

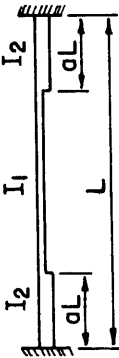
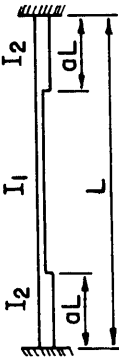
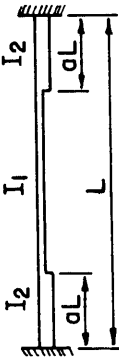
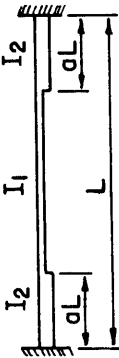
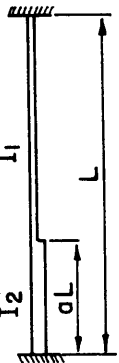
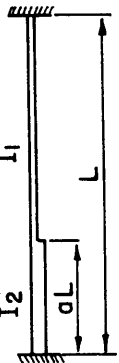
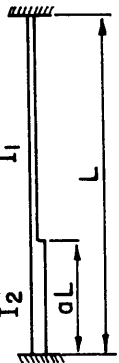
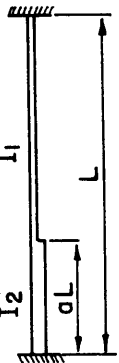
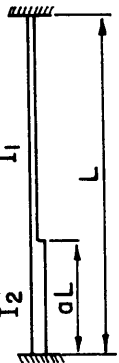
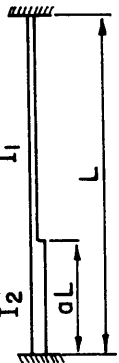
BRIDGE DESIGN PRACTICE

MOMENT DISTRIBUTION FACTORS

For Members With Abrupt Changes in Section

Values for distributing dead load moments of continuous beams.

- c = carry-over factor.
- k = stiffness coefficient. Stiffness factor (K) =  $kEI_1/L$
- f = fixed-end moment coefficient for uniform load.

$b = \frac{I_1}{I_2}$ Applies to Both Types of Spans		SYMMETRICAL SPAN				UNSYMMETRICAL SPAN				SUBSCRIPTS 1 = Large End 2 = Small End	
											
.667	.15	.550	4.95	.089	.15	.489	.562	4.76	4.15	.093	.080
.5		.583	5.64	.093		.485	.600	5.24	4.23	.101	.076
.4		.605	6.18	.095		.483	.627	5.56	4.29	.106	.074
.333		.616	6.51	.097		.481	.646	5.83	4.34	.110	.073
.667	.20	.558	5.22	.089	.30	.468	.592	5.32	4.20	.095	.079
.5		.595	6.19	.093		.451	.664	6.45	4.35	.104	.074
.4		.623	7.02	.096		.441	.718	7.26	4.47	.113	.071
.333		.645	7.68	.098		.434	.761	8.01	4.57	.119	.070
.667	.25	.558	5.43	.089	.40	.451	.597	5.57	4.21	.093	.079
.5		.600	6.67	.093		.424	.676	6.96	4.36	.101	.074
.4		.631	7.74	.096		.408	.745	8.16	4.49	.108	.071
.333		.656	8.76	.098		.400	.798	9.27	4.63	.115	.069
.667	.30	.555	5.61	.089	.50	.437	.585	5.69	4.21	.050	.078
.5		.595	7.08	.093		.400	.667	7.29	4.37	.096	.074
.4		.629	8.40	.096		.377	.734	8.76	4.50	.102	.071
.333		.653	9.63	.098		.363	.798	10.15	4.62	.107	.069

