(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITRY SUPPLEMENTARY EXAMINATIONS 2019/2020 ACADEMIC YEAR

FIRTH YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND STRUCTURAL ENGINEERING

COURSE CODE: CSE 516

COURSE TITLE: DESIGN OF BRIDGES

DATE: WEDNESDAY 21ST OCTOBER 2020 TIME: 8.00 – 10.00 AM

INSTRUCTIONS:

1. Answer ALL Questions in SECTION A and any ONE questions in SECTION B
2. BS 5400 Bridge Design Codes are allowed
3. Examination duration is **2 Hours**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 5 Printed Pages. Please Turn Over.

SECTION A: COMPULSORY (ANSWER ALL QUESTIONS)

Question ONE (15 marks)

Given the following design data for a proposed bridge. Determine the critical design bending moment due to LIVE loading.

- Span of bridge = 30m centre to centre of the bearings
- Width of bridge = 9m
- Design HB loading = 30 Units

Question TWO (15 marks)

Analysis of a three span steel bridge girder shown in figure **Q2-(a)** using the influence line method gave the bending moment influence diagram in figure **Q2-(b)** for critical moments at Points B as shown on the figure. Using the given influence line diagram.

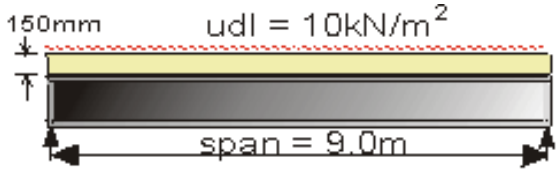
i. Determine the critical bending moment due HA loading. **(8 marks)**

ii. Determine the critical sagging bending moment due 40 units of HB loading. **(7 marks)**

SECTION B: ANSWER ONE QUESTION

Question THREE (40 marks)

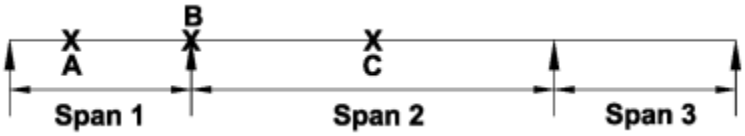
Design a simply supported beam which carries a 150mm thick concrete slab together with a nominal HA live load udl of 10.0 kN/m^2. The span of the beam is 9.0m centre to centre of bearings and the beams are spaced at 2.6m intervals. The slab will be assumed to be laid on top of the beams with no positive connection to the compression flange**. (40 marks)**



Question FOUR (40 marks)

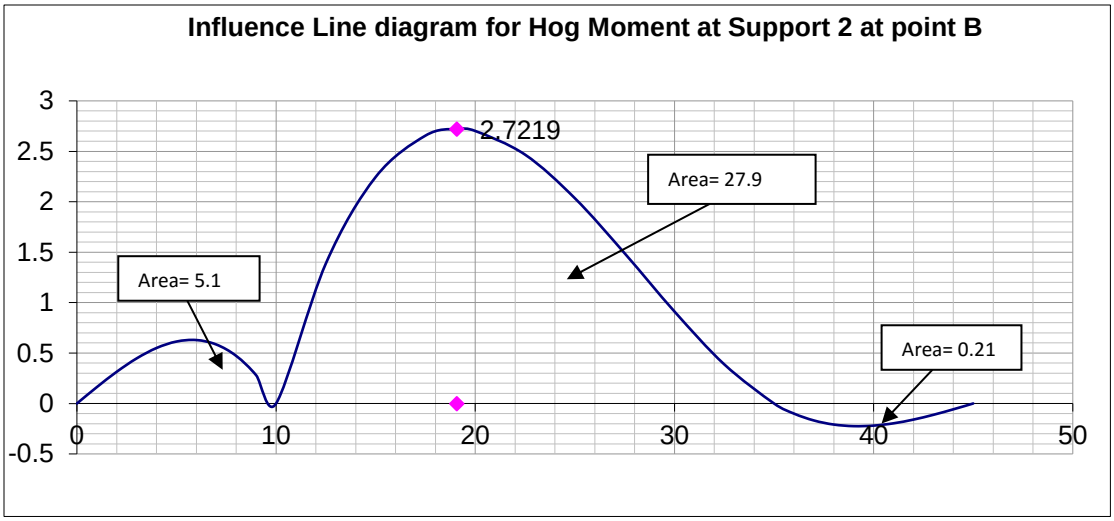
Design a simply supported reinforced concrete deck slab using a unit strip method. The deck carries a 100mm depth of surfacing, together with a nominal HA live load UDL of 16.0 kN/m^2 and knife edge load of 25kN/m. The deck should also be designed to carry 30 units of HB load. The span of the deck is 12.0m centre to centre of bearings. **(40 marks)**

