Module 7

Influence Lines

Lesson 40

Influence Lines for Simple Trusses

Version 2 CE IIT, Kharagpur

Instructional Objectives:

The objectives of this lesson are as follows.

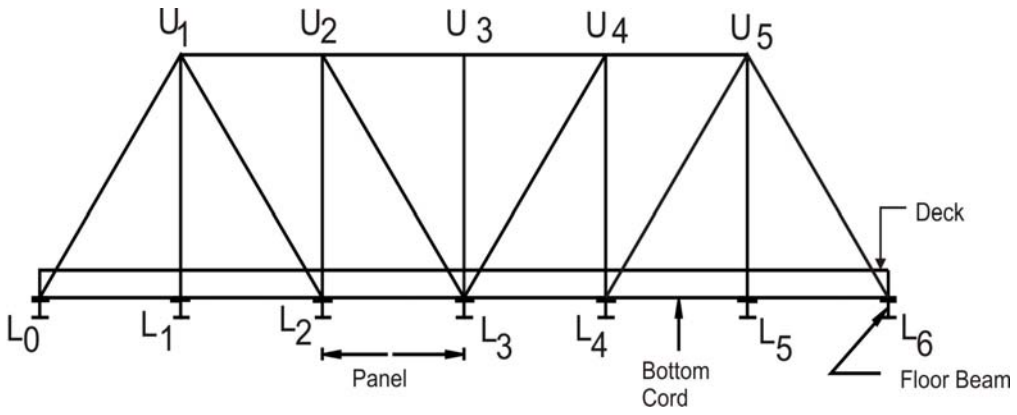
- Understand the bridge truss floor system and load transfer mechanism
- Draw the influence line for the truss reactions
- Draw the influence line for the truss member forces

40.1 Introduction

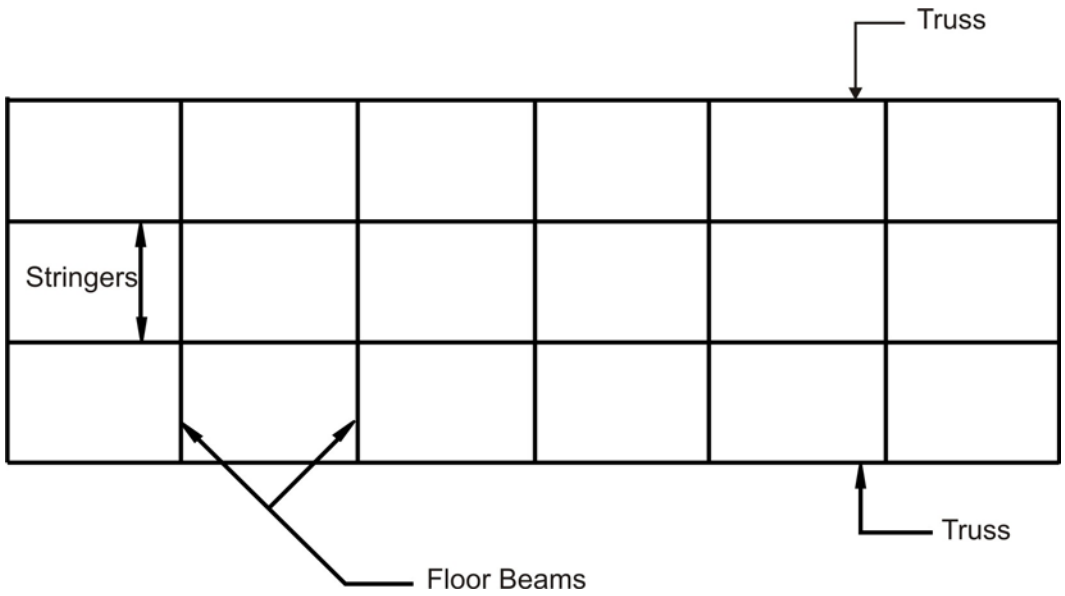
In previous lessons, we have studied the development of influence lines for beams loaded with single point load, UDL and a series of loads. In similar fashion, one can construct the influence lines for the trusses. The moving loads are never carried directly on the main girder but are transmitted across cross girders to the joints of bottom chord. Following section will explain load transmission to the trusses followed by the influence lines for the truss reactions and influence lines for truss member forces.

40.2 Bridge Truss Floor System

A typical bridge floor system is shown in Figure 40.1. As shown in Figure, the loading on bridge deck is transferred to stringers. These stringers in turn transfer the load to floor beams and then to the joints along the bottom chord of the truss.



Front view



Floor plan

Figure 40.1 Bridge floor system

It should be noted that for any load position; the truss is always loaded at the joint.

