

ASSESSMENT SUMMARY

Made by BST

Checked by

Date JUL16

Reference	<p>THE SAFE LOAD-CARRYING CAPACITY OF THE EXISTING ACCESS BRIDGE AT OUGHTIBRIDGE MILLS IN SHEFFIELD HAS BEEN ASSESSED IN ACCORDANCE WITH CURRENT BD CODES.</p>
Pg# 13	<p>THE BRIDGE CAPACITY HAS BEEN FOUND TO BE GOVERNED BY THE EXISTING STIFFENED TRANSVERSE STEEL BEAMS, THESE ARE CAPABLE OF CARRYING AN ALL IN THE RANGE OF 26 TO 32 TONNES, DEPENDING ON THE ACTUAL CONDITION OF THE ROAD SURFACE.</p> <p>AS THE BRIDGE IS PROPOSED TO BE USED AS A TEMPORARY ACCESS TO/OUT OF A CONSTRUCTION SITE, IT IS ADVISABLE THAT A SINGLE "HGV" VEHICLE IS PRESENT ON THE BRIDGE AT ONE TIME (UP TO 32 TONNES GROSS WEIGHT) AND THAT THE CURRENT SPEED LIMIT OF "10 MPH" IS MAINTAINED DURING THE CONSTRUCTION PERIOD. THESE LIMITATIONS WILL HELP REDUCE ANY POTENTIAL EFFECTS OF LOAD IMPACT, OVERLOADING AND LATERAL BUNCHING. HENCE, A SINGLE NOTIONAL LANE HAS ONLY BEEN CONSIDERED IN THIS ASSESSMENT.</p>



Project OUGHTIBRIDGE MILLS

Section ACCESS BRIDGE

ASSESSMENT

Job No LS1611

Page No INDEX

Revision

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BRIDGE DESCRIPTION

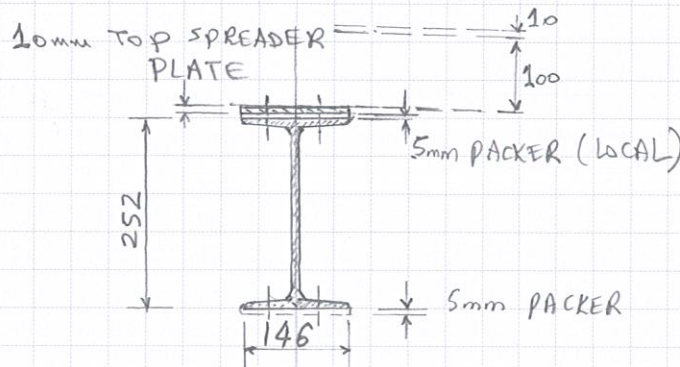
(CONT...)

EXISTING STEEL BRIDGE IS TO BE USED AS A TEMPORARY ACCESS STRUCTURE TO A CONSTRUCTION SITE, FORMELY, KNOWN AS 'THE OUGHTIBRIDGE PAPER MILL' SITE.

THE PHYSICAL CONDITION OF THE BRIDGE HAS BEEN INPECTED & ASSESSED BY 'UP & UNDER LTD' IN APRIL 2016; THEIR SITE FINDINGS ARE INCLUDED IN REPORT REF 'UL4666/PMO/MAY2016 - ISSUE 1'.

TYPICALLY, THE BRIDGE CONSISTS OF A SINGLE-SPAN STEEL STRUCTURE SPANNING OVER THE RIVER DON IN SHEFFIELD TO THE EAST OF THE PAPER MILL SITE.

THE BRIDGE COMPRISES A 10mm THK, MILD STEEL PLATE WELDED TO 15x100mm DP STEEL STIFFENERS @ 125mm CENTRES SPANNING ACROSS LONGITUDINAL STEEL IB'S MEASURED AT UB252x146x31 kg/m (REF.5) & LOCATED @ 500mm CENTRES. 10mm THK, FULL LENGTH MILD STEEL PLATES RUN ALONG EACH IB SUPPORTED BY 5mm THK PACKERS LOCAL TO BOLTED CONNECTIONS INTO THE TOP FLANGES.