APPENDIX—SECTION 3

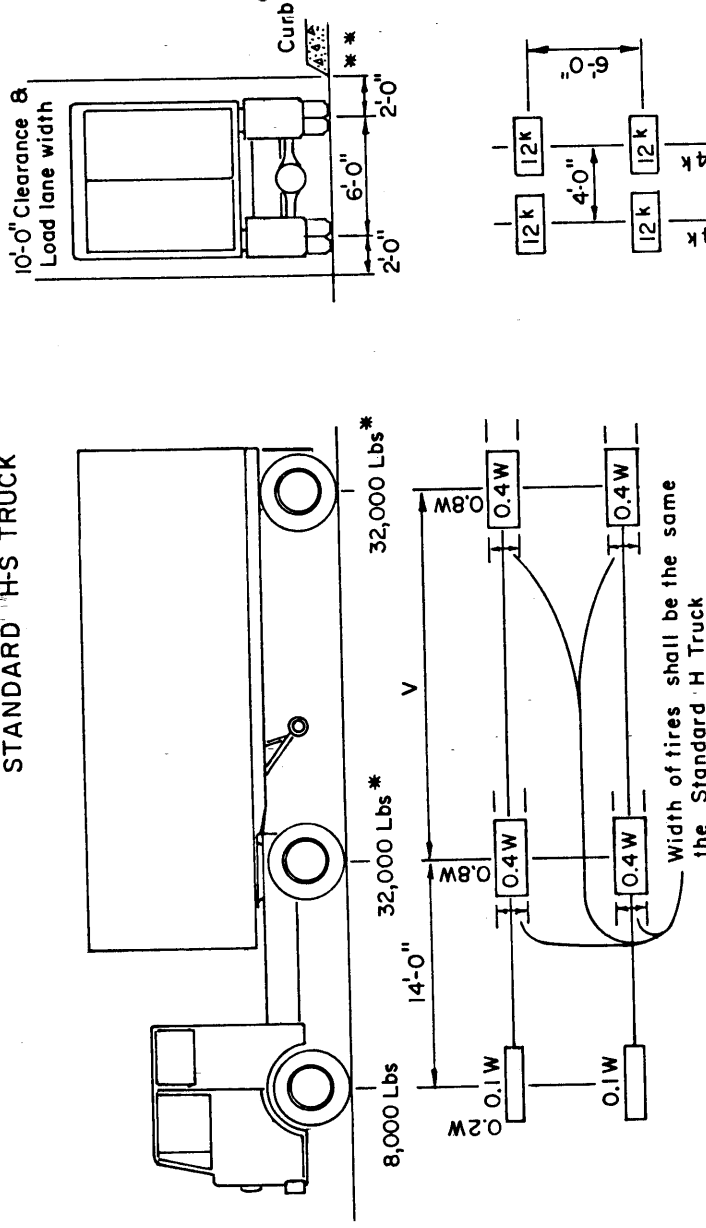
BRIDGE LOADINGS

TABLE OF CONTENTS

H20-S16-44 Loading	Page
Moment, Shear And Reaction Tables	3-A-1
Live Load Shear Design Data	3-B-1 thru 3-B-11
	3-C-1

Note : Only one truck per lane is to be used for a maximum moment or shear determination for either simple or continuous spans

### STANDARD "H-S" TRUCK

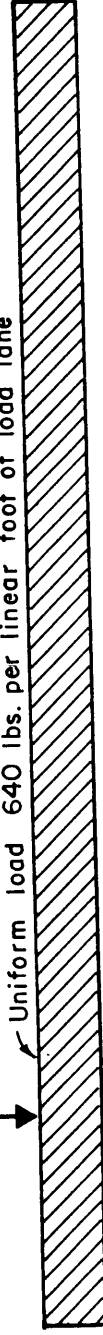


W = Combined weight on the first two axles which is the same for the corresponding H truck.

V = Variable spacing - 14 ft. to 30 ft., inclusive. Spacing to be used is that which produces maximum stresses.

Concentrated load { 18,000 for Moment \*  
26,000 for Shear

Uniform load 640 lbs. per linear foot of load lane



\* For continuous spans another concentrated load of equal weight shall be placed in one other span in the series, in such position as to produce maximum negative moment.

### MOMENTS, SHEARS, AND REACTIONS FOR CONTINUOUS SPANS LIVE LOADING H20-S16-44

#### (a) General

The following live load tables may be used for most designs. The left side of the table lists maximum simple beam moments and fixed end moments that result from the loading that produces that simple beam moment. The right side of the table lists maximum fixed end moments and the simple beam moments that result from the loading that produces that fixed end moment. The center of the table lists maximum shears and reactions. Accuracy is within 2% for members with uniform or nearly uniform moment of inertia.

