likely to be strained and to cause failure afterwards, and the extreme test is no more a guarantee against failure than the lighter test.

3. The rolling loads assumed for the calculation of the strains in girders should give nearly an equivalent to a maximum of two engines of the heaviest class (if there is room for them on the span), with their full complement of water and fuel, with the remainder of the span covered with a train of wagons of the heaviest type, fully loaded. If this load, with an additional engine in the case of large span bridges, be adopted in testing bridges after erection, it will suffice.

4. In long spans the loaded wagons should be both before and behind the engines, so that the engines may stand as near as possible to the centre of the span. Officers who test wrought-iron bridges should ascertain, and report, whether this load, together with the dead load (including the rails, platform, ballasting, asphalte, girders or cross-girders, &c., &c.,) (but exclusive of the additional engine specified in the preceding paragraph in the case of large span bridges), produces a strain exceeding the specified stress in any part of the material, whether in the main girders, cross-girders, or rail-bearers.

5. The specified stress will be assumed at—

5 tons per square inch for iron in tension.

4 „ „ „ „ „ „ „ compression.

6½ „ „ „ „ for steel in compression and tension.

6. When material is exposed to a tensile strain, deduction must be made to allow for the diminution of area caused by rivet holes or otherwise. When subject to a compressive strain, deduction should be made to allow for diminution of area caused by imperfectly filled *rivet* holes, and by holes for pins or bolts whether filled or not.

7. The testing load should pass over the bridge three times, and the deflection and oscillation (when practicable) should be noted at each time of passing.

8. At the first passage, the testing train should proceed slowly, and should be *brought to a stand* with its heaviest portion as near as possible to the centre of the span. It should remain in this position for at least 10 minutes.

9. At the second passage, also, the train should proceed slowly, and be brought to a stand, but need not remain in that position longer than is necessary to observe the deflection. The object of this test is to ascertain the deflection after the girder has recovered from the first test.

10. At the third, the train should pass over the bridge at a speed of 20 miles an hour.

11. When practicable, graphic diagrams should be taken of the deflection and oscillation under the test loads in the manner described in Appendix A attached.

12. For structures of cast-iron the breaking load should be determined from the formula:—

$B=3L+6l$, where:

B=Total breaking load.

L=Total permanent load, structure, platform, &c.

l=Maximum moving load=for each track, 2 of the heaviest engines as near as possible to the centre of the span, and the rest of the span covered with goods wagons of the heaviest type fully loaded.

Section VII—Forms.

FORMS A AND B.

List of Curves and Gradients.

It is not necessary to give a "complete" list of Curves and Gradients, but simply an abstract under different classes. For the sake of uniformity, the classes given below should be adopted on all Railways.

No.	Form A. Radius of curves, &c.	Length, miles.	No.	Form B. Gradients.	Length, miles.
	300 feet.			1 in 30	
	Above 300 ,, to 400 feet inclusive .			Above 1 in 30 to 1 in 50 inclusive .	
	,, 400 ,, to 500 ,, ,, .			,, 1 in 50 to 1 in 80 ,, .	
	,, 500 ,, to 600 ,, ,, .			,, 1 in 80 to 1 in 100 ,, .	
	,, 600 ,, to 1,000 ,, ,, .			,, 1 in 100 to 1 in 150 ,, .	
	,, 1,000 ,,			,, 1 in 150 to 1 in 300 ,, .	
	Straight line			,, 1 in 300 to 1 in 1,000 ,, .	
				,, 1 in 1,000	
				Level	
	Total .			Total .	

All curves below the minimum of 300 feet radius, and all gradients below the minimum of 1 in 30, must be especially noted in addition to the above.

FORM C.

List of Ballast.

Position.	Length, miles.	Character of Ballast.
M M		
Between 1 and 28	28	Gravel.
,, 28 ,, 32	4	Broken-stone.
,, 32 ,, 45	13	Burnt clay and sand.
,, 45 ,, 81	36	Kunker.
,, 81 ,, 100	19	Burnt clay.
Total .	100	

FORM D.

