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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS



**DYNAMIC TESTING OF PRESTRESSED CONCRETE
SLEEPER OF NEW DESIGN TO DRG. NO. T-5475**

REPORT NO. TM-2

DECEMBER 1994

**RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAKNAGAR, LUCKNOW - 226011**

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This report is based on study made by the Track Machines and Monitoring Dte. of RDSO. Although, every care has been taken in analysing it objectively, the views expressed in this report are subject to modifications from time to time in the light of fresh data. Further, they do not necessarily represent the views of the Ministry of Railways (Railway Board), Government of India.

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TEST REPORT: DYNAMIC TESTING OF TRACK PANEL COMPRISING OF PRC SLEEPER TO DRAWING NO. T-5473 ON 60 KG RAILS

1.0 INTRODUCTION

Track Design Directorate has evolved a new design of PSC sleeper for 60 Kg.rails by bringing down the quantity of HTS wires from 9.7Kg to 6 Kg per sleeper. The object of test was to carry out fatigue test on this sleeper (in a full rail panel of 13 m length) on Track Panel Fatigue Testing Equipment in Track Laboratory.

2.0 DETAILS OF TEST

2.1 The test was carried out on Track Panel Fatigue Testing Equipment in Track Lab. on one rail panel of 13 m length with sleeper density 1660/Km, i.e. sleeper spacing 60cm c/c.

2.2 The fastening used were ERC/Mk-III as per RDSO's Drawing No. T-3701 with its components i.e. GR sole plate as per RDSO's Drawing No. T-3711 and G.F.N. liner as per RDSO's Drawing No. T-3706.

2.3 The ballast cushion under the sleeper was 300 mm.

2.4 The track panel was laid to proper alignment, level and gauge and manually packed.

2.5 Loading norms :

Vertical (V)	= +25t to + 2t	at 3.3 Hz frequency -
Lateral (L)	= +10t to + 0.8t	
L/V	= 0.40	

upto 4×10^6 cycles.

3.0 INSTRUMENTATION

Stresses in concrete sleeper were measured under dynamic condition by strain gauges of SR-4 type, 67mm gauge length. The location of gauges for the sleeper loaded directly is shown in Fig. 1 and for the sleeper adjacent to the loaded sleeper is shown in Fig. 2.

4.0 OBSERVATIONS

The following observations and readings were taken:-

- i) Variations in the gauge and cross level at every 1×10^6 cycles.
- ii) Cracks in sleeper at every 1×10^6 cycles.
- iii) Stresses in sleepers at every 1×10^6 cycles under dynamic

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loadings at the loaded sleeper and the adjacent sleeper

iv) Condition of fastenings after completing the test.

v) Condition of G.R. sole plate and GFN liner after completing the test.

vi) Track modulus at every 1×10^6 cycles. (under the actuator)

5.0 RESULTS

5.1 The variations in gauge and cross levels at every 1×10^6 cycles are as given below:-

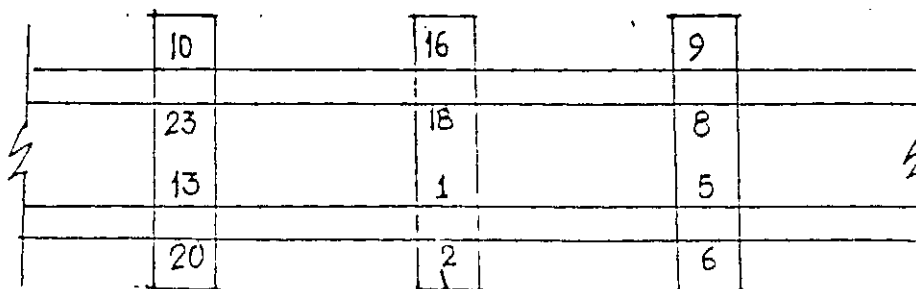
Stage	Initial	⁶ 1x10 cycles	⁶ 2x10 cycles	⁶ 3x10 cycles	⁵ 4x10 cycles	REMARKS
Gauge in mm	1673	1673	1673	1673	1673	No change
Level	West side rail was lower by -----no change----- 5 mm.					

5.2 No cracks in the sleeper were noticed during the test cycles.

5.3.1 The values of stresses (for the loaded sleeper and the adjacent one) as computed at every one million cycles upto four million cycles, i.e. completion of test, are given in Annexure-I/1 to 7.

5.3.2 Graphs showing the stresses under different loading conditions at every one million cycles upto four million cycles are placed at Annexure-II/1 to 3.

5.4 Condition of fasteing after completion of test.



Sl. No.	ERC No.	Toe Gap (mm)		Toe Load (KG)		REMARKS
		Before Test	After Test	Before Test	After Test	
1.	TP-10	19.70	20.19	835	790	
2.	TP-23	19.90	19.97	950	850	
3.	TP-13	19.34	20.11	835	825	
4.	TP-20	19.40	19.79	815	760	
5.	TP-16	19.96	20.06	815	780	
6.	TP-18	20.10	20.36	870	850	
7.	TP-1	19.54	19.90	805	750	
8.	TP-2	19.87	20.30	835	750	
9.	TP-9	20.90	21.03	805	760	
10.	TP-8	20.98	21.54	820	735	
11.	TP-5	20.05	20.19	825	740	
12.	TP-6	20.05	20.41	850	740	

5.5 Condition of G.R. Sole Plate and GFN liners:- No deterioration was observed.

5.6 The value of track modulus has been calculated as per formula given below:-

$$U = \left| \frac{P}{Y} \frac{92.6}{I^{1/4}} \right|^{4/3}$$

Where,

U (Track Modulus) in Kg/cm/cm.