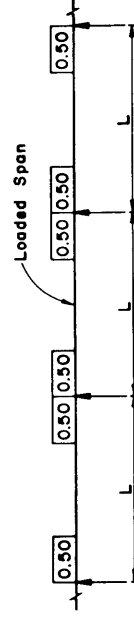
For extremely unbalanced spans or for spans adjacent to hinges. The designer will have to determine the loading which will produce maximum moments.

The values for moments, shears, and reactions are for one lane of H20-S16-44 loading without impact. Either alternative loading or lane loading has been used where these loadings produce more critical stresses than the Standard H-S Truck.

The following discussion summarizes the assumptions and decisions made in the development of these live load tables.

#### (b) Moment at Midspan

To obtain the maximum positive moment at midspan, the span was loaded to obtain the maximum SBM. Although the assumption that the maximum SBM occurs at midspan is not strictly correct except where only one axle of the truck is on the span or where the lane loading is used, the error introduced is considered to be insignificant. The decision to change loading was made on the basis of the positive moment after the FEM's were distributed, assuming distribution factors of 0.50 at the joints. The figure used in this calculation is shown below.



The spans on which the loadings are changed in this section of the table will not be the same as the spans shown in the table on page 9-1 because the table shown on page 9-1 is for simply supported spans.

When the adjacent spans are between 0.75L and 1.33L in length, assuming the loaded span to be of "L" length, the maximum resulting error in positive moment at midspan is 1.35%.

There is no significant error if an adjacent span is "L" in length and has a hinge located between 0.175L and 0.20L from the far end of the span being designed.

For the case where the hinge is located between 0.175L and 0.20L from the near end, adjacent to the loaded span, the maximum error is slightly less than 5%. Since this maximum error occurs at a span of 14' it is recommended it be ignored.

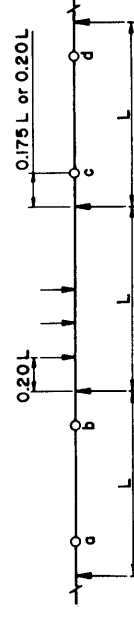
For your information, the tabulation below shows the limits for each loading for this particular case.

Loaded Span	Span in feet
Truck	1 to 12
Alternative	13 to 39
Truck	40 to 155
Lane	156 on up

#### (c) Moments for 0.2 or 0.8 points

Since the LL positive envelop curve is not an exact parabola, the SBM's and the FEM's are given for the loadings at the 0.2 point of a span fixed at both ends. The change in type of loading was determined on the basis of the positive moment at the 0.2 point after the FEM's were distributed, assuming distribution factors of 0.50 at the joints.

If the adjacent spans are between 0.75L and 1.33L in length, assuming the loaded span to be of "L" length, the values in the table may be used up to a span length of 225' with a maximum error of 5%. Beyond a span length of 225' the designer should determine whether the Truck or the Lane Loading is the critical loading if the adjacent spans are not the same length as the loaded span.