List of Important Waterways.

Name of River.	Position, mile.	Drainage area, square miles.	Rise of flood water above low-water below.	Declivity of bed, feet per mile.	Maximum velocity in flood, feet per second.	Openings. No.	Openings. Clear span.	Openings. Flood area, feet.	Openings. Flood discharge, feet per second.	Openings. Value of K*	Character of foundations.	Remarks.

* Value of K in the formula Log. K=Log. D.—¾ Log. M.
Where D=Total discharge of the river in extreme flood in feet per second.
M=Drainage area in square miles.
K=Coefficient for Colonel Dickens's formula.

FORM E.

Abstract of Waterway.

Clear spans.	Total area of waterway.	Area per mile of railway.	Remarks.
In culverts and bridges not exceeding 10 feet clear span			
In ditto exceeding 10 feet, but not exceeding 20 ,, ,, ...			
In ditto ,, 20 ,, ,, 40 ,, ,, ...			
In ditto ,, 40 ,, ,, 60 ,, ,, ...			
In bridges exceeding 60 feet clear span			
Total .			

FORM F.

Abstract of large Bridges.

Name of River, &c.	Position, mile.	Openings. Number.	Openings. Clear span.	Height of underside of girders above. Flood level.	Height of underside of girders above. River bed, (Maximum).	Remarks.*

* In the case of a bridge being adapted for road traffic, it should be stated whether the accommodation provided is for foot traffic, or wheel traffic, or both, and whether such traffic is carried on the same or different level to the railway.

FORM G.

List of Stations.

Name.	Class.	Position, mile.	Distance apart. Station to Station.	Distance apart. Of Engine Stations.	On what gradient.	On what curve.	Remarks.
Average distance apart .							

FORM H.

List of Station Machinery, &c.

Name of Station.	Number.							
	Tanks.	Pumps.	Water cranes.	Hydrants.	Station signals.	Distant signals	Engine turn-tables.	Weigh-bridges.
Total number .								
Average number per 100 miles of Railway								

FORM I.

List of Station Buildings, Staff Quarters, &c.

Name of Station.	Number required.													
	Passenger Stations.	Refreshment rooms.	Waiting rooms.	Third class waiting sheds.	Latrines.	Goods sheds.	Engine sheds.	Carriage sheds.	Station masters' quarters.	Running room for guards.	Running room for drivers.	Staff quarters.	Porters' quarters.	Police quarters.
Total number .														
Average number per 100 miles of Railway . .														

FORM K.

List of Level Crossings.

	Description of Level crossing.	Number.	Average No. per 100 miles.	Remarks.
A	With gates closing across the Railway, and with huts . .			
B	With gates not closing across the Railway, but with huts .			
C	Level-crossings without huts			

Govt. of India Central Printing Office, No. 329 P. W. D.—12-12-86—100.

Enclosure to Public Works Department Circular No. 19 Railway, dated 30th August 1883.

APPENDIX A.

To the rules for the Inspection of Railways prior to opening.

Memorandum on a self-recording arrangement for testing girder bridges.

There are now a large number of important bridges in India already erected, and others in course of construction; these bridges are carefully tested in the manufacturer's yards in England, and again on erection in India, and if the results of these tests were recorded in a convenient form, they would be of great use in detecting faults in design in girders already built, and would also be of value for reference when designing new bridges.

The self-recording arrangement shown in the accompanying sketch might, it is believed, be used with advantage for this purpose, as it is exceedingly simple and inexpensive, is self-acting, is independent of errors of observation, and records, on a diagram drawn by the girder itself, all its movements, both lateral and vertical during test.

The arrangements will be understood at once from the sketch. The pencil is parallel to the centre line of the bridge, and the paper at right angles to the same. If therefore the girder under test move simply up and down in a vertical plane, a vertical line would be the result, showing by its length the actual amount of such movement. Lateral oscillation converts this line into a figure more or less complicated, which will be a closed figure or not according to whether or not the girder returns exactly to its former position.