Y (deflection) in mm

P (Load on sleeper) in t

I (Moment of inertia of rail section I_{xx}) in cm⁴

6.0 REMARKS

- 6.1 The conditions of sleeper, G.R. Sole Plate, GFN liners and the fastenings were found good and all these withstood the test.
- 6.2 There was no gauge variation after completion of the full cycles of loading.
- 6.3 The maximum stress on sleeper under load at initial stage was observed at the centre top of the sleeper for gauge no G-3 and G-9 and its value was 74.3 Kg/cm^2 (tensile). The sleeper was centre binding at this stage. Centre bound was removed after 1×10^6 cycle.
- 6.4 The track moduli values, initial and elastic ranged from 19.1 Kg/cm/cm to 34.49 Kg/cm/cm and from 193.07 Kg/cm/cm to 238.45 Kg/cm/cm respectively.

Encl. Fig. I and II
Annexure I/1 - 7 & II/1 - 3.

DYNAMIC TESTING OF PSC SLEEPER, DRAWING NO. T-5475 FOR 60 Kg RAIL OF B.G. UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm

G.F. = 2.1

Shunt Resistance = 200 k ohm

Calibration factor $286 \mu\text{strain} = 30 \text{ mm}$

Young Modulus for concrete (E) = $4.875 \times 10^5 \text{ Kg/cm}^2$

Stress Value at Initial Stage i.e. Zero cycles

Loading (t)	Gauge no.	Output				Stress Range (Kg/cm ²)
		Division min max (mm)	Stress min max (kg/cm ²)			
V=25/2	1	0 1	0 4.65	0	4.65	
L=10/0.8	2	0 2	0 9.3	0	9.3	
L/V=0.4	3	0 16	0 74.3	0	74.3	
	4	0 11.5	0 53.4	0	53.4	
	5	1 4.5	4.65 20.9	0	16.25	
	6	-0.25 2	-1.16 9.3	0	10.46	
	7	0 1	0 4.65	0	4.65	
	8	0.25 2	1.16 9.3	0	8.14	
	9	0 16	0 74.3	0	74.3	
	10	0 11.5	0 53.4	0	53.4	
	11	0 3	0 13.95	0	13.95	
	12	0.25 2	1.16 9.3	0	8.14	

Note: (-) Indicate Compressive stress.

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DYNAMIC TESTING OF PSC SLEEPER, DRAWING NO. T-F475 FOR 60 Kg RAIL OF B.G. UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm

G.F. = 2.1

Shunt Resistance = 200 k ohm

Calibration factor $286 \mu\text{strain} = 30 \text{ mm}$

Young Modulus for concrete (E) = $4.875 \times 10^5 \text{ Kg/cm}^2$

Stress Value at 1×10^6 cycles

Loading (t)	Gauge no.	Output				Stress Range kg/cm^2 (kg/cm ²)
		Division min max (mm)	Stress min max (kg/cm ²)			
V=25/2	1	0 0	0 0	0	0	0
L=10/0.8	2	-3 2	-13.95 9.3			23.25
	3	0.5 14.5	2.32 67.42			65.10
	4	-2 7	-9.3 32.55			41.85
	5	0 3	0 13.95			13.95
	6	2 0	2 0			9.3
	7	0.5 1	2.32 4.65			2.33
	8	-1.5 2	-6.98 9.3			16.28
	9	0 13	0 60.45			60.45
	10	-2.5 4.5	-11.62 20.92			32.54
	11	0.5 3	2.32 13.95			11.63
	12	0 1	0 4.65			4.65

Note: (-) Indicate Compressive stress.

DYNAMIC TESTING OF PSC SLEEPER, DRAWING NO. T-5475 FOR 60 Kg RAIL OF B.G. UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm

G.F. = 2.1

Shunt Resistance = 200 k ohm

Calibration factor 286μ strain = 30 mm

Young Modulus for concrete (E) = 4.875×10^5 Kg/cm²

Stress Value at 1×10^6 cycles after packing

Loading (t)	Gauge no.	Output				Stress Range (Kg/cm ²)
		Division min max (mm)		Stress min max (kg/cm ²)		
L=25/2	1	0	0	0	0	0
V=10/0.8	2	0	2	0	9.3	9.3
	3	-1	9	-4.65	41.85	46.5
	4	0	7	0	32.55	32.55
	5	1	6.5	4.65	30.20	25.55
	6	0	2	0	9.3	9.3
	7	0	2	0	9.3	9.3
	8	-0.5	0.5	-2.3	2.3	4.6
	9	-1	7.5	-4.65	34.88	39.53
	10	-3	3	-13.95	13.95	27.90
	11	0	5.5	0	25.58	25.58
	12	0	2	0	9.3	9.3

Note: (-) Indicate Compressive stress.