LOADING		TRUCK (T)		ALTERNATIVE		LANE (L)		SPAN IN FT.	
1	300	16.0	8.0	8.0	10.2	2.0	10.2	4.7	2.4
2	300	24.0	12.0	12.0	15.4	3.1	15.4	9.5	4.7
3	300	32.0	16.0	16.0	20.5	4.1	20.5	13.9	6.2
4	300	40.0	20.0	20.0	25.6	5.1	25.6	17.8	8.2
5	300	48.0	24.0	24.0	30.7	6.1	30.7	21.7	9.2
6	300	56.0	28.0	28.0	35.8	7.2	35.8	25.6	10.2
7	300	64.0	32.0	32.0	41.0	8.2	41.0	29.5	11.2
8	300	72.0	36.0	36.0	46.1	9.2	46.1	33.4	12.2
9	300	80.0	40.0	40.0	51.2	10.2	51.2	37.3	13.2
10	300	88.0	44.0	44.0	56.3	11.3	56.3	41.2	14.2
11	300	96.0	48.0	48.0	61.4	12.3	61.4	45.1	15.2
12	300	104.0	52.0	52.0	66.6	13.3	66.6	49.0	16.2
13	300	112.0	56.0	56.0	71.7	14.3	71.7	52.9	17.2
14	300	120.0	60.0	60.0	76.8	15.4	76.8	56.8	18.2
15	300	128.0	64.0	64.0	81.9	16.4	81.9	60.7	19.2
16	300	136.0	68.0	68.0	87.0	17.4	87.0	64.6	20.2
17	300	144.0	72.0	72.0	92.1	18.4	92.1	68.5	21.2
18	300	152.0	76.0	76.0	97.2	19.4	97.2	72.4	22.2
19	300	160.0	80.0	80.0	102.3	20.4	102.3	76.3	23.2
20	300	168.0	84.0	84.0	107.4	21.4	107.4	80.2	24.2
21	300	176.0	88.0	88.0	112.5	22.4	112.5	84.1	25.2
22	300	184.0	92.0	92.0	117.6	23.4	117.6	88.0	26.2
23	300	192.0	96.0	96.0	122.7	24.4	122.7	91.9	27.2
24	300	200.0	100.0	100.0	127.8	25.4	127.8	95.8	28.2
25	300	208.0	104.0	104.0	132.9	26.4	132.9	99.7	29.2
26	300	216.0	108.0	108.0	138.0	27.4	138.0	103.6	30.2
27	300	224.0	112.0	112.0	143.1	28.4	143.1	107.5	31.2
28	300	232.0	116.0	116.0	148.2	29.4	148.2	111.4	32.2
29	300	240.0	120.0	120.0	153.3	30.4	153.3	115.3	33.2
30	300	248.0	124.0	124.0	158.4	31.4	158.4	119.2	34.2

When one of the adjacent spans has a hinge located 0.175L or 0.20L from the far end, locations “a” and “d” in the figure above, the table values may be used without any error. For the hinge located at “c”, the maximum error is 1%. In case the hinge is placed at “b”, the tabulation shown below is to be used to determine whether a loading different from that in the table should be used for a particular span length.

Loading	Span in feet
Truck	1 to 9
Alternative	10 to 32
Truck	33 to 168
Lane	169 on up

(d) *Spans Simply Supported at One End*

The FEM's and the SBM's for spans simply supported at one end have been given at the 0.2, 0.4, 0.6, and 0.8 points of the span. The change in loading was made on the basis of the positive moment at the point under consideration, assuming that the distributed LL moment at the first interior support is equal to 46.42 percent of the FEM. This percentage is based on distribution factors of 0.50 at the joints, the end span being  $\frac{3}{4}$  the length of the interior spans.

No significant error, 1% or less, is introduced even if the end span is the same length as the interior spans except for the loadings at the 0.8 point where the error may be as high as 10%. Therefore, when the end span is approximately the same length as the interior span, it may be necessary for the designer to use a loading other than that shown in the table for the 0.8 point. To help in determining when this is the case, the tabulation below shows the limits of each loading for the case where the end span and interior spans are of length "L".

Loading	Span in feet
Truck	1 to 17
Alternative	18 to 59
Truck	60 to 262
Lane	263 on up

If the end span is one-half the length of the interior spans, a maximum error of 1% may result except for the loadings at the 0.8 point where the error may be as high as 9%. To help in determining whether an-

other loading should be used for the 0.8 point when the end span is approximately one-half the length of the interior spans, the tabulation below shows the limits for each loading when the end span length is one-half "L".

Loading	Span in feet
Truck	1 to 11
Alternative	12 to 37
Truck	38 to 190
Lane	191 on up

(e) *Maximum Shears and Reactions*

To help in plotting the shear diagram, the LL shear at midspan is given. The designer should note that the LL values given in this table may have to be increased for moment shear.

(f) *Negative Moments*

In calculating the FEM's for the negative moments, the loadings were placed so as to obtain a maximum FEM at joint B. The assumption that the maximum final distributed moment will result from the maximum FEM @ B is in error in the order of 0.3% for a span continuous at both ends.