On the sketch are given facsimiles of diagrams actually obtained from the 60 feet Warren girders on the Nizam's Line. It will be seen how much the figure varies under the same load according to the speed, and according to whether it is taken from the top or bottom boom.

The paper can generally be fixed to scaffolding, staging or other structure used in erecting the girders, but if such be not available, a trestle can generally be put up for the purpose at a trifling cost, care being taken to select for experiment the land spans where the girders are at the least height above the ground. Where a number of bridges have to be tested, the girders of which are at a moderate height, a portable trestle may be used and carried from one to the other in the testing train.

In the sketch the bar carrying the pencil is shown straight, but in some cases it will have to be cranked to enable it to be attached to special forms of girders.

In practice the following points require attention :—

(*a*).—The pencil should be sharp pointed, and the extreme sharpness rubbed off by a few strokes on a piece of paper. The point should be looked to before each test. The pencil should not be very hard, about H or F being the best. A pencil of lead or copper might be used on "metallic" paper; this would prevent risk of the pencil point breaking just at the moment of test, but would not give such a fine line in the diagram.

(*b*).—The paper should be hard with a fine smooth surface. Card is the best material for the purpose. It should be two or three times the size of the expected figure and fastened so as to be truly at right angles to the rails.

(*c*).—After the card is fixed a truly vertical line should be marked on it with a plumb line before commencing work.

(*d*).—The position of the pencil point on the figure at beginning and end of test should be carefully marked.

(*e*).—In every case two diagrams should be taken simultaneously, one from the top and the other from the bottom boom of the girder. If the two main longitudinal girders are not rigidly connected by distance pieces, a pair of diagrams should be taken from *each* girder at the same time.

(*f*).—Diagrams should always be taken from the centre of the span, but for spans of 150 feet or upwards, diagrams should also be taken at intermediate points.

(*g*).—Several diagrams should be taken for each test to get an average, as with anything except a very moderate speed, the motion of the bridge is a good deal modified by the motion of the engine and the position of its cranks when passing the point at which the diagram is being taken. If the oscillation of the engine be synchronous and in the same direction as the wave along the girder when passing the point of observation, the movement will be a maximum.

(*h*).—Immediately the card is taken down the following particulars should be noted on it :—

The top of the card.
The side nearest the bridge.
Nature and weight of load.
Speed.
Name of bridge and number of girder.
Top or bottom boom.
Position of pencil point at commencement and end of test.

(*i*).—Care should be taken that the trestle or scaffolding on which the card is supported is quite free from the bridge, and that there is no plank or anything from one to the other by which vibration might be communicated.

Government of India Central Printing Office—No. 329 P. W. D.—12-12-86—100.

Enclosure to P. W. Dept. Circular No. [illegible]