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DYNAMIC TESTING OF PSC SLEEPER, DRAWING NO. T-5475 FOR 60 Kg RAIL OF F.G. UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm

G.F. = 2.1

Shunt Resistance = 200 k ohm

Calibration factor 286μ strain = 30 mm

Young Modulus for concrete (E) = 4.875×10^5 Kg/cm²

Stress Value at 2×10^6 cycles

Loading (t)	Gauge no.	Output		Stress		Stress Range ² (Kg/cm ²)
		Division min max (mm)	Stress min max (kg/cm ²)			
V=25/2	1	-1 0	-4.65 0	4.65		
L=10/0.8	2	0 2	0 9.3	9.3		
	3	1 5	4.65 23.23	18.58		
	4	0 1.75	0 8.13	8.13		
	5	0.5 5	2.3 23.25	29.95		
	6	0.5 2.5	2.3 11.62	9.32		
	7	0.5 0	2.3 2.3	2.3		
	8	0.25 2.0	1.16 9.3	8.14		
	9	1 6.25	4.65 29.03	24.38		
	10	0.5 3	2.3 13.95	11.65		
	11	0.5 5.5	2.3 25.55	23.25		
	12	0 2	0 9.3	9.3		
	13	0.5 3	2.3 13.95	11.65		
	14	1 3	4.65 13.95	9.3		
	15	0 3.5	0 16.27	16.27		
	16	0.5 3	2.3 13.95	11.65		
	17	1 2	4.65 4.65	9.3		
	18	1 6.25	4.65 29.03	24.38		

Note: (-) Indicate Compressive stress.

DYNAMIC TESTING OF RSC SLEEPER, DRAWING NO. T-5475 FOR 60 Kc RAIL OF B.G. UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm

G.F. = 2.1

Shunt Resistance = 200 k ohm

Calibration factor $285 \mu\text{strain} = 30 \text{ mm}$

Young Modulus for concrete (E) = $4.875 \times 10^5 \text{ Kg/cm}^2$

Stress Value at 2×10^6 cycles after packing.

Loading (t)	Gauge no.	Output				Stress Range ² (Kg/cm ²)
		Division min max (mm)	Stress min max (kg/cm ²)			
L=25/2	1	-1 0	0 -4.65	4.65		
V=10/0.8	2	0 1	0 4.65	4.65		
	3	1 6	4.65 27.88	23.23		
	4	0.5 2	2.3 9.3	7.0		
	5	0 6	0 27.88	27.88		
	6	0 2	0 9.3	9.3		
	7	0.5 1	2.3 4.65	2.35		
	8	0.25 1	1.16 4.65	3.49		
	9	1 6.5	4.65 30.19	25.54		
	10	0 2	0 9.3	9.3		
	11	0 5.25	0 24.39	24.39		
	12	-0.25 2	-1.16 9.3	10.45		
	13	0.25 3	1.16 13.95	12.79		
	14	-1 0	-4.65 0	-4.65		
	15	1 4	4.65 18.58	13.93		
	16	0 2	0 9.3	9.3		
	17	-0.5 0	-2.3 0	2.3		
	18	0.75 7	3.48 32.52	29.04		

Note: (-) Indicate Compressive stress.

DYNAMIC TESTING OF PCC SLEEPER, DRAWING NO. T-5475 FOR 60 Kg RAIL ON B.G. UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm

G.F. = 2.1

Shunt Resistance = 200 k ohm

Calibration factor 286μ strain = 30 mm

Young Modulus for concrete (E) = 4.875×10^5 Kg/cm²

Stress Value at 3×10^6 cycles

Loading (t)	Gauge no.	Output		Stress		Stress Range 2 (Kg/cm ²)
		min (mm)	max	min (kg/cm ²)	max	
V=25/2	1	0	0	0	0	0
L=10/0.8	2	-0.5	0.5	-2.3	2.3	4.6
	3	0	7	0	32.32	32.32
	4	-0.25	3.75	-1.16	17.42	18.58
	5	0.25	5	1.16	23.23	22.07
	6	0	2	0	9.3	9.3
	7	0	2	0	9.3	9.3
	8	-0.25	1.75	-1.16	8.13	9.29
	9	0	7.75	0	36.0	36.0
	10	-1	3	-4.65	13.95	18.6
	11	-0.5	4	2.3	18.58	16.28
	12	0	2	0	9.3	9.3
	13	-0.5	0	-2.3	0	2.3
	14	1	4	4.65	18.58	13.93
	15	0	2	0	9.3	9.3
	16	-	-	-	-	-
	17	1	4	4.65	18.58	13.93
	18	0	5.25	0	21.39	24.39

Note: (-) Indicate Compressive stress.

DYNAMIC TESTING OF SAC SLEEPER, DRAWING NO. T-5475 FOR 60 Kg
RAIL OF B.G. UNDER SMALL TRACK PANEL FATIGUE TESTING
EQUIPMENT