Figure Q2-(a)



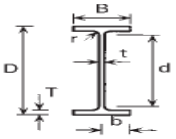
Span 1= 9m, span 2= 18m, span 8= 10m

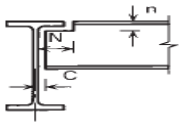
Figure Q2-(b)



Tables of dimensions and gross section properties

UNIVERSAL BEAMS

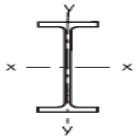




DIMENSIONS

Section Designation	Mass per Metre kg/m	Depth of Section D mm	Width of Section B mm	Thickness Web t mm	Thickness Flange T mm	Root Radius r mm	Depth between Fillets d mm	Ratios for Local Buckling Flange b/T	Ratios for Local Buckling Web d/t	Dimensions for Detailing End Clearance C mm	Dimensions for Detailing Notch N mm	Dimensions for Detailing Notch n mm	Surface Area Per Metre m^2	Surface Area Per Tonne m^2
1016 ∞ 305 ∞ 487 # †	486.6	1036.1	308.5	30.0	54.1	30.0	867.9	2.85	28.9	17	150	86	3.19	6.57
1016 ∞ 305 ∞ 437 # †	436.9	1025.9	305.4	26.9	49.0	30.0	867.9	3.12	32.3	16	150	80	3.17	7.25
1016 ∞ 305 ∞ 393 # †	392.7	1016.0	303.0	24.4	43.9	30.0	868.2	3.45	35.6	14	150	74	3.14	8.01
1016 ∞ 305 ∞ 349 # †	349.4	1008.1	302.0	21.1	40.0	30.0	868.1	3.77	41.1	13	150	70	3.13	8.96
1016 ∞ 305 ∞ 314 # †	314.3	1000.0	300.0	19.1	35.9	30.0	868.2	4.18	45.5	12	150	66	3.11	9.90
1016 ∞ 305 ∞ 272 # †	272.3	990.1	300.0	16.5	31.0	30.0	868.1	4.84	52.6	10	152	63	3.10	11.4
1016 ∞ 305 ∞ 249 # †	248.7	980.2	300.0	16.5	26.0	30.0	868.2	5.77	52.6	10	152	56	3.08	12.4
1016 ∞ 305 ∞ 222 # †	222.0	970.3	300.0	16.0	21.1	30.0	868.1	7.11	54.3	10	152	52	3.06	13.8
914 ∞ 419 ∞ 388 #	388.0	921.0	420.5	21.4	36.6	24.1	799.6	5.74	37.4	13	210	62	3.44	8.87
914 ∞ 419 ∞ 343 #	343.3	911.8	418.5	19.4	32.0	24.1	799.6	6.54	41.2	12	210	58	3.42	9.95
914 ∞ 305 ∞ 289 #	289.1	926.6	307.7	19.5	32.0	19.1	824.4	4.81	42.3	12	156	52	3.01	10.4
914 ∞ 305 ∞ 253 #	253.4	918.4	305.5	17.3	27.9	19.1	824.4	5.47	47.7	11	156	48	2.99	11.8
914 ∞ 305 ∞ 224 #	224.2	910.4	304.1	15.9	23.9	19.1	824.4	6.36	51.8	10	156	44	2.97	13.3
914 ∞ 305 ∞ 201 #	200.9	903.0	303.3	15.1	20.2	19.1	824.4	7.51	54.6	10	156	40	2.96	14.7