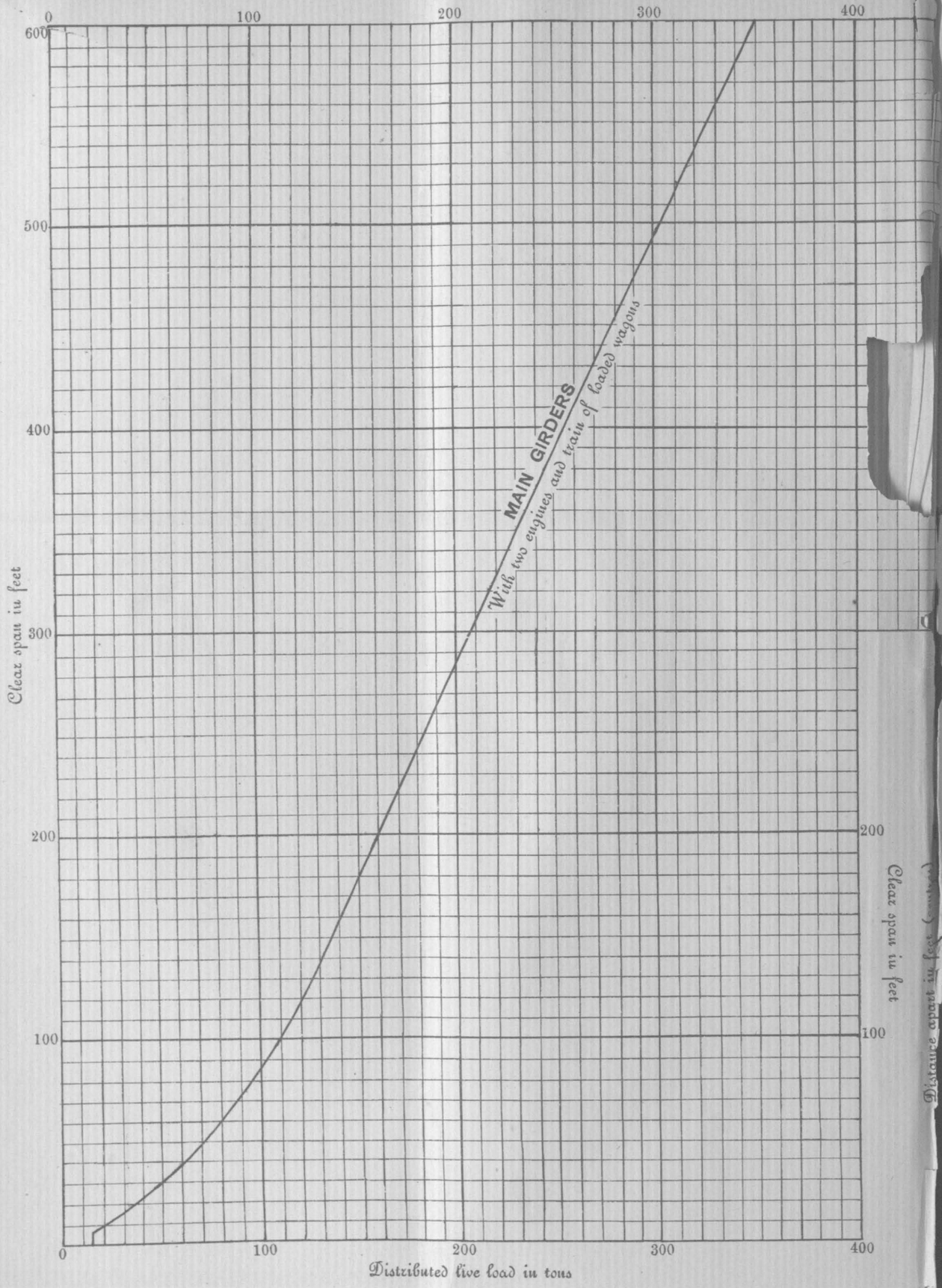
TYPE DRAWINGS
INDIAN STATE RAILWAYS

NEW SERIES.

LIVE LOADS O[illegible]

FOR SPANS WITH [illegible]

Distrib[illegible]

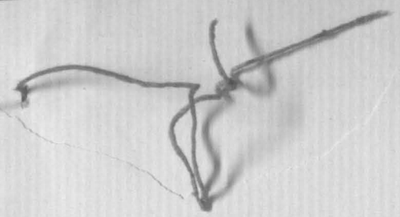


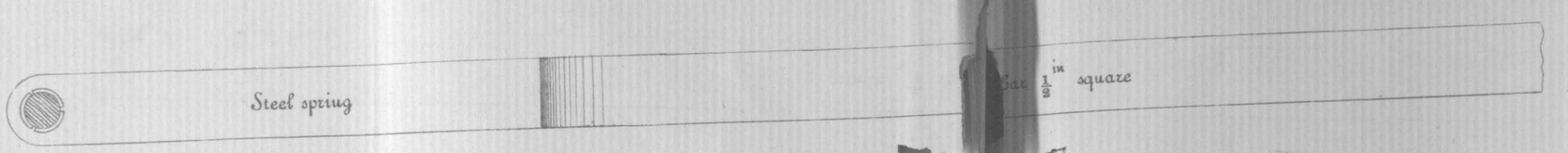
These diagrams shew distributed live load in tons to be allowed for on Main and Cr[illegible]os[illegible] grams do not shew actual wheel loads, but the distributed loads equivalent to the actual loads. shewn on the diagram as a live load of 14 tons distributed.

