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DYNAMIC TESTING OF SHALLOW PRESTRESSED CONCRETE SLEEPER TO DRG. No T-4852 ON 60 Kg. RAILS

REPORT No. TM-12

MARCH 1998

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

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RESEARCH DESIGNS AND STANDARDS ORGANISATION
LUCKNOW - 226011

This report is based on study made by the Track Machine 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.

R.K. Mehta
Director (TM)

O.P. AGARWAL
Executive Director (TM)

CONTENTS

TEST REPORT: DYNAMIC TESTING OF SHALLOW PSC SLEEPER TO DRAWING NO. T-4852 ON 60 Kg RAILS

1.0 INTRODUCTION :

Track Design Directorate has evolved the design of Shallow PSC sleeper for 60 Kg rail by reducing the depth at rail seat by 55 mm for Mumbai suburban track between Churchgate to Virar. Track Design Directorate in their letter no. CT/SRC/3/2/FPT dt. 27-3-96 has desired to conduct the fatigue test on this sleeper.

1.1 Tests were conducted in two phases. Firstly by laying one full length of track panel and secondly under (fatigue loading) Pulsator as brought out in paras 2 & 3 respectively.

2.0 TEST ON RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT :

2.1 The test was carried out under Rail 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 60 cm 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 kept 200 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 3.33 Hz frequency upto 4×10^6 cycles.

2.6 INSTRUMENTATION :

Stresses in concrete sleeper were measured for static loading and under dynamic condition by strain gauges of SR-4 type, 57mm gauge length. The location of gauges on the sleeper loaded directly is shown in Fig. 1 and for the sleeper adjacent to the loaded sleeper is shown in Fig. 2.

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2.7 OBSERVATIONS

2.7.1 The following observations and readings were taken:-

i) Variations in the gauge and cross level at every $1x10^6$ cycles.

ii) Stresses in sleepers under dynamic loading at the loaded sleeper and the adjacent sleeper at initial stage and after at every 1 million cycles.

iii) Cracks in sleeper if any and stage at which it starts and its propagation.

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 initially and at every $1x10^6$ cycles. (under the actuator)

2.8 RESULTS

2.8.1 The variations in gauge and cross levels at every $1x10^6$ cycles are as given below.

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

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

2.8.3 The values of stresses (for sleeper below vertical actuator 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 5.

2.8.4 Graphs showing the stresses under different loading conditions initially and at every one million cycles upto four million cycles are placed at Annexure-II/1 to 5.

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2.8.5 Condition of fastening after completion of test.

Sl. No.	ERC No.	Toe Gap (mm) Before Test	Toe Gap (mm) After Test	Toe Load Before Test	Toe Load After Test	REMARKS
1.	TP-1	20.27	20.77	855	750	
2.	TP-2	18.80	19.65	830	772	
3.	TP-3	19.54	20.94	840	803	
4.	TP-4	19.20	19.55	880	786	
5.	TP-5	19.46	20.28	960	852	
6.	TP-6	18.85	19.22	940	876	
7.	TP-7	20.00	20.83	880	838	
8.	TP-8	18.63	19.52	920	872.	
9.	TP-9	20.40	20.55	910	803	
10.	TP-10	18.64	19.07	800	751	
11.	TP-11	19.47	20.48	880	803	
12.	TP-12	19.69	20.06	865	752	

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

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

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

Where, U = Track modulus in kg/cm/cm.

Y = deflection in cm.

P = load in kg.

I = moment of inertia of rail section in

3.0 CONVENTIONAL FATIGUE LOADING TEST UNDER PULSATOR :

3.1 The test was carried out on pulsator for two rail seat under bending for a span of 650 mm.

3.2 The test arrangement has been shown in Fig. 3

3.3 The loading norms:

Vertical (V) = 17.50 t to 2.5 t at 5 Hz frequency upto 2×10^6

3.4 Observations :

Initial crack propagation started from bottom of sleeper at the beginning on both the rail seat after applying the pulsating load and gradually started increasing, the propagation with number of cycles shown in Fig. 4 and 5 for east face and west face of rail seat 'A' and 'B' respectively.

4.0 Summarised Test Results :

The result of tests under both the conditions are summarised below.

4.1 Under Track Panel Testing Equipment :

The sleeper withstood dynamic test loading of 2t to 25t at 3.33 Hz upto 4 million cycles.

4.2 Under Pulsator Loading :

4.2.1. Rail Seat 'A' :

As soon as pulsating load started, the initial crack started and propagated for a length of 58 mm on west face and 40 mm on east face. Finally the crack propagated for a height of 75 mm on west face and 60 mm on east face after two million cycles.

4.2.2. Rail Seat 'B' :

As soon as pulsating load started, the initial crack started and propagated for a length of 55 mm on west face and 80 mm on east face. Finally the crack propagated for a height of 82 mm on west face and 92 mm on east face after two million cycles.

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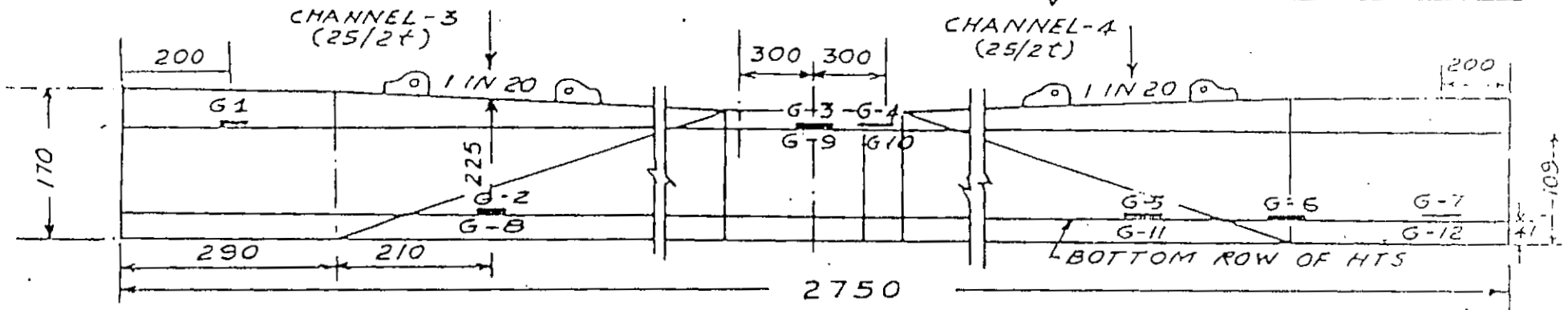
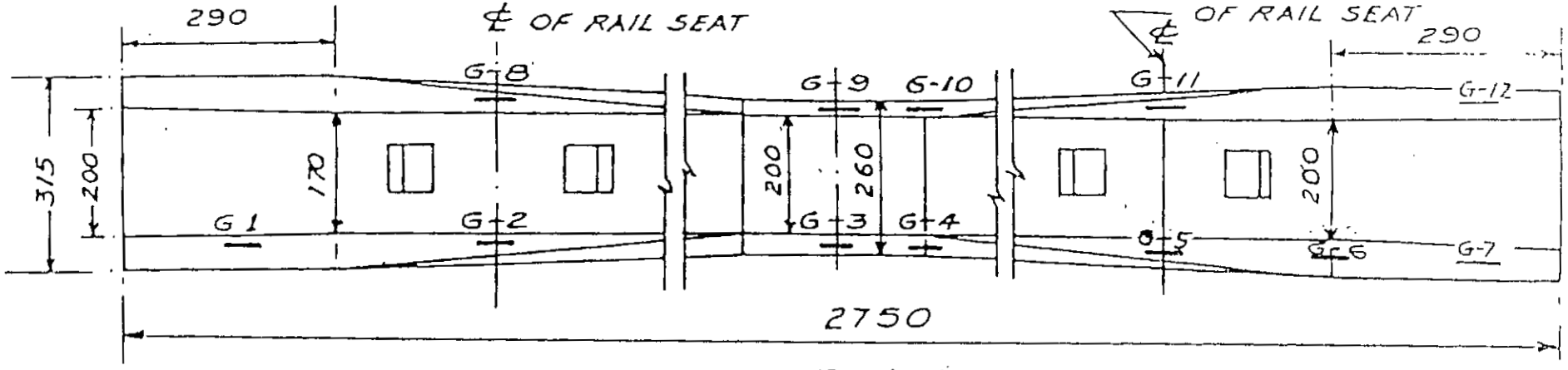
Encl. Annexure I/1-6 and II/1-4.