Gauge Resistance = 220.2 ohm

G.F. = 2.1

Shunt Resistance = 200 k ohm

Calibration factor $286 \mu\text{strain} = 30 \text{ mm}$

Young Modulus for concrete (E) = $4.875 \times 10^5 \text{ Kg/cm}^2$

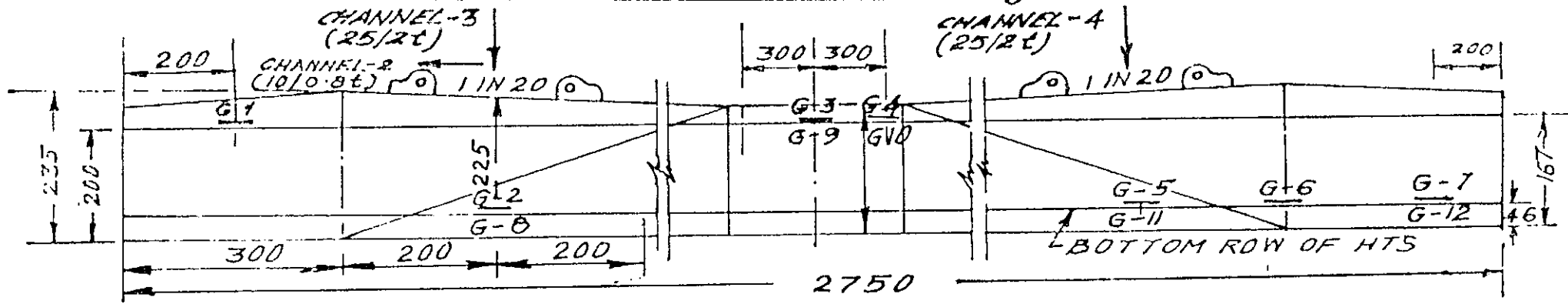
Stress Value at 4×10^6 cycles

Loading (t)	Gauge no.	Output		Stress		Stress Range ² (Kg/cm ²)
		Division min max (mm)		min max (kg/cm ²)		
V=25/2	1	-0.25 0.25		-1.16 1.16		2.32
L=10/0.8	2	-0.5 0.25		-2.3 1.16		3.46
	3	0.5 8		2.3 37.16		34.86
	4	0.5 4		2.3 18.58		16.28
	5	0.25 4		1.16 18.58		17.42
	6	0 1.75		0 8.13		8.13
	7	- -		- -		-
	8	-0.25 0.75		-1.16 3.48		4.64
	9	0.75 7.75		3.48 36.0		32.52
	10	-0.25 4		-1.16 18.58		19.74
	11	0.25 4		1.16 18.58		17.42
	12	0.25 1.75		1.16 8.13		6.97
	13	0.25 1		1.16 4.65		3.49
	14	0.75 4		3.48 18.58		14.10
	15	0 2.75		0 12.77		12.77
	16	0 1		0 4.65		4.65
	17	1 4		4.65 18.58		13.93
	18	0 23.23		0 23.23		23.23

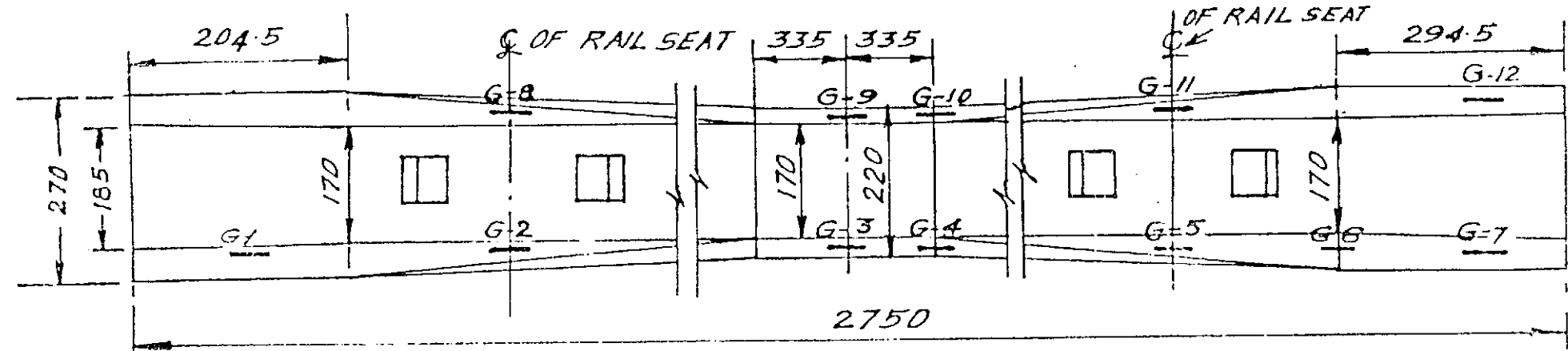
Note: (-) Indicate Compressive stress.

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PSC SLEEPER FOR BG. 60 Kg (UIG.) RDSO/T-5475