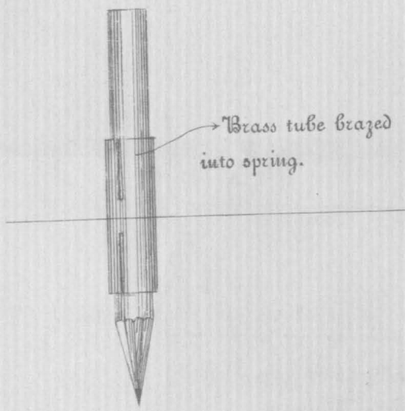
Enclosure to P. W. Department,
Cir. No. 19, Ry., Dated 30th August, 1883.

APPEN[illegible]A.

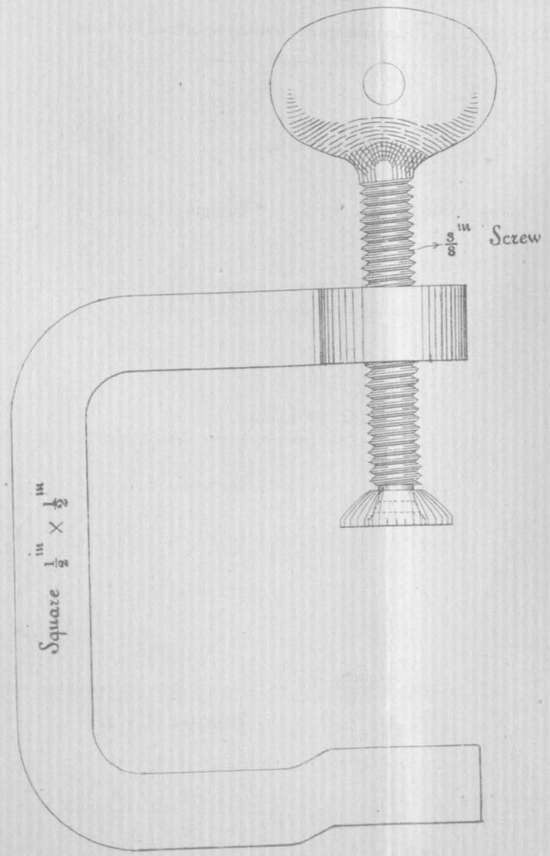
ARRANGEMENT FOR [illegible]STING BRIDGES.