TYPICAL LONG'L IB

FOR EASE OF CONSTRUCTION THE LONGITUDINAL BEAMS ARE ARRANGED IN THREE SECTIONS ALONG THE FULL LENGTH OF THE

Reference

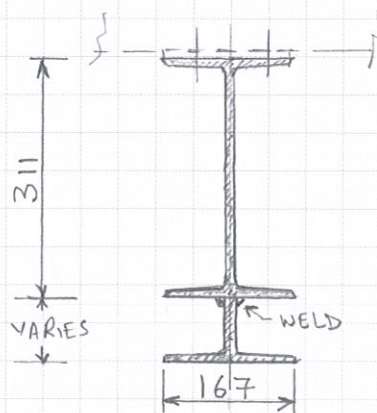
(CONT--&gt;)

BRIDGE, AS SHOWN IN THE DIMENSIONAL SURVEY DRAWINGS Nos LW4666/PMO/A3/01 TO 06 INCLUSIVE.

FROM SURVEY EACH LONGITUDINAL BEAM SPANS APPROX. 3100 mm ( $\approx 10$  ft) ON TOP OF EITHER 4N $\approx$  TRANSVERSE IB'S, MEASURED AT UB311 x 167 x 54 kg/m (REF. 5) (MILD STEEL), WITHIN THE MIDDLE SECTION OF THE DECK OR 3N $\approx$  IB'S WITHIN THE END SECTIONS (REFER TO DWG No 01 FOR BEAM LAYOUT).

IT SHOULD BE NOTED THAT ALL TRANSVERSE BEAMS (TYPES A TO D) HAVE T-SECTIONS WELDED TO THE BOTTOM FLANGES AT SOMETIME IN THE PAST. IT IS BELIEVED THAT THIS REMEDIAL MEASURE WAS IMPLEMENTED TO ENHANCE THE LOAD-CARRYING CAPACITY OF THE BEAMS BY VARIABLY INCREASING THEIR OVERALL DEPTHS / INERTIAS.

SITE CONNECTIONS BETWEEN THE LONG & TRANSVERSE BEAMS ARE ALL FOUND TO BE BOLTED WITH SIGNS OF SURFACE CORROSION / DISCOLOURION.



TYPICAL TRANSVERSE IB (TOP) + VARIABLE T-STIFFENER (BTM)

Reference

THE TRANSVERSE BEAMS IN TURN SIT ON TOP OF A STEEL TRUSS STRUCTURE COMPRISING TWO MAIN LATTICE GIRDERS OF RIVETED PLATES & ANGLES, LINKED BY TRANSVERSE CROSS BRACING @  $\frac{1}{3}$ RD POINTS. EACH GIRDER IS SIMPLY SUPPORTED ON STONE PADSTONES ON STONE MASONRY ABUTMENTS & LATERALLY RESTRAINED BY BRACING. FOR LATTICE GIRDER DETAILS REFER TO DWG NOS 02 & 03.

SCOPE OF ASSESSMENT

THE OBJECTIVE OF THESE CALCULATIONS IS TO DETERMINE THE SAFE LOAD-CARRYING CAPACITY OF THE BRIDGE SO THAT IT CAN BE USED AS A TEMPORARY ACCESS BRIDGE DURING THE DEVELOPMENT & CONSTRUCTION WORKS OF 'OUGHTI BRIDGE MILLS' PROJECT & ITS NEWLY PROPOSED COMPOSITE BRIDGE UPSTREAM OF THE EXISTING STRUCTURE.

FOUR BASIC ELEMENTS ARE TO BE CONSIDERED DURING THIS ASSESSMENT:

- a) DECK PLATE & STIFFENERS.
- b) LONGITUDINAL UB 252x146x31 & TOP 10mm THK SPREADER PLATE (MILD STEEL) @ ULS IN ACCORDANCE WITH BDS6/10.
- c) TRANSVERSE UB 311x167x54 WITH BTM T-SECTIONS @ ULS (BDS6/10).
- d) RIVETED LATTICE TRUSS GIRDER @ ELASTIC STRESS LIMIT STATE.

CONSEQUENTLY, THE LEAST LOAD-CARRYING CAPACITY OF THE ABOVE ELEMENTS WILL REPRESENT THE BRIDGE CAPACITY FOR THIS SPECIFIC CONSTRUCTION SITE.

Reference

LIST OF CODES & DOCUMENTS :

- 1 - BS648:1964 SCHEDULE OF WEIGHTS OF BUILDING MATERIALS.
- 2 - BD21/01: THE ASSESSMENT OF HIGHWAY BRIDGES & STRUCTURES.
- 3 - BS5400-3:2000 CODE OF PRACTICE FOR DESIGN OF STEEL BRIDGES.
- 4 - BD56/10: THE ASSESSMENT OF STEEL HIGHWAY BRIDGES & STRUCTURES.
- 5 - HISTORICAL STRUCTURAL STEELWORK HANDBOOK, 1962.
- 6 - "CONDITION & DIMENSIONAL SURVEY OF PAPER MILL ACCESS BRIDGE, OUGHTIBRIDGE" REPORT REF: UU 4666/PMO/MAY 2016 - ISSUE 1.
- 7 - BS449-2:1948 SPECIFICATION FOR THE USE OF STRUCTURAL STEEL IN BUILDING.