Fig. 1, 2, 3, 4 and 5

SHALLOW PSC SLEEPER FOR BG. 60 Kg (UIC.) RDSO/T-4852



ELEVATION



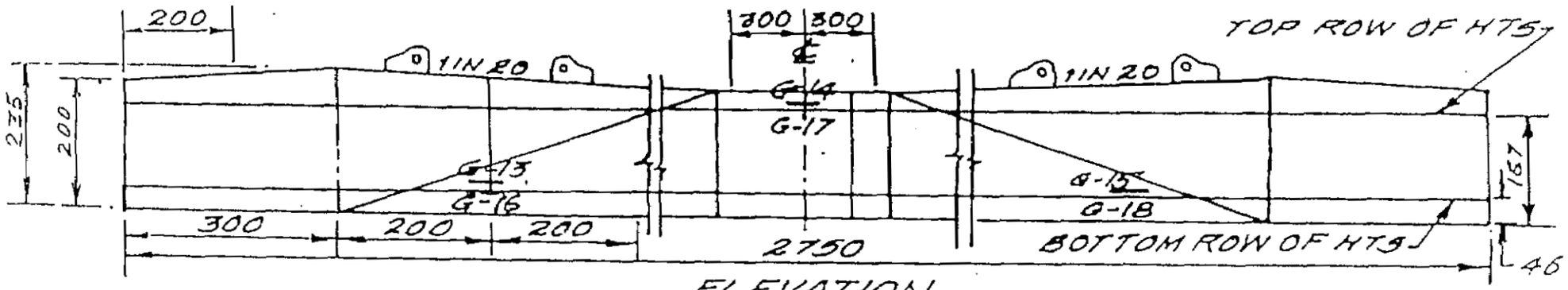
PLAN

NOTE :-

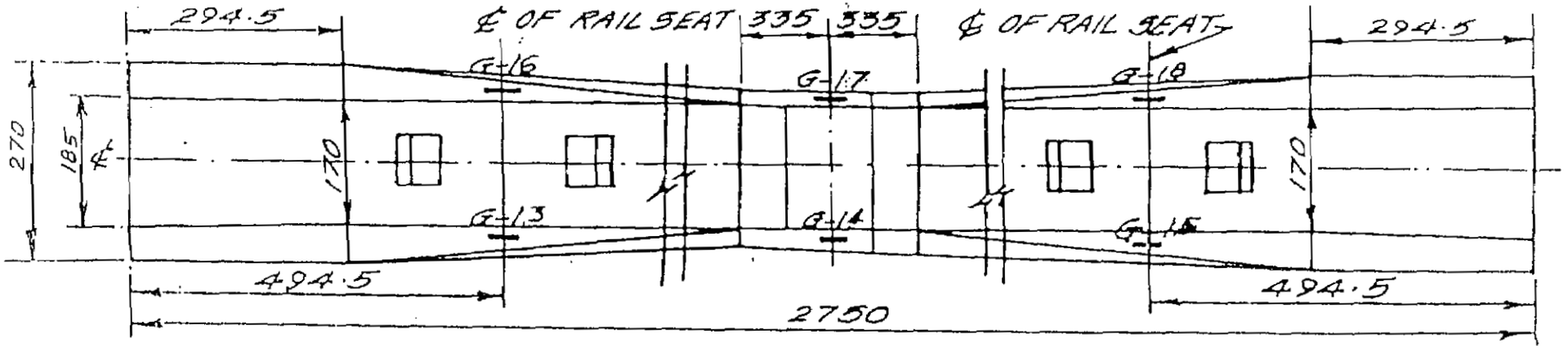
LOCATIONS OF STRAIN GAUGES ON LOADED SLEEPER

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) RDSO/T-5475



ELEVATION

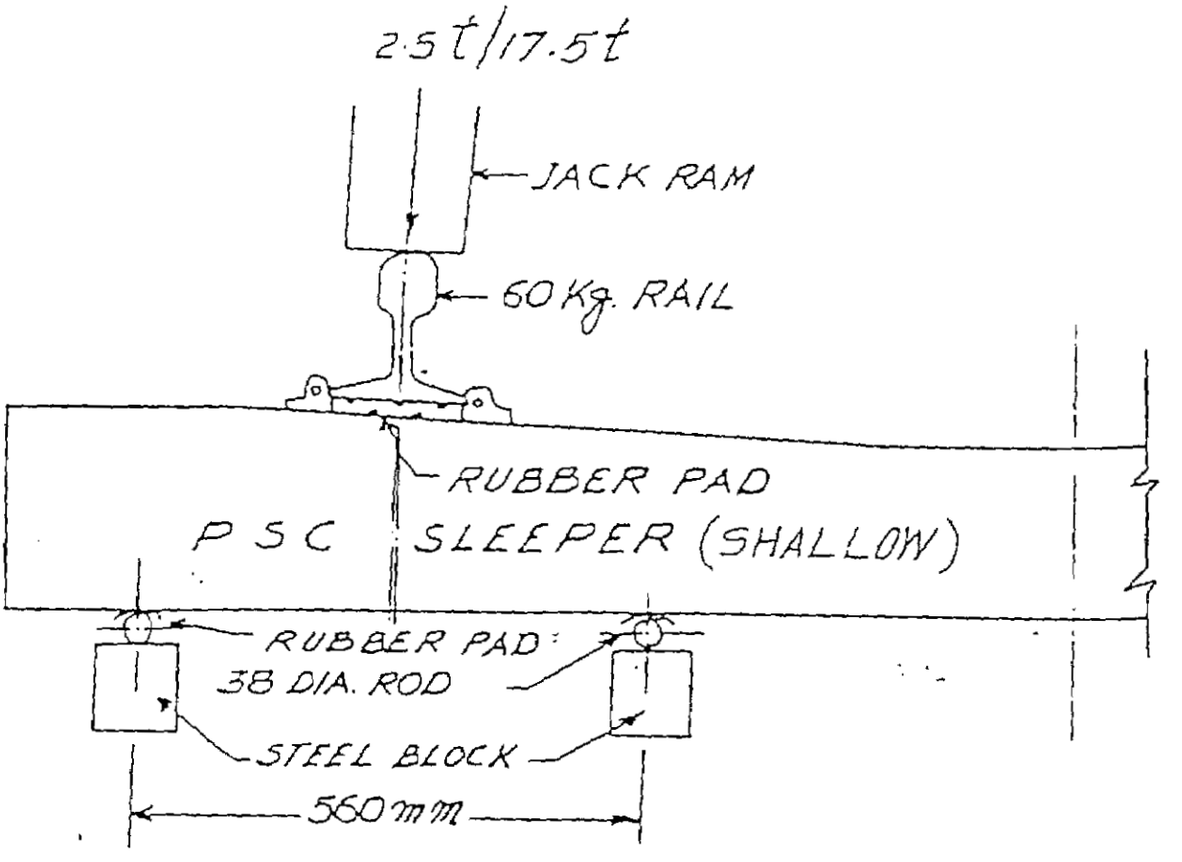


PLAN

LOCATIONS OF STRAIN GAUGES ON SLEEPER ADJACENT TO LOADED SLEEPER

NOTE:-