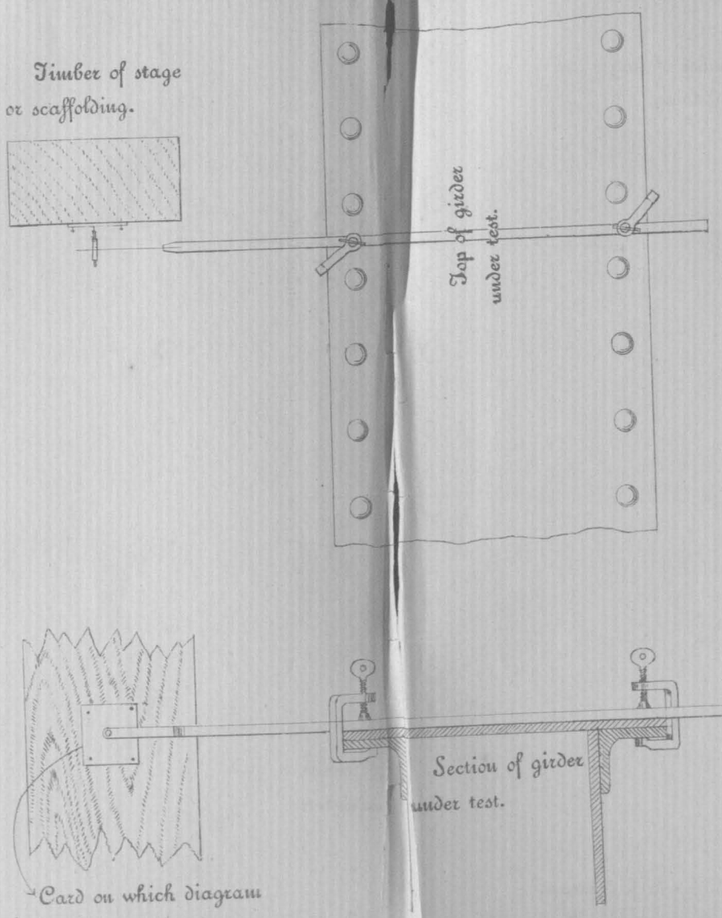












Specimens of diagrams actually taken from 60 feet Warren Girders, on Nizam's State Railway.
Load = G.I.P. Engine and Tender weighing 38 tons.

Speed 45 miles.

Top boom. Bottom boom.



Speed 20 miles.

Top. Bottom.



Speed 4 miles.

Top Bottom.