ELEVATION



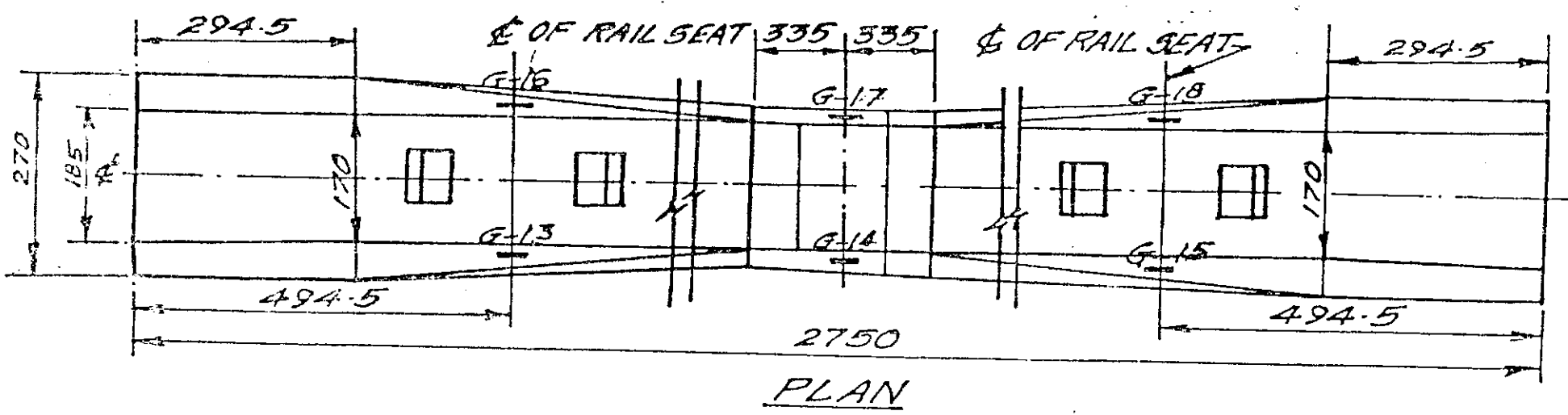
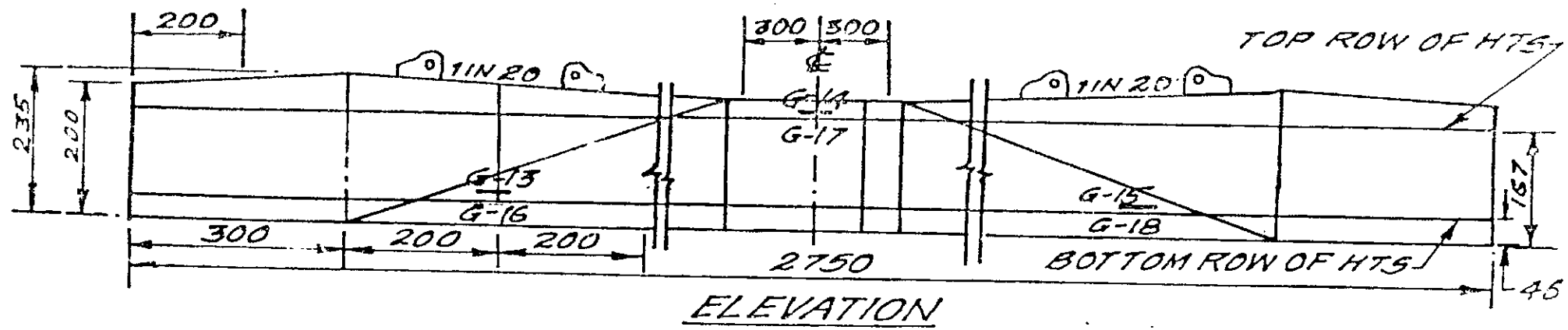
PLAN

LOCATIONS OF STRAIN GAUGES ON LOADED SLEEPER

NOTE:-

HEIGHTS OF BOTTOM AND TOP TIERS OF HTS IN CASE OF RDSO/T-2496 ARE 40 AND 150 mm RESPECTIVELY.