(APPENDED)

Reference

 a) DECK PLATE & STIFFENERS

CLEAR C/W WIDTH = 4.3 m.

O/A WIDTH OF HGV = 2.55 m (MAX)

 & CHECK DECK UNDER 1 N<sup>o</sup> HGV.

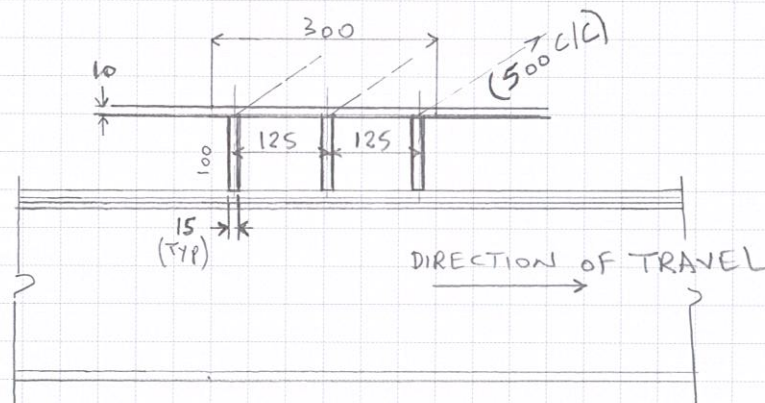
CONSIDER A SINGLE WHEEL LOAD AT MIDPOINT OF TWO LONGITUDINAL BEAMS:

BD 21/01

 CONTACT AREA = 300 x 300 mm FOR AN EFFECTIVE PRESSURE OF 1.1 N/mm<sup>2</sup>.

TABLE 5.3.2

CONSERVATIVELY, ASSUME SWL = 100 kN (HP CAT'RY).


LOADS: CONSIDER A TYPICAL T-SECTION @ CENTRE.

$$DL = (10^3 \times 10 \times 0.125 + 0.1 \times 15 \times 10^3) \times 77 = 0.211 \text{ kN/m (SLS)}$$

$$LL = 1.1 \times 125 \times 10^3 \times 1/10^3 = 137.5 \text{ kN/m (SLS) @ 300mm LONG.}$$

BD 21/01

$$\therefore S_A = (1.1 \times 0.211 \times 1.05) \text{ \& } (1.1 \times 137.5 \times 1.5 \times 0.3) \\ = 0.243 \text{ kN/m \& } 68 \text{ kN @ MIDPOINT (ULS)}$$

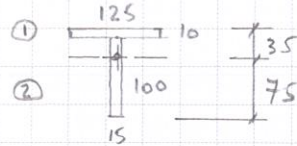
CONTINUOUS ELEMENT

FORCES 
$$BM_x = 0.243 \times 0.5 \times 0.105 + 68 \times 0.158 \times 0.5 = 5.38 \text{ kNm}$$

$$\& V_u = 0.243 \times 0.5 \times 0.605 + 68 \times 0.679 = 46.25 \text{ kN}$$

 FOLLOWING THE INSPECTION FINDINGS THEN A CONDITION FACTOR  $F_c$  OF 0.9 IS USED.

Reference

SECTION PROPERTIES


$$A_1 = 1250 \text{ mm}^2$$

$$A_2 = 1500 \text{ mm}^2$$

$$\Sigma A = 2750 \text{ mm}^2$$

$$\bar{Y} = (1250 \times 105 + 1500 \times 50) \div 2750 = 75 \text{ mm}$$

$$I_{xx} = \frac{125 \times 10^3}{12} + 1250 \times 30^2 + \frac{15 \times 100^3}{12} + 1500 \times 25^2 = 3322.9 \times 10^3 \text{ mm}^4$$

$$Z_{xT} = I_{xx} / 35 = 94.94 \times 10^3 \text{ mm}^3$$

$$Z_{xB} = I_{xx} / 75 = 44.30 \times 10^3 \text{ mm}^3$$

SECTION IS LATERALLY RESTRAINED (WELDED DECK):

$$BS5400-3 \quad M_D^{-ve} = (94.94 \times 10^3 \times 165 \times 10^{-6}) \times 0.9 = 14.1 \text{ kNm} > BM_x \therefore \text{OK}$$

$$BS449-2 \quad \& V_D = 0.9 \times (15 \times 100 \times 0.6 \times 165) \div 1.05 \times 1.1 \times 10^3 = 115.7 \text{ kN} > V_U \therefore \text{OK}$$