838 ∞ 292 ∞ 226 #	226.5	850.9	293.8	16.1	26.8	17.8	761.7	5.48	47.3	10	150	46	2.81	12.4
838 ∞ 292 ∞ 194 #	193.8	840.7	292.4	14.7	21.7	17.8	761.7	6.74	51.8	9	150	40	2.79	14.4
838 ∞ 292 ∞ 176 #	175.9	834.9	291.7	14.0	18.8	17.8	761.7	7.76	54.4	9	150	38	2.78	15.8
762 ∞ 267 ∞ 197	196.8	769.8	268.0	15.6	25.4	16.5	686.0	5.28	44.0	10	138	42	2.55	13.0
762 ∞ 267 ∞ 173	173.0	762.2	266.7	14.3	21.6	16.5	686.0	6.17	48.0	9	138	40	2.53	14.6
762 ∞ 267 ∞ 147	146.9	754.0	265.2	12.8	17.5	16.5	686.0	7.58	53.6	8	138	34	2.51	17.1
762 ∞ 267 ∞ 134	133.9	750.0	264.4	12.0	15.5	16.5	686.0	8.53	57.2	8	138	32	2.51	18.7
686 ∞ 254 ∞ 170	170.2	692.9	255.8	14.5	23.7	15.2	615.1	5.40	42.4	9	132	40	2.35	13.8
686 ∞ 254 ∞ 152	152.4	687.5	254.5	13.2	21.0	15.2	615.1	6.06	46.6	9	132	38	2.34	15.4
686 ∞ 254 ∞ 140	140.1	683.5	253.7	12.4	19.0	15.2	615.1	6.68	49.6	8	132	36	2.33	16.6
686 ∞ 254 ∞ 125	125.2	677.9	253.0	11.7	16.2	15.2	615.1	7.81	52.6	8	132	32	2.32	18.5
610 ∞ 305 ∞ 238	238.1	635.8	311.4	18.4	31.4	16.5	540.0	4.96	29.3	11	158	48	2.45	10.3
610 ∞ 305 ∞ 179	179.0	620.2	307.1	14.1	23.6	16.5	540.0	6.51	38.3	9	158	42	2.41	13.5
610 ∞ 305 ∞ 149	149.2	612.4	304.8	11.8	19.7	16.5	540.0	7.74	45.8	8	158	38	2.39	16.0
610 ∞ 229 ∞ 140	139.9	617.2	230.2	13.1	22.1	12.7	547.6	5.21	41.8	9	120	36	2.11	15.1
610 ∞ 229 ∞ 125	125.1	612.2	229.0	11.9	19.6	12.7	547.6	5.84	46.0	8	120	34	2.09	16.7
610 ∞ 229 ∞ 113	113.0	607.6	228.2	11.1	17.3	12.7	547.6	6.60	49.3	8	120	30	2.08	18.4
610 ∞ 229 ∞ 101	101.2	602.6	227.6	10.5	14.8	12.7	547.6	7.69	52.2	7	120	28	2.07	20.5
533 ∞ 210 ∞ 122	122.0	544.5	211.9	12.7	21.3	12.7	476.5	4.97	37.5	8	110	34	1.89	15.5
533 ∞ 210 ∞ 109	109.0	539.5	210.8	11.6	18.8	12.7	476.5	5.61	41.1	8	110	32	1.88	17.2
533 ∞ 210 ∞ 101	101.0	536.7	210.0	10.8	17.4	12.7	476.5	6.03	44.1	7	110	32	1.87	18.5
533 ∞ 210 ∞ 92	92.1	533.1	209.3	10.1	15.6	12.7	476.5	6.71	47.2	7	110	30	1.86	20.2
533 ∞ 210 ∞ 82	82.2	528.3	208.8	9.6	13.2	12.7	476.5	7.91	49.6	7	110	26	1.85	22.5