40.3 Influence lines for truss support reaction

Influence line for truss reactions are of similar to that a simply supported beam. Let us assume that there is truss with overhang on both ends as shown in Figure 40.2. In this case, the loads to truss joints are applied through floor beams as discussed earlier. These influence lines are useful to find out the support, which will be critical in terms of maximum loading.

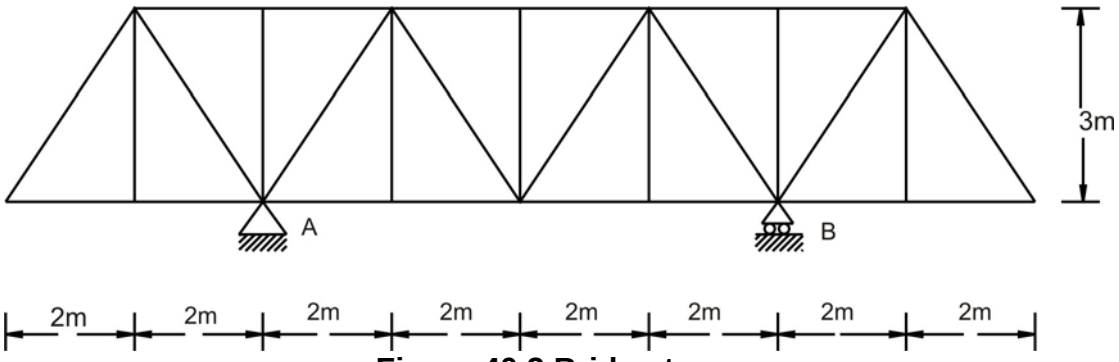
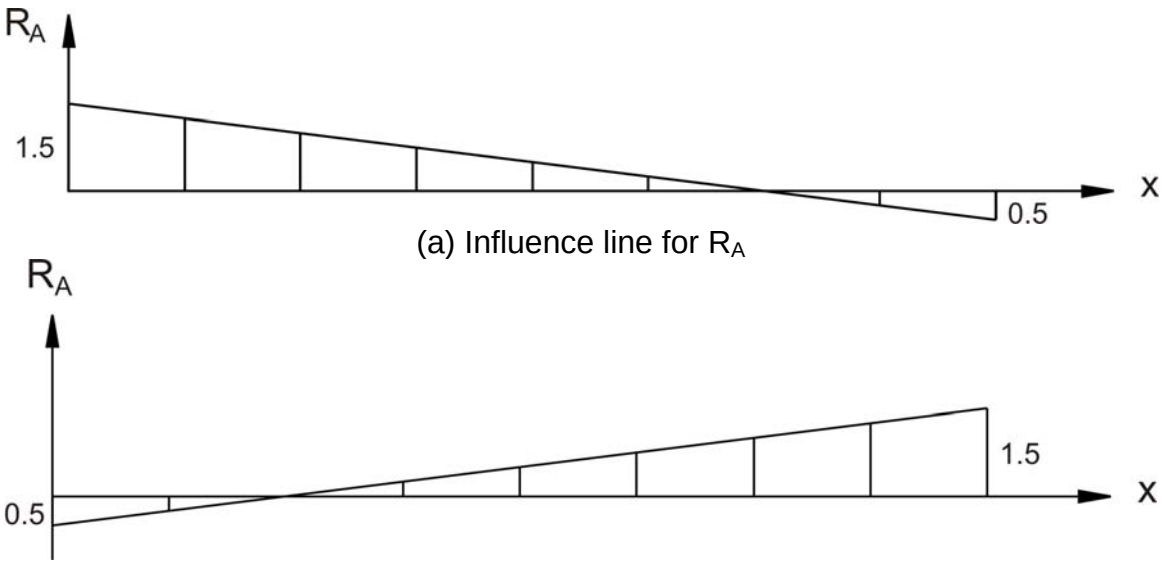


Figure 40.2 Bridge truss

The influence lines for truss reactions at A and B are shown in Figure 40.3.



(a) Influence line for R_A

(b) Influence line for R_B

Figure 40.3: Influence lines for support reactions

40.4 Influence lines for truss member forces

Influence lines for truss member force can be obtained very easily. Obtain the ordinate values of influence line for a member by loading each joint along the deck with a unit load and find member force. The member force can be found out using the method of joints or method of sections. The data is prepared in tabular form and plotted for a specific truss member force. The truss member carries axial loads. In the present discussion, tensile force nature is considered as positive and compressive force nature is considered as negative.

40.4.1 Numerical Examples

Example 1:

Construct the influence line for the force in member GB of the bridge truss shown in Figure 40.4.