HEIGHT OF BOTTOM & TOP TIERS OF HTS IN CASE OF RDSO/T-2496 ARE 40 AND 150 mm. RESPECTIVELY.

FIG-3



CONVENTIONAL FATIGUE LOADING ON SHALLOW PSC SLEEPER UNDER PULSATOR (DRG. No. RDSO/T-4852)

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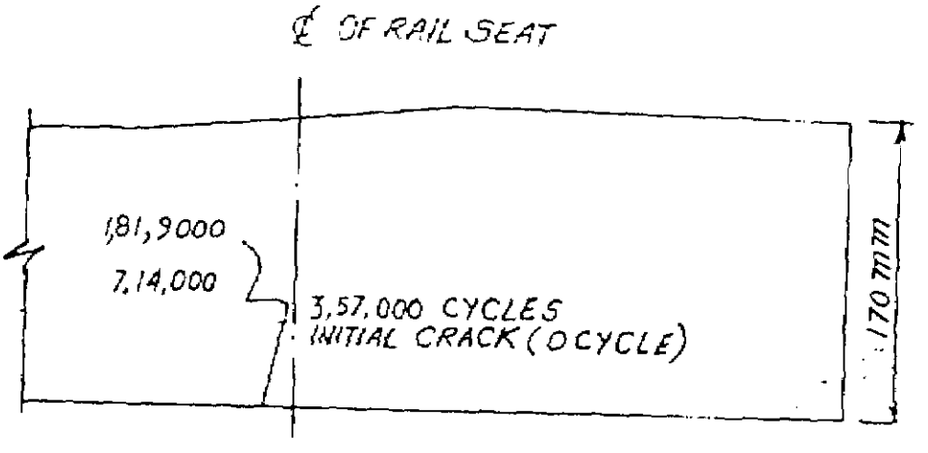
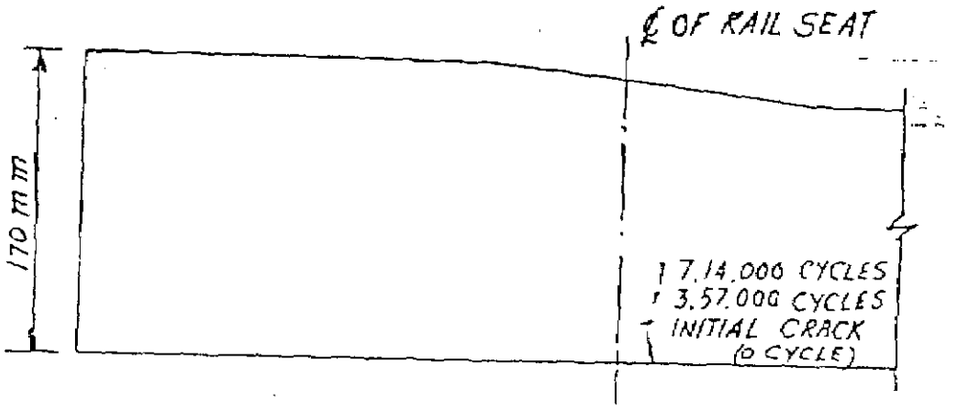
SKETCH SHOWING THE CRACK PROPAGATION OF SHALLOW PRESTRESSED CONCRETE SLEEPER TO ORG.NO. RDSO/T-4852 UNDER PULSATOR RAIL SEAT 'A' (JOB NO TM/TL/12/97-2)