To calculate the maximum negative moment at a joint, the Lane Loading is usually the governing loading except for spans 45 feet or less in length where the Truck Loading with its 32 kips axles variably spaced from 14 feet to 30 feet inclusive may govern. A separate table will be issued to handle this case.

For very short spans adjacent to a relatively long span, the Truck Loading placed in the long span may give higher negative moment at the joint under consideration than if the Lane Loading was placed on both the short and long spans. Therefore, the SBM's, FEM'S, and location of the rear axle of the Truck have been given for this case up to 125 feet for the span simply supported at one end and 144 feet for the span fixed at both ends. Beyond these span lengths, the Lane Loading will give a higher FEM @ B.

Where the Truck Loading is used to obtain the maximum longitudinal moment for the design of columns, the simple beam reaction at the bent may be obtained by dividing the "SBM" by "aL".

(a) *Spans with Hinge Points*

Tables for One Lane Live Load for span in which a hinge occurs at  $1/5$ ,  $1/6$ ,  $1/7$  and  $1/8$  points are also included.







SPAN IN FT.	LOADING	TRUCK (T)	ALTERNATIVE (A)	LANE (L)	IMPACT	POSITIVE MOMENTS (kip feet)										NEGATIVE MOMENTS (kip feet)									
						SBM	FEM	SBM	FEM	SBM	FEM	SBM	FEM	SBM	FEM	SBM	FEM	SBM	FEM	SBM	FEM	SBM	FEM	SBM	FEM
210	149	4473L	2824	2824	2824	2727	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703
209	150	4435	2800	2800	2800	2775	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751	2751
208	150	4397	2775	2775	2775	2751	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727	2727
207	151	4359	2751	2751	2751	2727	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703	2703
206	151	4322	2727	2727	2727	2703	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679	2679
205	152	4285	2703	2703	2703	2679	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655
204	152	4247	2679	2679	2679	2655	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631
203	152	4210	2655	2655	2655	2631	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607	2607
202	153	4173	2631	2631	2631	2607	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583	2583
201	153	4137	2607	2607	2607	2583	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559	2559
200	154	4100	2583	2583	2583	2559	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535	2535
199	154	4064	2565	2565	2565	2535	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511
198	155	4027	2535	2535	2535	2511	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487	2487
197	155	3991	2511	2511	2511	2487	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463	2463
196	156	3955	2490	2490	2490	2463	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439	2439
195	156	3920	2467	2467	2467	2439	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415	2415
194	157	3884	2444	2444	2444	2415	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391	2391
193	157	3848	2421	2421	2421	2391	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367	2367
192	158	3813	2398	2398	2398	2367	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343	2343
191	158	3778	2375	2375	2375	2343	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319	2319
190	159	3743	2353	2353	2353	2319	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295	2295
189	159	3708	2330	2330	2330	2295	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271	2271
188	160	3674	2308	2308	2308	2271	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247	2247
187	160	3639	2286	2286	2286	2247	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223	2223
186	161	3605	2264	2264	2264	2223	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200	2200
185	161	3571	2242	2242	2242	2200	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176	2176
184	162	3536	2220	2220	2220	2176	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152	2152
183	162	3503	2198	2198	2198	2152	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128	2128
182	163	3469	2176	2176	2176	2128	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104	2104
181	163	3435L	2155	2155	2155	2104	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080

LOADING		TRUCK (T)	ALTERNATIVE (A)	LANE (L)	IMPACT	SPAN IN FT.	

## APPENDIX—BRIDGE LOADINGS

LOADING		TRUCK (T)	ALTERNATIVE	LANE (L)	SPAN IN FT.
					IMPACT
					SBM @ CTR
					SBM @ B
					FEM @ C
					SBM @ 2L
					FEM @ 2L
					SBM @ C
					FEM @ C
					SBM @ 0.2 or 0.8 POINTS
					FEM @ 0.2 or 0.8 POINTS
					SBM @ 0.2 or 0.8 POINTS
					FEM @ 0.2 or 0.8 POINTS
					SBM @ 0.2 or 0.8 POINTS
					FEM @ 0.2 or 0.8 POINTS
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					SBM @ 0.2 or 0.8 POINTS
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[illegible]