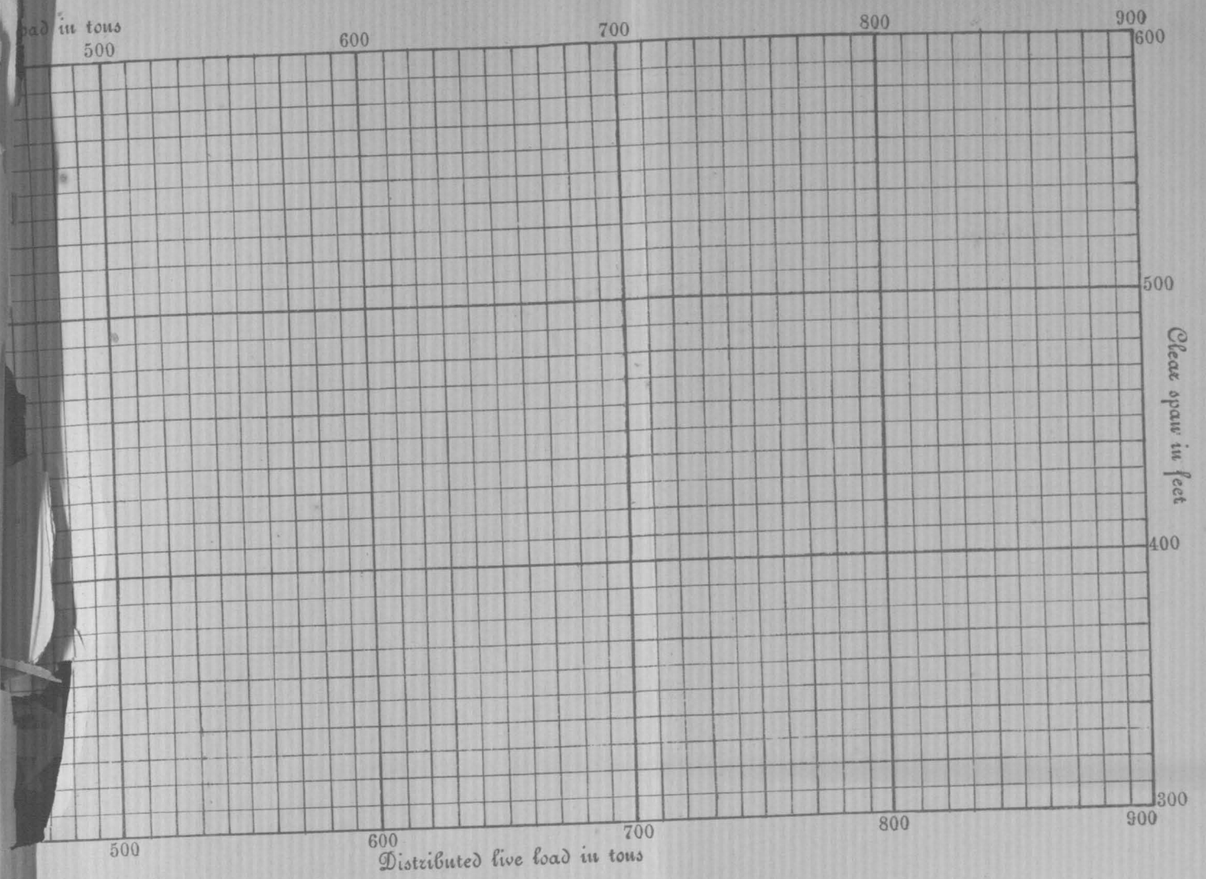


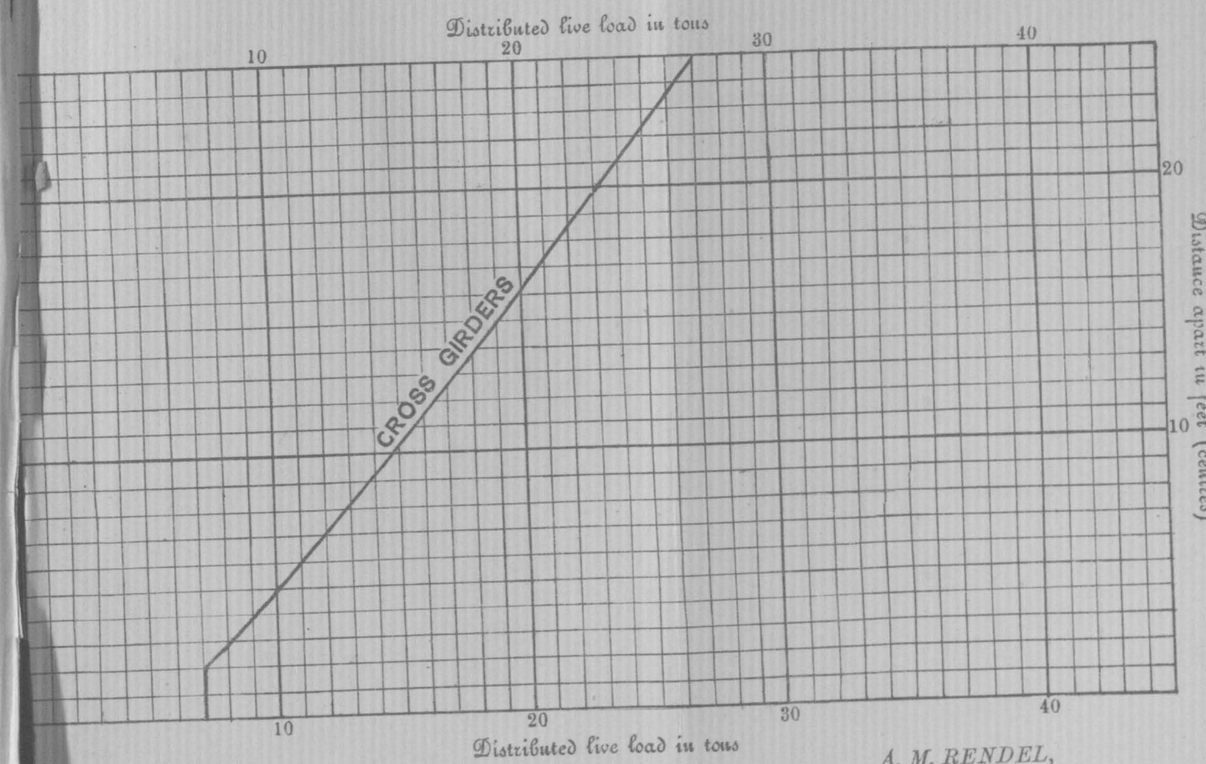
THOS D. BONA, Supdt.

METRE GAUGE.
I. B. No. A.

DER BRIDGES.

LINE OF RAILWAY.





…rders of bridges carrying a single line of Railway. The dia-
…lus 7 tons on a pair of wheels in the centre of a span would be

A. M. RENDEL,
Consg. Engr. to the Secy. of State.
GUILFORD L. MOLESWORTH,
Consg Engr. to the Govt. of India.
3rd June, 1881.

THOS D. BONA, *Supdt.*