WEST FACE



EAST FACE

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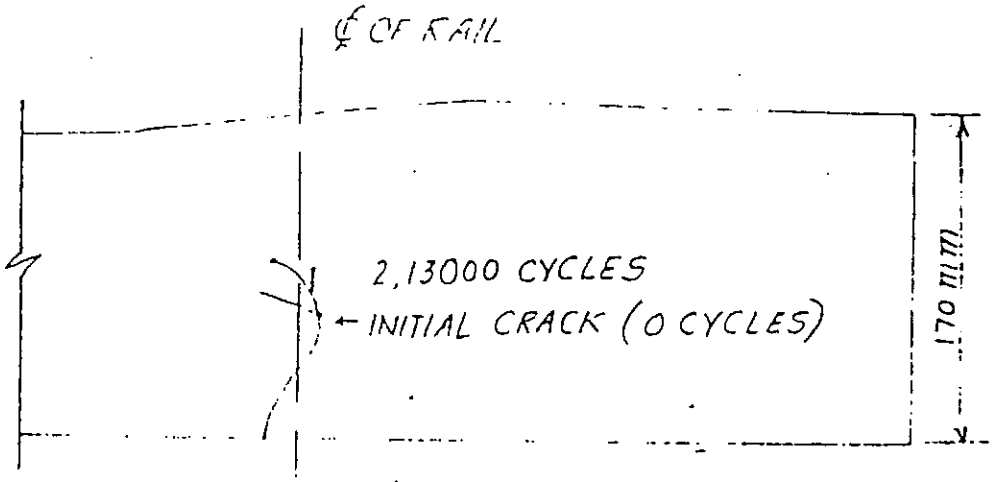
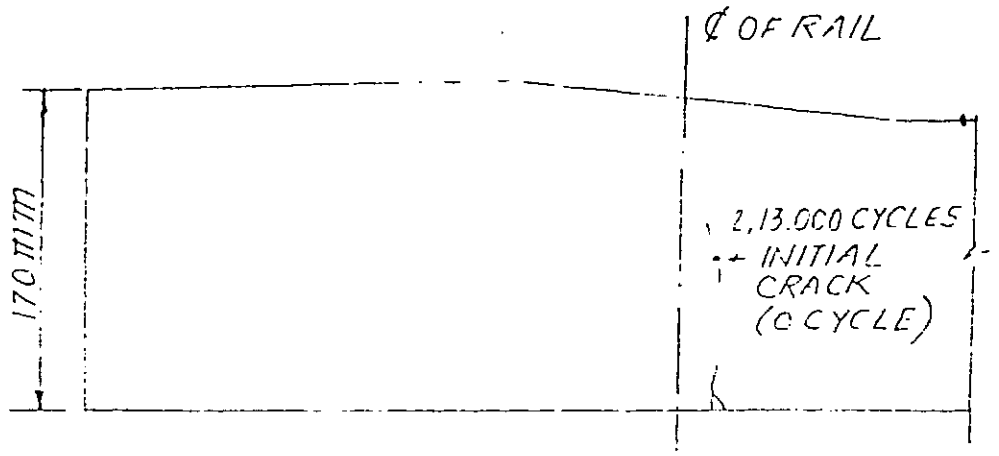
	TRACED BY	APPROVED BY

SKETCH SHOWING THE CRACK PROPAGATION OF SHALLOW PRESTRESSED CONCRETE SLEEPER TO DRG. NO. RDSO/T-4852 UNDER PULSATOR RAIL SEAT 'B' (JOB NO. TM/TL/12/97-3)



WEST FACE



EAST FACE

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DYNAMIC TESTING OF SHALLOW PSC SLEEPER, DRAWING NO. T-4852 FOR 60 Kg. RAIL UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm
G.F. = 2.1
Shunt Resistance = 200 k ohm
Calibration factor 286 strain = 30 mm

Young Modulus for concrete (E) = 4.875×10^5 Kg/cm^2
Stress Value at Initial Stage i.e. Zero cycles

Loading (Max/Min) (t)	Gauge no.	Output Division min	Output Division max	Stress min (kg/cm^2)	Stress max (kg/cm^2)	Stress Range (kg/cm^2)
V=25/2	1	0	0.25	0	1.16	1.16
	2	0	3	0	13.95	13.95
	3	-1.25	-0.25	-5.81	-1.16	4.65
	4	-1.0	-0.25	-4.65	-1.16	3.49
	5	0	4.50	0	24.92	24.92
	6	OFF				
	7	0	1	0	4.65	4.65
	8	1	7	4.65	32.55	27.9
	9	-1.0	-0.5	-4.65	-2.32	2.33
	10	-1	0	-4.65	0	4.65
	11	0	5	0	23.25	23.25
	12	-1	0	-4.65	0	4.65
	13	0	3	0	13.95	13.95
	14	0.5	1	2.32	4.65	2.33
	15	0.5	3.5	2.32	16.27	13.95
	16	0.5	4.5	2.32	20.92	18.6
	17	OFF				
	18	0	4	0	18.60	18.6

Note: (1) (-) Indicates Compressive stress.

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DYNAMIC TESTING OF SHALLOW PSC SLEEPER. DRAWING NO. T-4852 FOR Kg. RAIL UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm
G.F. = 2.1
Shunt Resistance = 200 k ohm
Calibration factor 286 strain = 30 mm

Young Modulus for concrete (E) = 4.575×10^{5} Kg/cm^{2}

Stress Value at 1×10^{6} cycles

Loading (Max/Min) (t)	Gauge no.	Output Division min (mm)	Output Division max (mm)	Output Stress min (kg/cm²)	Output Stress max (kg/cm²)	Stress Range 2 (kg/CM²)
V=25/2	1	0	0.25	0	1.16	1.16
	2	OFF				
	3	-0.5	0.5	-2.32	2.32	4.65
	4	0	0.5	0	2.32	2.32
	5	OFF				
	6	OFF				
	7	0	0.5	0	2.32	2.32
	8	-2	2.5	-9.30	11.62	20.92
	9	0	1.50	0	6.98	6.98
	10	0	1.50	0	6.98	6.98
	11	0.50	4	1.16	18.6	17.44
	12	0.50	1	2.32	4.65	2.33
	13	0.5	2.5	2.32	11.62	9.20
	14	OFF				
	15	[illegible]	3	0	13.95	13.95
	16	0.35	2	1.16	9.30	8.14
	17	0	1	0	4.65	4.65
	18	[illegible]	3	0	13.95	13.95

Note: (1) (-) Indicate Compressive stress.

DYNAMIC TESTING OF SHALLOW PSC SLEEPER, DRAWING NO. T-4952 FOR 60 Kg. RAIL UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm
G.F. = 2.1
Shunt Resistance = 200 k ohm
Calibration factor 286 strain = 30 mm

Young Modulus for concrete (E) = 4.875×10^{5} Kg/cm^{2}

Stress Value at 2×10^{6} cycles

Loading (Max/Min) (t)	Gauge no.	Output Division min (mm)	Output Division max (mm)	Output Stress min (kg/cm²)	Output Stress max (kg/cm²)	Stress Range Z (Kg/cm²)
V=25/2	1	0	1	0	4.65	4.65
	2	OFF				
	3	-0.5	0	-2.32	0	2.32
	4	-1.0	0	-4.65	0	4.65
	5	OFF				
	6	OFF				
	7	0	0.50	0	2.32	2.32
	8	0	4	0	18.60	18.60
	9	-0.50	0.50	-2.32	2.32	4.65
	10	0	1.0	0	4.65	4.65
	11	0.50	4.0	2.32	18.60	16.28
	12	0	1.0	0	4.65	4.65
	13	0.5	3.0	2.32	13.95	11.63
	14	OFF				
	15	0.75	3.75	3.48	13.95	9.30
	16	1.0	4.0	4.65	18.60	14.15
	17	0	1.0	0	4.65	4.65
	18	0.50	3.0	2.32	13.95	11.63

Note: '(' ... Indicate Compressive stress.