PSC SLEEPER FOR B.G. 60Kg (UIC) RD50/T-5475



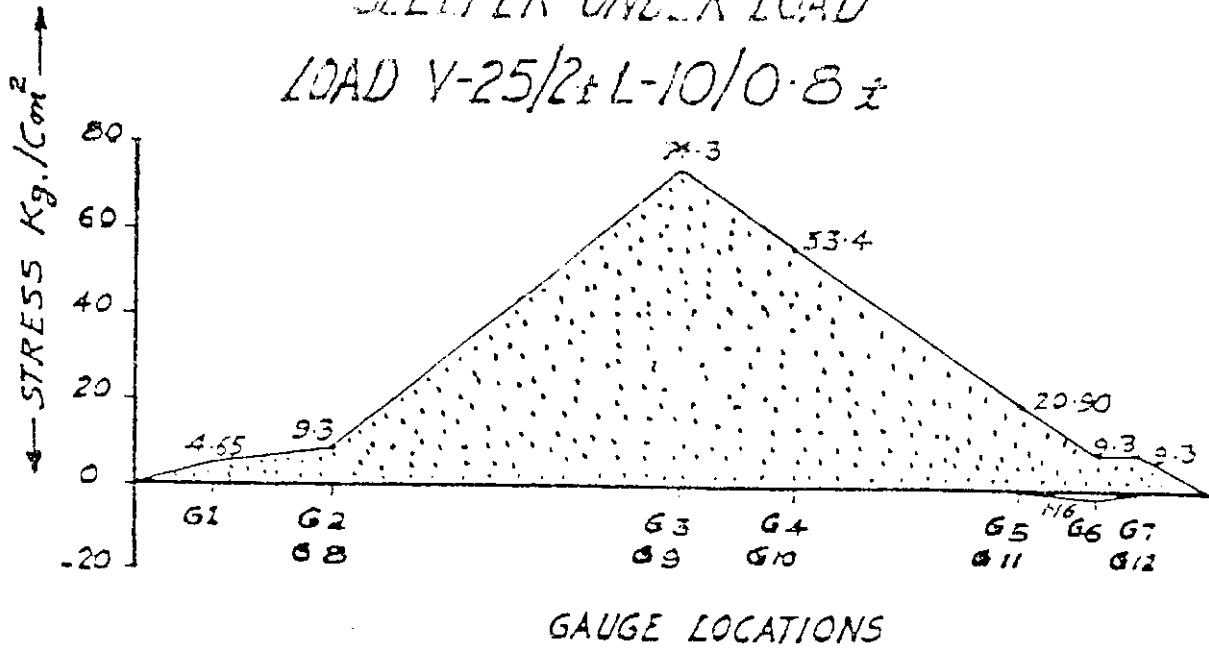
LOCATIONS OF STRAIN GAUGES ON SLEEPER
ADJACENT TO LOADED SLEEPER

NOTE:-
HEIGHT OF BOTTOM & TOP TIERS OF HTS
IN CASE OF RD50/T-24-95 ARE 40 AND
150 MM RESPECTIVELY 09134

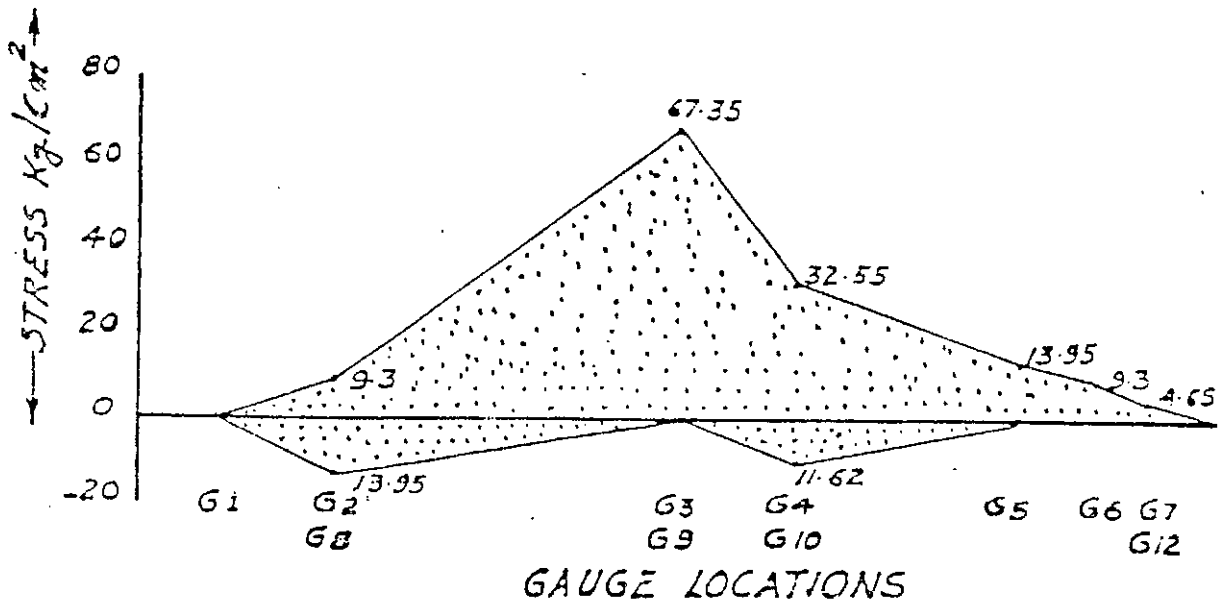
TESTING OF PSC SLEEPER FOR B.G. 60Kg. (UIC) DRG. N: T-5475