CHECK SECTION IN BENDING + SHEAR:

$$\frac{M}{M_D} + \left(1 - \frac{M_f}{M_D}\right) \left(\frac{2V}{V_R} - 1\right) = \frac{5.38}{14.1} + 0 = 0.38 < 1 \quad (M_f = M_D) \therefore \text{OK}$$

$$\& \frac{V}{V_D} = \frac{46.25}{115.7} = 0.40 < 1 \quad (V_R = V_D)$$

RESULT: STIFFENED DECK PLATE IS ADEQUATE FOR ALL OF 40 TONNES IN ACCORDANCE WITH BD21/01. (SWL=100kN)

## ASSESSMENT

Made by BST

Checked by

Date JUN 16

Reference	b) <u>LONGITUDINAL UB252 x 146 x 31 &amp; TOP</u> <u>10 mm THK SPREADER PLATE : 3100 SPANS (TYP)</u>
Pg# 02	CONSIDER THE MOST ONEROUS BEAMS WITH HIGH SHEAR & BENDING FORCES WITHIN THE END SECTIONS OF DECK.
BD21/01	ASSESS A TYPICAL BEAM OF A 500mm WIDE LOADED COVER UNDER THE EFFECTS OF DEAD, (HA+KEL) ALL LOADS FULL LOADED LENGTH, $L = 24.3 \text{ m}$ (REF. 6) $\therefore W = 336 \left(\frac{1}{24.3}\right)^{0.67} = 39.6 \text{ KN/m PER}$ $3.65 \text{ m WIDE LANE} = 10.85 \text{ KN/m}^2$ & $KEL = 120 \div 3.65 = 32.87 \text{ KN/m}$ DECK PLATE = $10 \times 10^3 \times 77 = 0.77 \text{ KN/m}^2$ STIFFENERS D.L = $0.1 \times 15 \times 10^3 \times 77 \div 0.125 = 0.924 \text{ KN/m}^2$ SPREADER PLATE = $0.146 \times 0.01 \times 77 = 0.11 \text{ KN/m}$ $\therefore$ TOTAL DL / BEAM = $0.11 + 0.31 + 0.5(0.924 + 0.77) = 1.27 \text{ KN/m (SLS)}$ & HA ALL = $10.85 \times 0.5 = 5.425 \text{ KN/m (SLS)}$ + HA KEL = $32.87 \times 0.5 = 16.5 \text{ KN (SLS)}$ $\therefore$ SA = $1.1 \times (1.05 \times 1.27 + 1.5 \times 5.425) + \text{PACKS} = 10.5 \text{ KN/m (ULS)}$ $+ 1.1 \times 1.5 \times 16.5 = 27.23 \text{ KN @ MIDSPAN (ULS)}$
2-SPAN CONTINUOUS BEAM :	<u>FORCES :</u> $BM_x = 0.125 \times 10.5 \times 3.1^2 + 0.188 \times 27.23 \times 3.1 = 28.5 \text{ KNm}$ & $V_u = 0.625 \times 3.1 \times 10.5 + 27.23 \times 0.688 = 39.1 \text{ KN}$ A CONDITION FACTOR OF $> 0.9$ IS TO BE ADOPTED. (Fc) FOR SECTION PROPERTIES REFER TO 'TEDDS' BEAM CHECK PAGES 'LB/1 & 2' - ATTACHED.

Reference

BS5400-3

CHECK SECTION IN BENDING + SHEAR:

$$F_f = G_f \cdot A_{fe} = 162 \times 146 \times 8.6 \times 10^{-3} = 203.4 \text{ kN}$$

$$d_f = 251.5 - 8.6 = 242.9 \text{ mm.}$$

$$\therefore M_f = 203.4 \times 0.2429 / 1.05 \times 1.1 = 42.77 \text{ kNm} < M_D.$$

$$\& M_f > 8M_x.$$

$$\text{HENCE, } \frac{M}{0.9M_b} = \frac{28.5}{0.9 \times 54.4} = 0.58 < 1 \therefore \text{OK}$$

$$\& \frac{V}{0.9V_D} = \frac{39.1}{0.9 \times 149} = 0.291 < 1 \therefore \text{OK}$$

'TEDDS'

RESULT: LONGITUDINAL BEAMS ARE ADEQUATE FOR THE 40 TONNES ALL LOAD LEVEL IN ACCORDANCE WITH BD21/01.