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DYNAMIC TESTING OF SHALLOW PSC SLEEPER, DRAWING NO. T-4852 FOR 60 Kg. RAIL UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm
G.F. = 2.1
Shunt Resistance = 200 K ohm
Calibration factor 256 strain = 30 mm

Young Modulus for concrete (E) = 4.875×10^{5} Kg/cm^{2}

Stress Value at 2×10^{6} cycles after packing

Loading (Max/Min) (t)	Gauge no.	Output Division min (mm)	Output Division max (mm)	Output Stress min (kg/cm)	Output Stress max (kg/cm)	Stress Range (Kg/cm^{2})
V=25/2	1	0.5	1	2.32	4.65	2.32
	2	OFF				
	3	-1.0	0	-4.65	0	4.65
	4	-1.0	0	-4.65	0	4.65
	5	OFF				
	6	OFF				
	7	0	0.75	0	3.50	3.50
	8	0.50	4	2.32	18.60	16.28
	9	0	0.25	0	1.16	1.16
	10	-0.50	0	-2.32	0	2.32
	11	0.50	7.25	2.32	33.71	31.39
	12	OFF				
	13	1.0	4.25	4.65	19.76	15.11
	14	OFF				
	15	1.0	3.0	4.65	13.95	9.30
	16	0.75	4.0	3.50	18.60	15.10
	17	0.50	1.0	2.32	4.65	2.32
	18	0.5	2.5	2.32	11.62	9.30

Note: (1) (-) Indicates Compressive stress.

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DYNAMIC TESTING OF SHALLOW PSC SLEEPER. DRAWING NO. T-4852 FOR 60 Kg. RAIL UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm
G.F. = 2.1
Shunt Resistance = 200 k ohm
Calibration factor 286 strain = 30 mm

Young Modulus for concrete (E = 4.875×10^5 Kg/cm^2

Stress Value at 3×10^6 cycles

Loading (Max/Min) (t)	Gauge no.	Output: Division min (mm)	Output: Division max (mm)	Output: Stress min (kg/cm)	Output: Stress max (kg/cm)	Stress Range (Kg/cm^2)
V=25/2	1	0	1	0	4.65	4.65
	2	OFF				
	3	0.5	0	2.32	0	2.32
	4	0	1	0	4.65	4.65
	5	OFF				
	6	OFF				
	7	0	0.50	0	2.32	2.32
	8	0.5	5.25	2.32	24.41	22.09
	9	0	1.5	0	6.98	6.98
	10	-0.5	0.5	-2.32	2.32	4.65
	11	0	5.0	0	23.25	23.25
	12	0	0.5	0	2.32	2.32
	13	0.5	3.25	2.32	15.11	12.79
	14	0.5	1.0	2.32	4.65	2.32
	15	1.0	3.50	4.65	16.27	11.62
	16	0.5	4.0	2.32	18.60	16.28
	17	1.0	1.5	4.65	6.98	2.32
	18	0	3.25	0	15.11	15.11

Note: (1) (-) Indicate Compressive stress.

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DYNAMIC TESTING OF SHALLOW PSC SLEEPER. DRAWING NO. T-4852 FOR 60 Kg. RAIL UNDER "RAIL TRACK PANEL FATIGUE TESTING EQUIPMENT"

Gauge Resistance = 120.2 ohm
G.F. = 2.1
Shunt Resistance = 200 k ohm
Calibration factor 286 strain = 30 mm
Young Modulus for concrete (E) = 4.875×10^{5} Kg/cm^2
Stress Value at 4×10^{6} cycles

Loading (Max/Min) (t)	Gauge no.	Output: Division min (mm)	Output: Division max (mm)	Output: Stress min (kg/cm)	Output: Stress max (kg/cm)	Stress Range (Kg/cm^2)
V=25/2	1	-0.50	0.50	-2.32	2.32	4.65
	2	OFF				
	3	-0.25	1.5	-1.16	6.98	8.14
	4	0	2.0	0	9.30	9.30
	5	OFF				
	6	OFF				
	7	0	0.50	0	2.32	2.32
	8	OFF				
	9	0	0.50	0	2.32	2.32
	10	-0.5	2.0	-2.32	9.30	11.62
	11	0	3.5	0	16.27	16.27
	12	OFF				
	13	0	3.0	0	13.95	13.95
	14	0	3.5	0	16.27	16.27
	15	0.50	4.50	2.32	20.92	18.60
	16	1.0	4.0	4.65	18.60	13.95
	17	0	2.5	0	11.62	11.62
	18	-0.25	3.0	-1.16	13.95	11.63

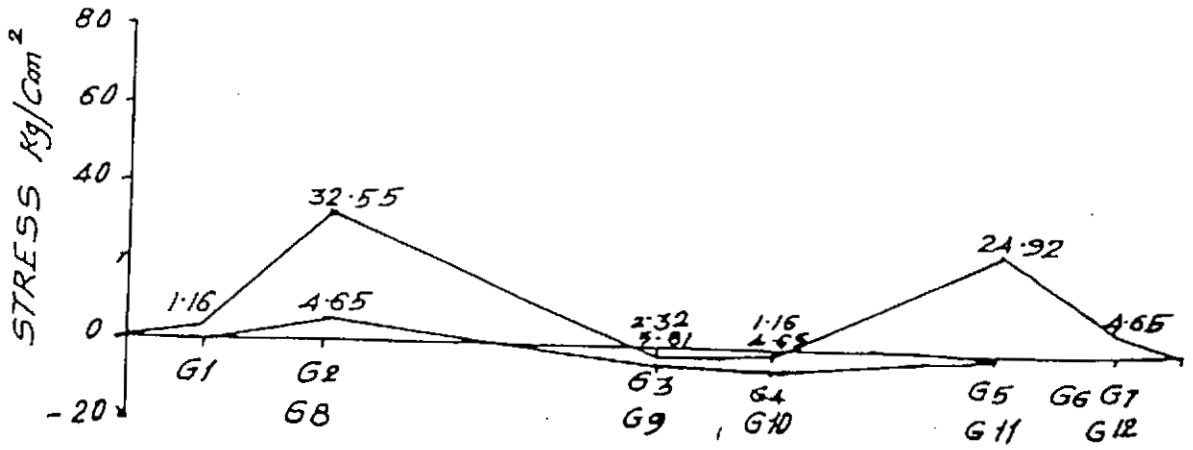
Note: 1. [illegible] compressive stress.