UNIVERSAL BEAMS



PROPERTIES

Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis x-x cm^4	Axis y-y cm^4	Axis x-x cm	Axis y-y cm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	u	x	H dm^6	J cm^4	A cm^2
1016 ∞ 305 ∞ 487 # †	1020000	26700	40.6	6.57	19700	1730	23200	2800	0.867	21.1	64.4	4300	620
1016 ∞ 305 ∞ 437 # †	910000	23500	40.4	6.49	17700	1540	20800	2470	0.868	23.1	55.9	3190	557
1016 ∞ 305 ∞ 393 # †	808000	20500	40.2	6.40	15900	1350	18500	2170	0.868	25.5	48.4	2330	500
1016 ∞ 305 ∞ 349 # †	723000	18500	40.3	6.44	14400	1220	16600	1940	0.872	27.9	43.3	1720	445
1016 ∞ 305 ∞ 314 # †	644000	16200	40.1	6.37	12900	1080	14900	1710	0.872	30.7	37.7	1260	400
1016 ∞ 305 ∞ 272 # †	554000	14000	40.0	6.35	11200	934	12800	1470	0.872	35.0	32.2	835	347
1016 ∞ 305 ∞ 249 # †	481000	11800	39.0	6.09	9820	784	11400	1250	0.861	39.9	26.8	582	317
1016 ∞ 305 ∞ 222 # †	408000	9550	38.0	5.81	8410	636	9810	1020	0.849	45.8	21.5	390	283
914 ∞ 419 ∞ 388 #	720000	45400	38.2	9.59	15600	2160	17700	3340	0.885	26.7	88.9	1730	494
914 ∞ 419 ∞ 343 #	626000	39200	37.8	9.46	13700	1870	15500	2890	0.883	30.1	75.8	1190	437
914 ∞ 305 ∞ 289 #	504000	15600	37.0	6.51	10900	1010	12600	1600	0.867	31.9	31.2	926	368
914 ∞ 305 ∞ 253 #	436000	13300	36.8	6.42	9500	871	10900	1370	0.865	36.2	26.4	626	323
914 ∞ 305 ∞ 224 #	376000	11200	36.3	6.27	8270	739	9540	1160	0.861	41.3	22.1	422	286
914 ∞ 305 ∞ 201 #	325000	9420	35.7	6.07	7200	621	8350	982	0.853	46.9	18.4	291	256
838 ∞ 292 ∞ 226 #	340000	11400	34.3	6.27	7990	773	9160	1210	0.869	35.0	19.3	514	289
838 ∞ 292 ∞ 194 #	279000	9070	33.6	6.06	6640	620	7640	974	0.862	41.6	15.2	306	247
838 ∞ 292 ∞ 176 #	246000	7800	33.1	5.90	5890	535	6810	842	0.856	46.5	13.0	221	224
762 ∞ 267 ∞ 197	240000	8180	30.9	5.71	6230	610	7170	959	0.868	33.2	11.3	404	251
762 ∞ 267 ∞ 173	205000	6850	30.5	5.58	5390	514	6200	807	0.865	38.1	9.39	267	220
762 ∞ 267 ∞ 147	169000	5460	30.0	5.40	4470	411	5160	647	0.858	45.2	7.40	159	187
762 ∞ 267 ∞ 134	151000	4790	29.7	5.30	4020	362	4640	570	0.853	49.8	6.46	119	171
686 ∞ 254 ∞ 170	170000	6630	28.0	5.53	4920	518	5630	811	0.872	31.8	7.42	308	217
686 ∞ 254 ∞ 152	150000	5780	27.8	5.46	4370	455	5000	710	0.871	35.4	6.42	220	194
686 ∞ 254 ∞ 140	136000	5180	27.6	5.39	3990	409	4560	638	0.869	38.6	5.72	169	178
686 ∞ 254 ∞ 125	118000	4380	27.2	5.24	3480	346	3990	542	0.863	43.8	4.80	116	159
610 ∞ 305 ∞ 238	210000	15800	26.3	7.23	6590	1020	7490	1570	0.887	21.3	14.5	785	303
610 ∞ 305 ∞ 179	153000	11400	25.9	7.07	4940	743	5550	1140	0.886	27.7	10.2	340	228
610 ∞ 305 ∞ 149	126000	9310	25.7	7.00	4110	611	4590	937	0.886	32.7	8.17	200	190
610 ∞ 229 ∞ 140	112000	4510	25.0	5.03	3620	391	4140	611	0.875	30.6	3.99	216	178
610 ∞ 229 ∞ 125	98600	3930	24.9	4.97	3220	343	3680	535	0.874	34.1	3.45	154	159
610 ∞ 229 ∞ 113	87300	3430	24.6	4.88	2870	301	3280	469	0.870	38.1	2.99	111	144
610 ∞ 229 ∞ 101	75800	2920	24.2	4.75	2520	256	2880	400	0.863	43.1	2.52	77.0	129
533 ∞ 210 ∞ 122	76000	3390	22.1	4.67	2790	320	3200	500	0.878	27.6	2.32	178	155
533 ∞ 210 ∞ 109	66800	2940	21.9	4.60	2480	279	2830	436	0.874	31.0	1.99	126	139
533 ∞ 210 ∞ 101	61500	2690	21.9	4.57	2290	256	2610	399	0.873	33.2	1.81	101	129
533 ∞ 210 ∞ 92	55200	2390	21.7	4.51	2070	228	2360	356	0.873	36.4	1.60	75.7	117
533 ∞ 210 ∞ 82	47500	2010	21.3	4.38	1800	192	2060	300	0.863	41.6	1.33	51.5	105