Project <b>Oughtibridge Mills, Sheffield</b>				Job no. <b>LS1611</b>	
Calcs for <b>Longitudinal Beam Check (ignore spreader plate)</b>				Start page no./Revision <b>LB/ 1</b>	
Calcs by <b>BST</b>	Calcs date <b>28/06/2016</b>	Checked by	Checked date	Approved by	Approved date

**HISTORICAL SECTION DESIGN**

Try Universal Beams To BS4 1962 10x5.75x21

For 1959 MS Rolled 1.50in or less

**SECTION PROPERTY DATA - I SECTIONS - METRIC UNITS**

D = 251.5 mm	B = 146.0 mm	A = 40.0 cm <sup>2</sup>
Mass = 31.3 kg/m	t = 6.1 mm	T = 8.6 mm
I <sub>xx</sub> = 4424.5 cm <sup>4</sup>	Z <sub>xx</sub> = 352.3 cm <sup>3</sup>	r <sub>xx</sub> = 10.4 cm
I <sub>yy</sub> = 403.7 cm <sup>4</sup>	Z <sub>yy</sub> = 55.7 cm <sup>3</sup>	r <sub>yy</sub> = 3.3 cm

**STRESS DATA - METRIC UNITS**

p <sub>bc</sub> = 162 N/mm <sup>2</sup>	p <sub>bt</sub> = 162 N/mm <sup>2</sup>
p <sub>t</sub> = 147 N/mm <sup>2</sup>	p <sub>q</sub> = 108 N/mm <sup>2</sup>

**SHEAR CAPACITY**

$F_{vy} = 39.1 \text{ kN}$

$A_v = k_s \times t \times D = 1380 \text{ mm}^2$

$P_{vy} = p_q \times A_v = 149 \text{ kN}$

Utilisation ratio  $\text{abs}(F_{vy})/P_{vy} = 0.262$

**PASS - Shear check**

**MOMENT CAPACITY - FULLY RESTRAINED**

$M_x = 28.5 \text{ kNm}$

$M_{cx} = \min(p_{bc} \times Z_{xx}, p_{bt} \times Z_{xx}) = 57.1 \text{ kNm}$

**PASS - Bending check**

**LTB CHECKS - BS449 1948**

$M_x = 28.5 \text{ kNm}$

Effective length  $L_{eyy} = k_{yy} \times L_{yy} = 3100 \text{ mm}$

Slenderness  $l_{yy} = L_{eyy} / r_{yy} = 94$

**PASS - L/r ratio <= 300**

$M_b = p_b \times Z_{xx} = 54.4 \text{ kNm}$

**PASS - Lat. tors. buckling check**

**DEFLECTION**

Maximum deflection  $\delta = \max(\text{abs}(\delta_{\max}), \text{abs}(\delta_{\min})) = 10.0 \text{ mm}$

Reference

 c) TRANSVERSE BEAMS LB 311x167x54 WITH BTM WELDED T-SECTIONS:

FROM SITE INSPECTION ALL BEAM TYPES 'A TO D' CANTILEVER BEYOND THE BEARING SUPPORTS AT BOTH SIDES OF THE TRAFFICKED WIDTH.

FOR ASSESSMENT PURPOSES THE RELIEVING LIVE EFFECTS OF THE CANTILEVERS ARE TO BE IGNORED. THEREFORE, NO FOOTWAY LOADS WILL BE APPLIED INCLUDING PARAPET LOADS.

IN ADDITION, BOLTED EXTENSIONS TO THE SOUTH ENDS OF ALL TRANSVERSE BEAMS WILL NOT BE CONSIDERED IN THE ASSESSMENT - CONSERVATIVE.