SLEEPER UNDER LOAD

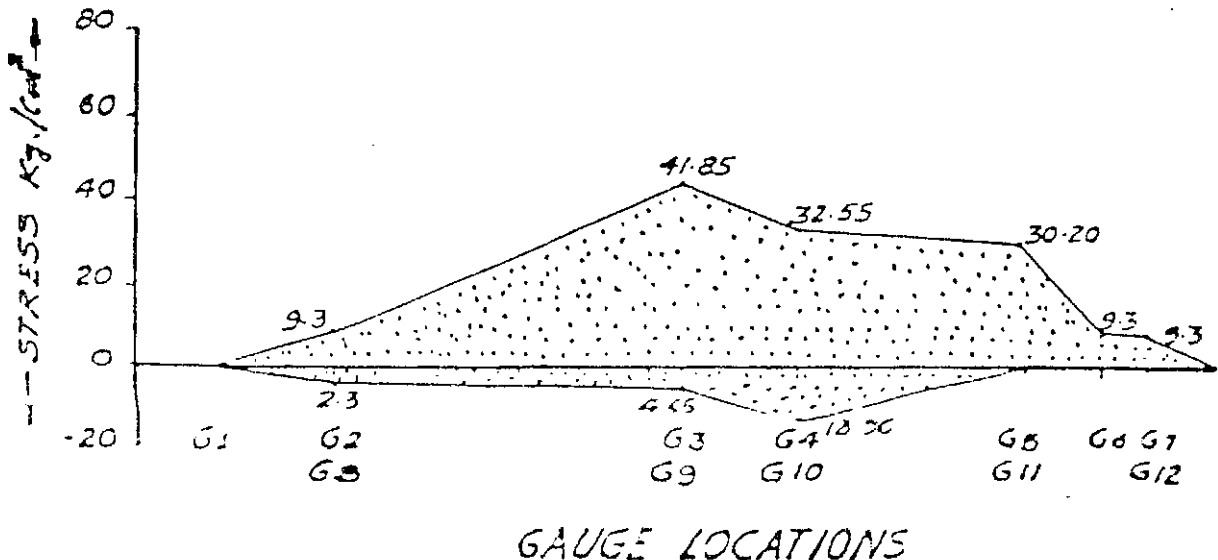
LOAD V-25/2 ± L-10/0.8 ±



MAXIMUM & MINIMUM STRESS RANGE AT INITIAL STAGE



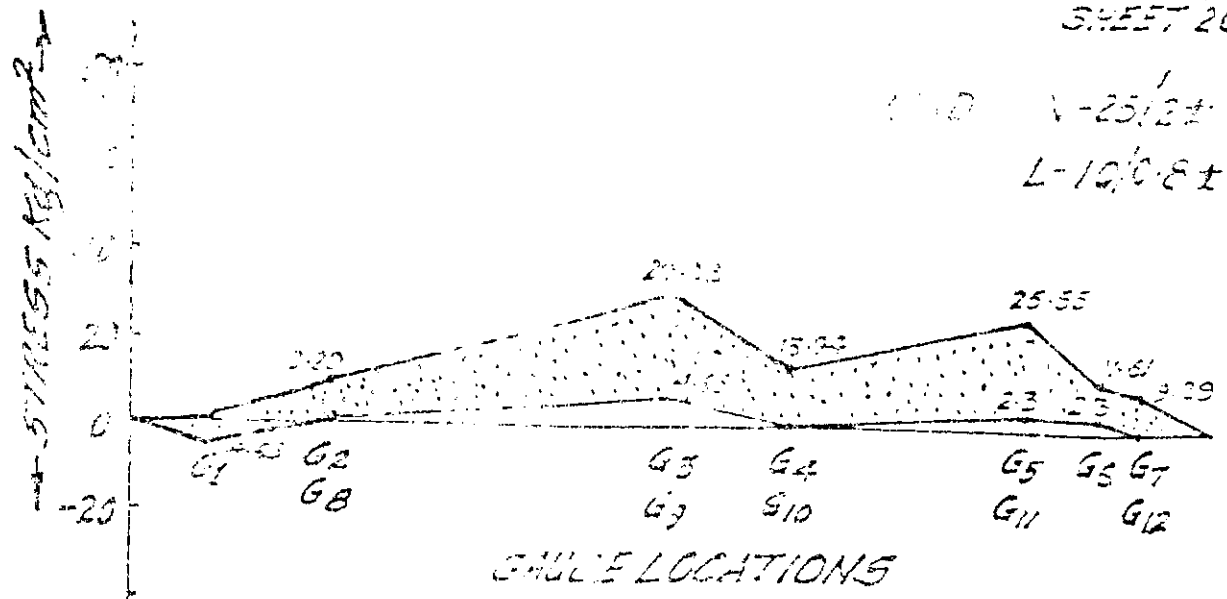
MAXIMUM & MINIMUM STRESS RANGE AT 1 MILLION CYCLES



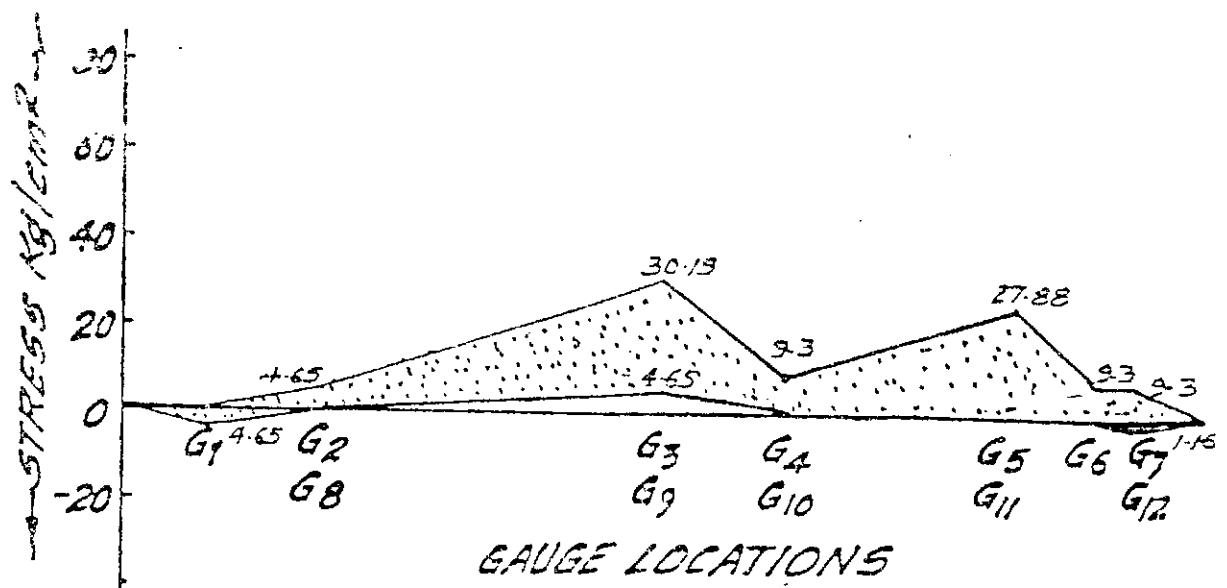
MAXIMUM & MINIMUM STRESS RANGE AFTER PACKING AT 1 MILLION CYCLE

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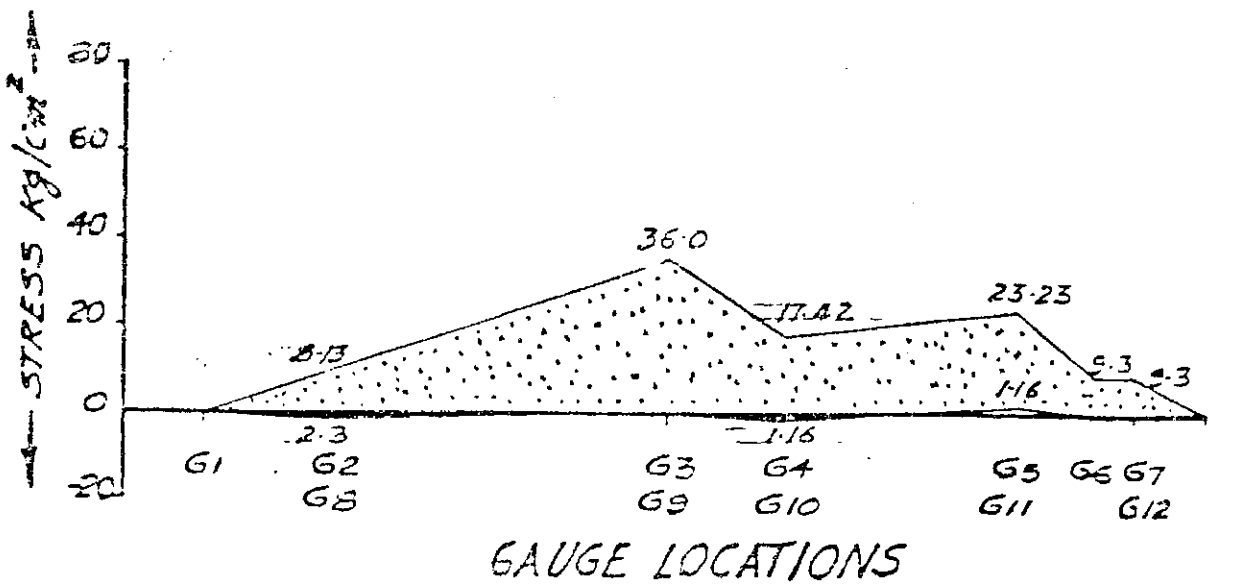