08901

TESTING OF SHALLOW PSC SLEEPER FOR B.G. 60 Kg. (UIC) ARG No. T-4852

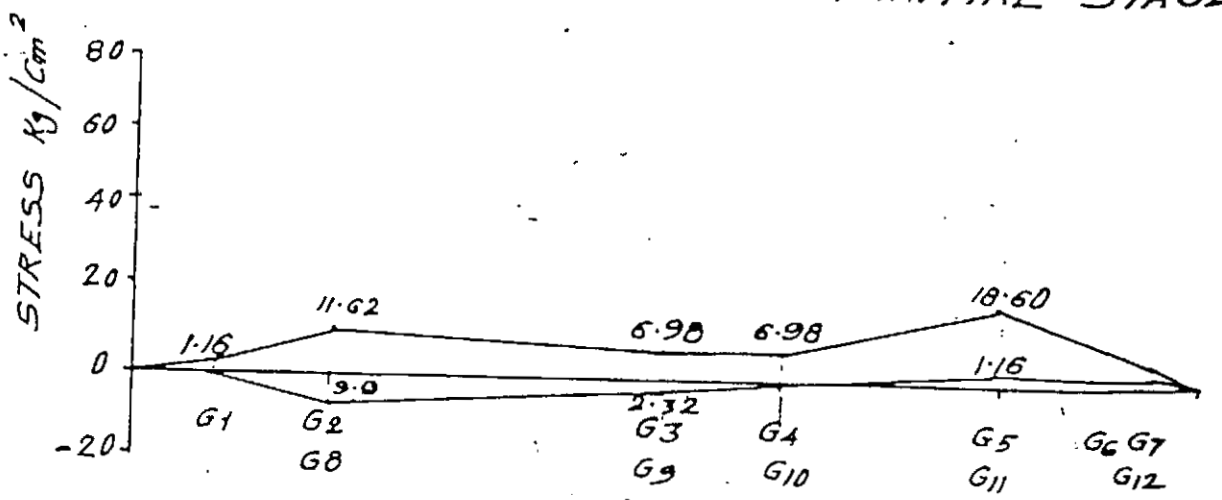
SLEEPER UNDER LOAD

LOAD V 2t/25t



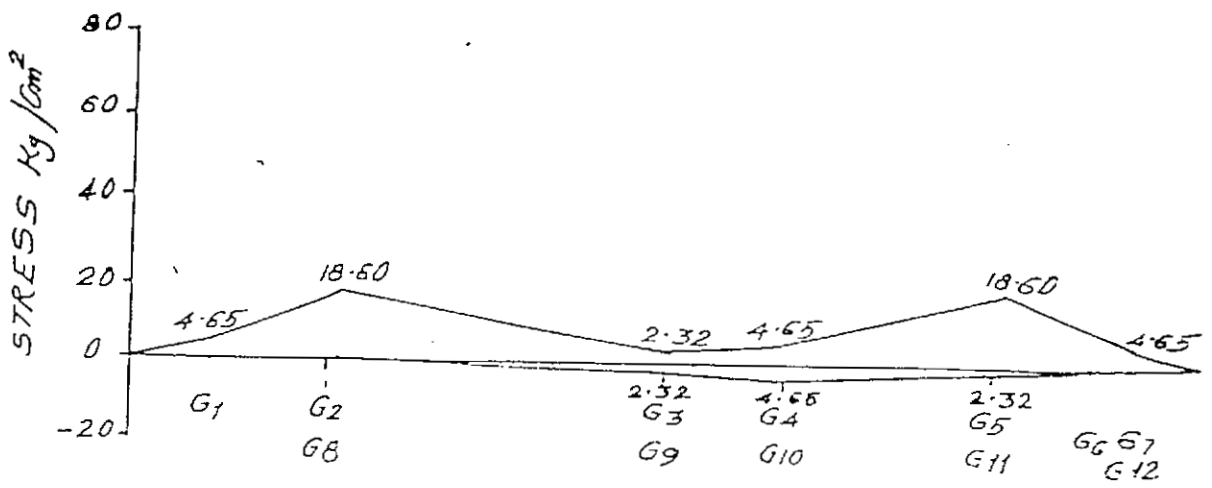
GAUGE LOCATION

MAXIMUM & MINIMUM STRESS RANGE AT INITIAL STAGE



GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT 1 MILLION CYCLES



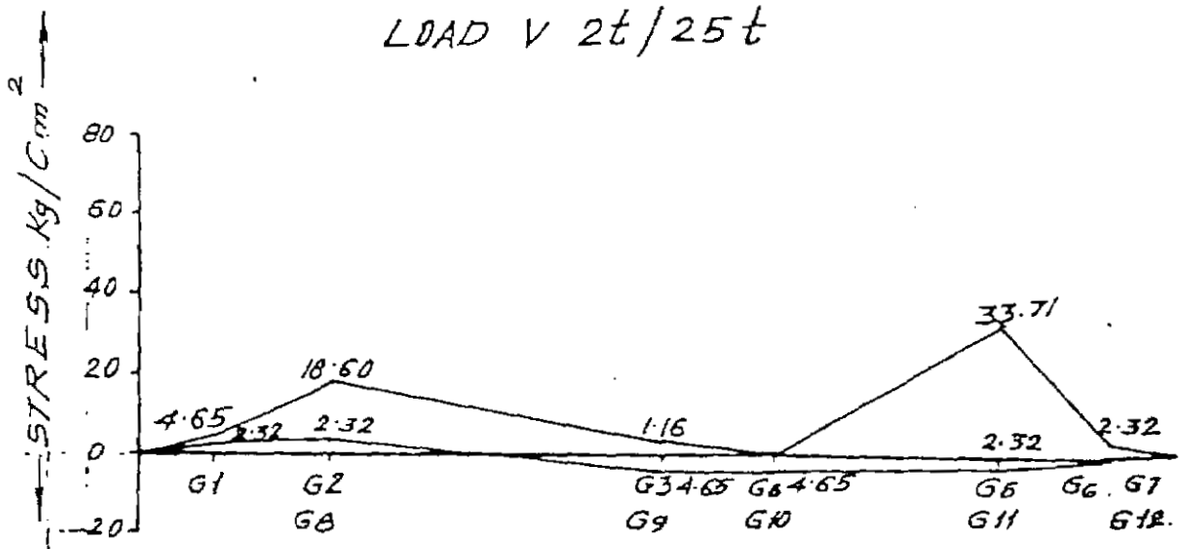
GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT 2 MILLION CYCLES