INSPECTION OF DWG NO: 01 IN THE CONDITION SURVEY REPORT SHOWS THAT BEAM TYPE B HAS THE MOST ONEROUS LOADING CONDITION: THIS BEAM FORMS A CENTRE SUPPORT TO THE LONGITUDINAL BEAMS THEREBY HAVING A GREATER APPLIED LOAD OF

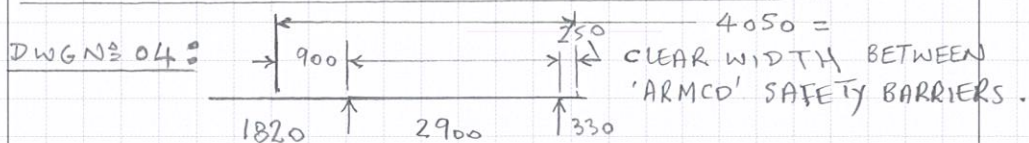
$$(1.25 \times \text{UDL} \times 3.1) \text{ KN/m} + (\text{HA KEL}).$$

BEAM SPAN:

FROM SITE MEASUREMENTS, SPAN = 5050mm (REF.6)

BEARING CENTRES  $\geq$  2900 mm (REF.6).

IDEALISED BEAM FOR ASSESSMENT:



ASSUME MAX HGV WIDTH PASSING OVER THE BRIDGE = 2500 mm. IT IS PRUDENT TO ASSESS THE BEAM FOR HA (UDL + KEL) APPLIED WITHIN THE MIDDLE WIDTH OF 2900 mm + IGNORE ANY RELIEVING EFFECTS OF THE CANTILEVERS.

Reference

LOADS :

Pg # 7

$$\text{DECK PLATE} = 0.77 \text{ KN/m}^2$$

$$\text{DECK STIFF'S} = 0.924 \text{ KN/m}^2$$

$$\text{LONG'L BEAMS + SPREADER PLATES} =$$

$$(0.31 + 0.11) \div 0.5 = 0.84 + \text{PACKS} = 0.90 \text{ KN/m}^2 \text{ say}$$

$$\text{TRANS BEAM SWT} = 0.54 + \text{LARGEST T-DEPTH} =$$

$$0.54 + (90/291) \times 0.54 = 0.71 \text{ KN/m}$$

 311-10-10 =  
291 mm

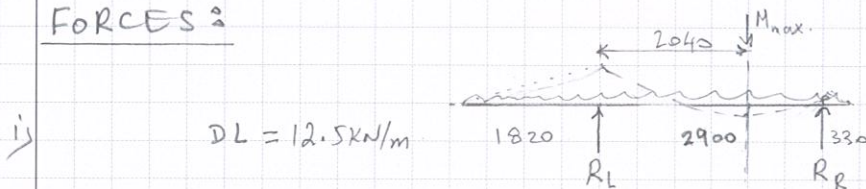
$$\therefore \text{TOTAL DL} = (0.77 + 0.924 + 0.90) \times 1.25 \times 3.1 + 0.71 = 10.76 \text{ KN/m (SLS)}$$

$$\text{HA WDL} = 10.85 \times 3.1 \times 1.25 = 42 \text{ KN/m (SLS)}$$

$$\& \text{ HA KEL} = 120 \text{ KN @ MIDPOINT OF 2900 mm}$$

$$\therefore S_A = 1.1 \times (1.05 \times 10.76 + 1.5 \times 42) = (12.5 D + 70 L) \text{ KN/m (SLS)}$$

$$+ 1.1 \times 1.5 \times 120 = 198 \text{ KN @ MIDPOINT OF 2900 mm}$$

FORCES :


$$R_L = (12.5 \times 4720^2 \times 0.5 - 12.5 \times 330^2 \times 0.5) \div 2900 \times 10^3 = 47.78 \text{ KN}$$

$$R_R = 5.05 \times 12.5 - 47.78 = 15.3 \text{ KN}$$

$$V = 0 \text{ @ } 47.78 - 12.5 \times X = 0 \therefore X = 3822 \text{ mm FROM LHS}$$

$$\therefore M_L^- = -12.5 \times 1.82^2 \times 0.5 = -20.7 \text{ KNm}$$

$$* M_{max}^+ = 47.78 \times (3.822 - 1.82) - 12.5 \times 3.822^2 \times 0.5 = +4.36 \text{ KNm}$$

$$M_R^- = -12.5 \times 0.33^2 \times 0.5 = -0.68 \text{ KNm}$$

$$V_L = 12.5 \times 1.82 = 22.75 \text{ KN (LHS)}$$

$$= 47.78 - 22.75 = 25.1 \text{ KN (RHS)}$$

$$* V_R = 12.5 \times 0.33 = 4.1 \text{ KN (RHS)}$$

$$= 14.9 - 4.1 = 10.8 \text{ KN (LHS)}$$

$$* M_{mid}^+ = 47.78 \times 1.45 - 12.5 \times (1.82 + 1.45)^2 \times 0.5 = +2.5 \text{ KNm}$$