1110 V-25/2±
L-10/0.8±



MAXIMUM & MINIMUM STRESS RANGE AT 2 MILLION CYCLES



MAXIMUM & MINIMUM STRESS RANGE AFTER PACKING AT 2 MILLION CYCLES

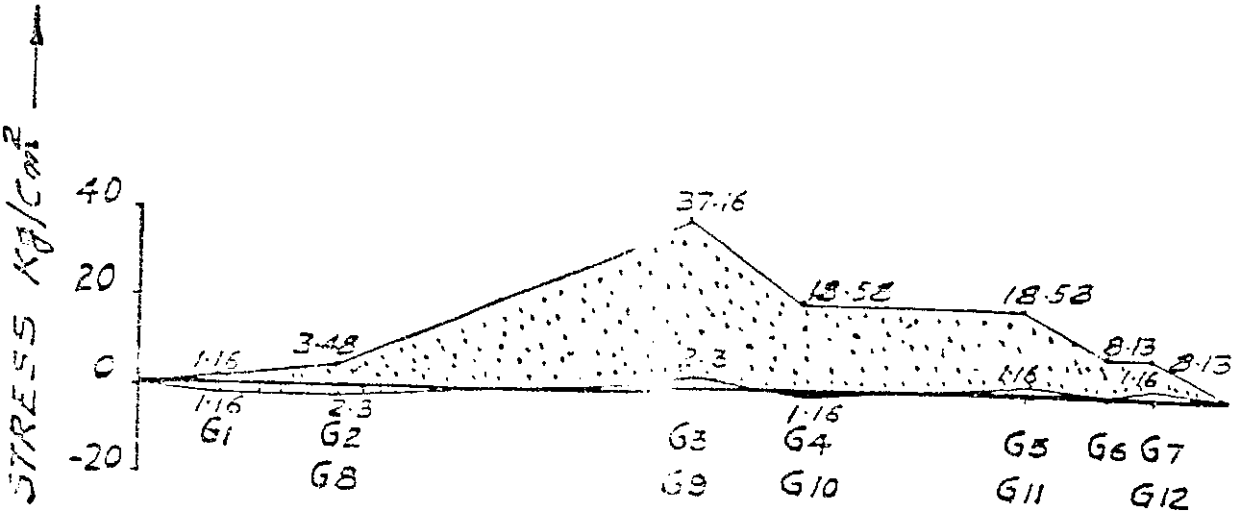


MAXIMUM & MINIMUM STRESS RANGE AT 3 MILLION CYCLES

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LOAD V-25/2±

L-10/0.8±



GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT 4 MILLION CYCLES