TESTING OF SHALLOW SLEEPER FOR B.G. 60 Kg. (UIC) DRG No. 4852

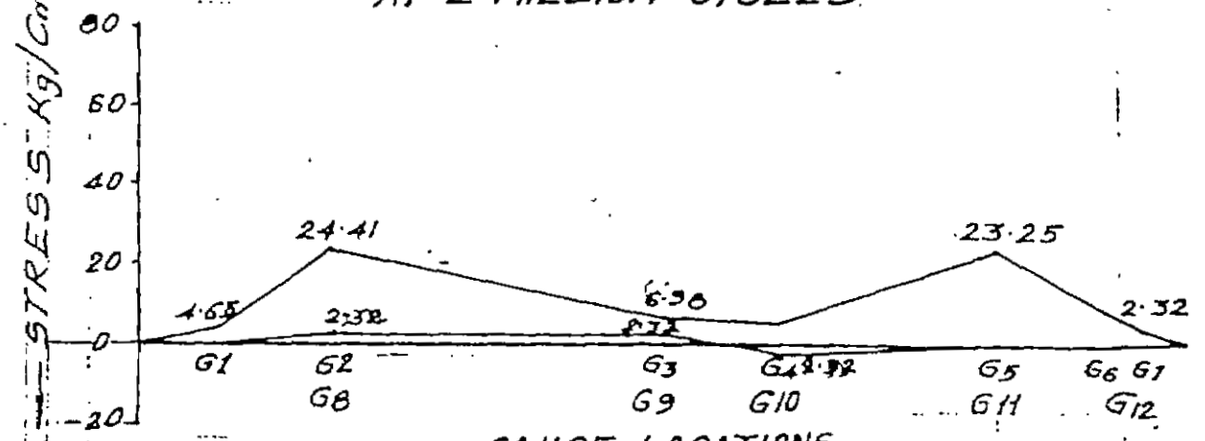
SLEEPER UNDER LOAD

LOAD V 2t/25t



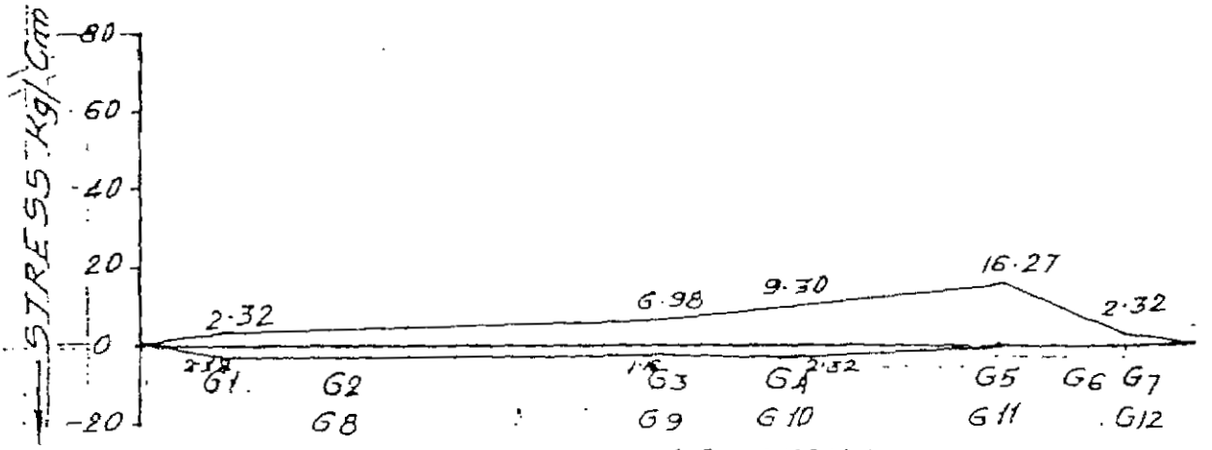
GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AFTER PACKING AT 2 MILLION CYCLES



GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT 3 MILLION CYCLES

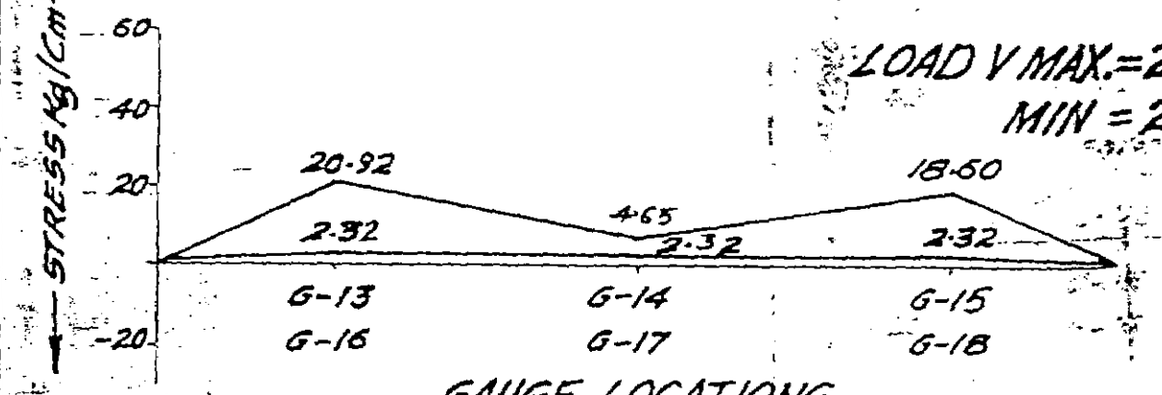


GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT 4-MILLION CYCLES

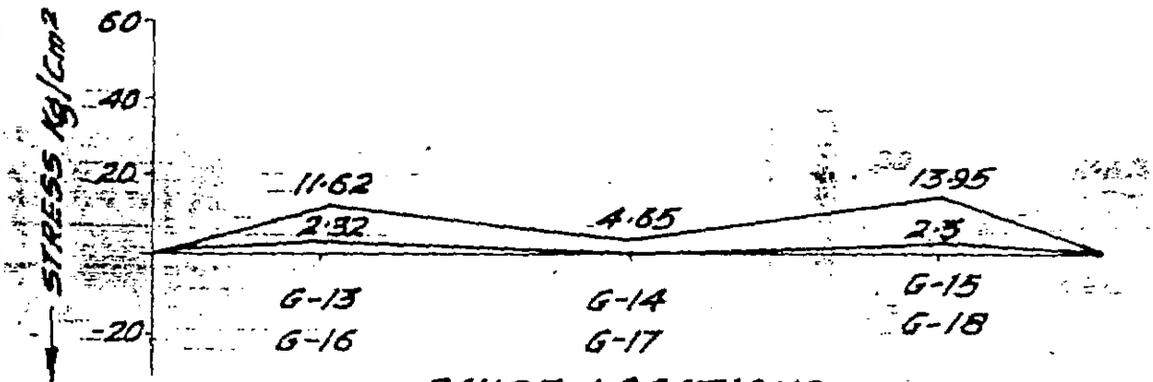
SLEEPER ADJACENT TO LOADED SLEEPER

LOAD V MAX.=25t
MIN = 2t



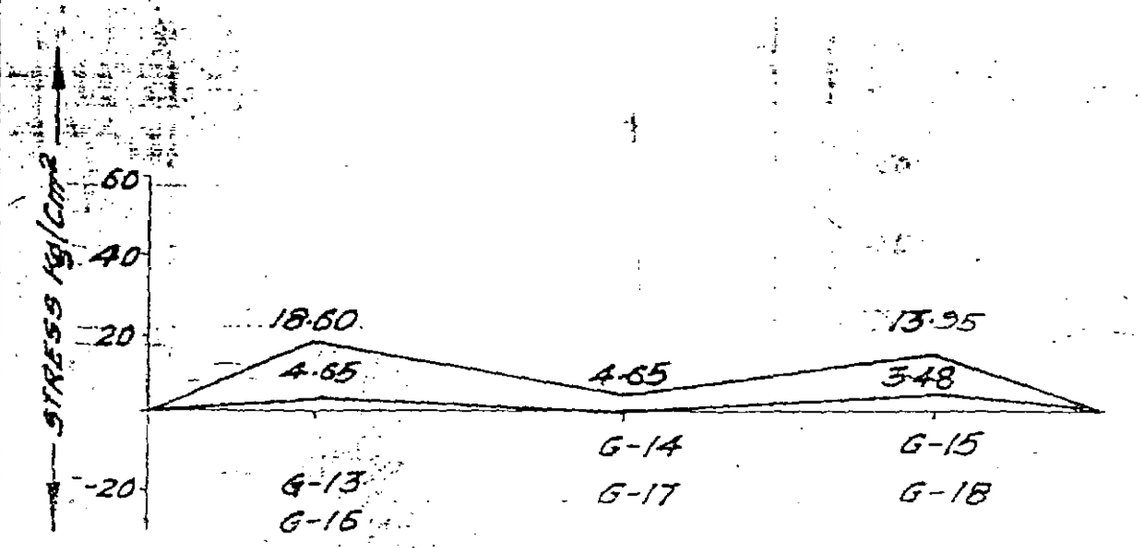
GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT INITIAL STAGE



GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT 1 MILLION CYCLES

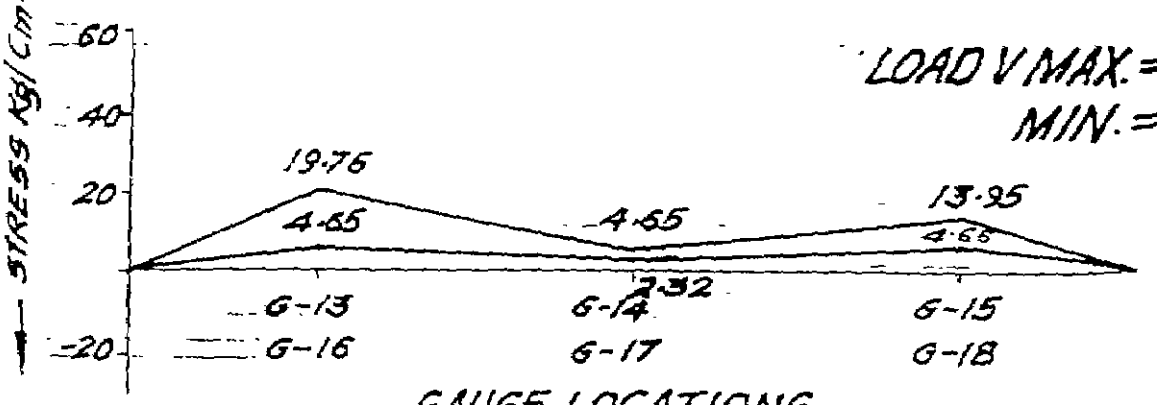


GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT 2 MILLION CYCLES

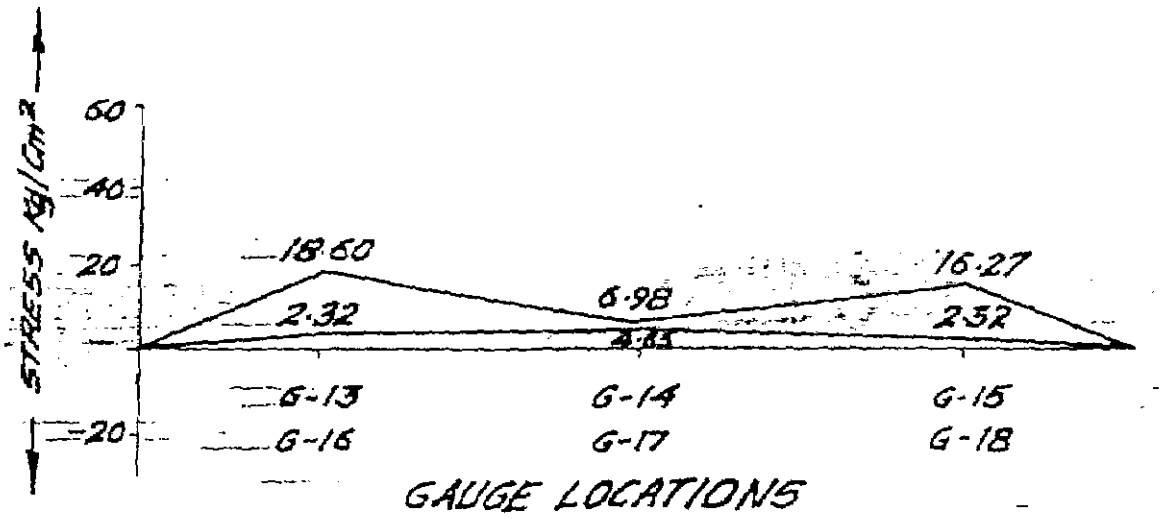
SLEEPER ADJACENT TO LOADED SLEEPER

LOAD V MAX. = 25t
MIN. = 2t



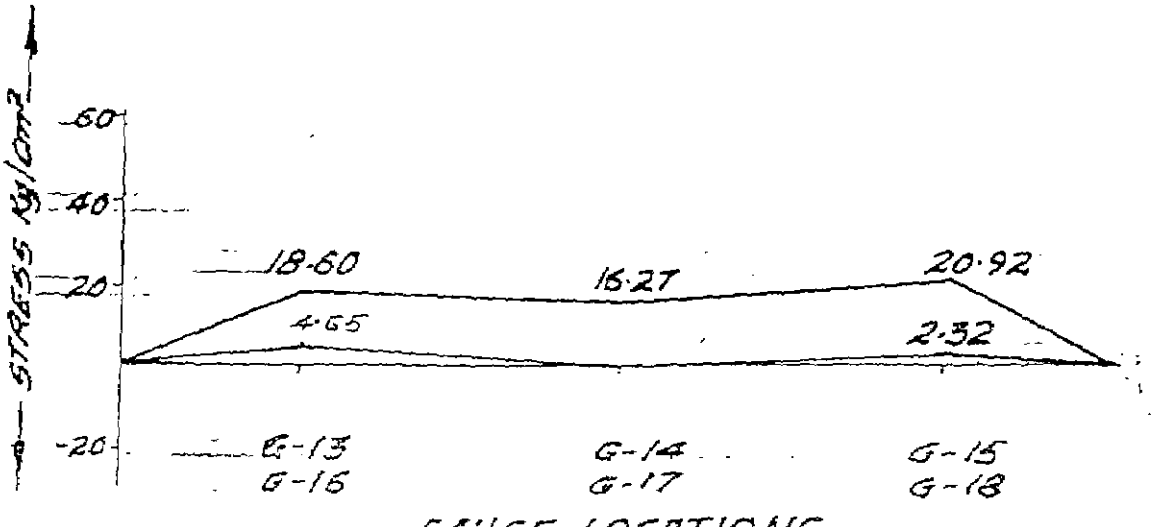
GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AFTER PACKING AT 2 MILLION CYCLES



GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT MILLION CYCLES



GAUGE LOCATIONS

MAXIMUM & MINIMUM STRESS RANGE AT 4 MILLION CYCLES