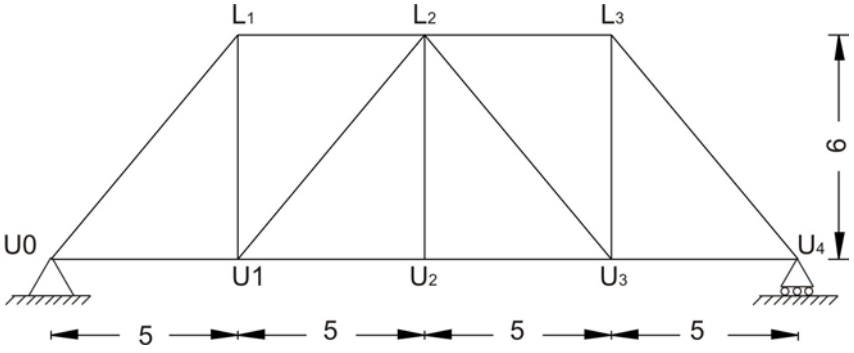


Figure 40.4: Bridge Truss (Example 1)

Solution:

Tabulated Values:

In this case, successive joints L_0, L_1, L_2, L_3, and L_4 are loaded with a unit load and the force F_{L2U3} in the member L_2U_3 are using the method of sections. Figure 40.5 shows a case where the joint load is applied at L_1 and force F_{L2U3} is calculated.

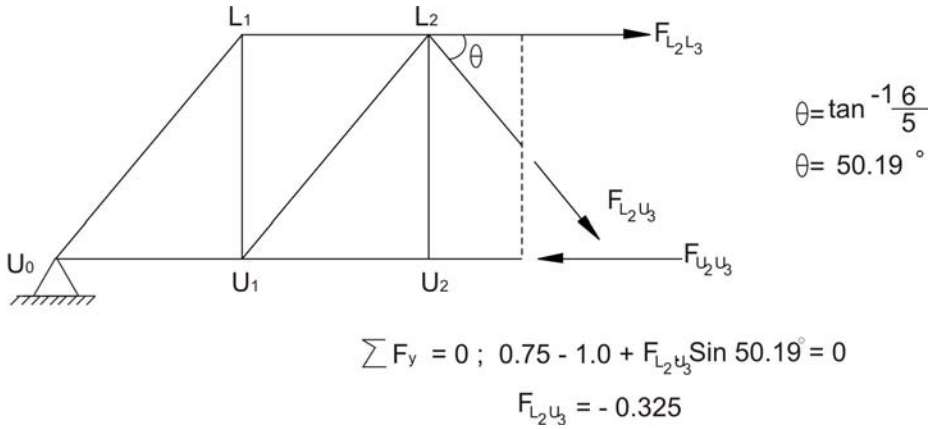


Figure 40.5: Member Force F_{L2U3} Calculation using method of sections.

The computed values are given below.

x	F_{L2U3}
0	0
5	-0.325
10	-0.650
15	0.325
20	0

Influence line: Let us plot the tabular data and connected points will give the influence line for member L_2U_3. The influence line is shown in Figure 40.6. The figure shows the behaviour of the member under moving load. Similarly other influence line diagrams can be generated for the other members to find the critical axial forces in the member.

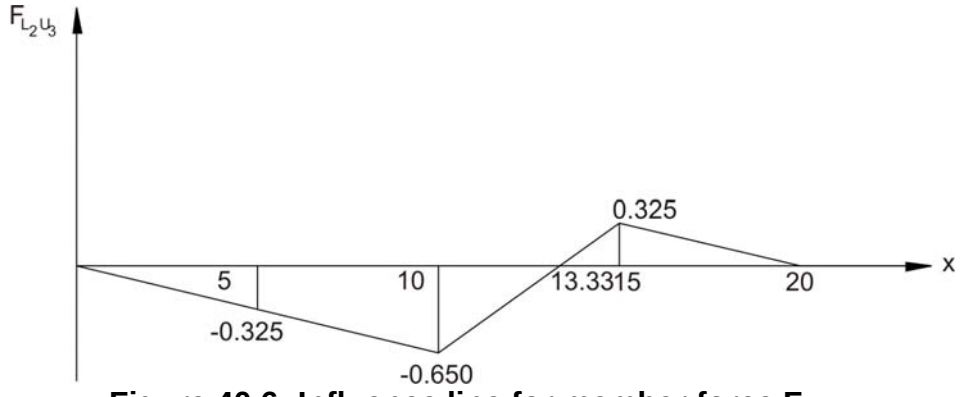


Figure 40.6: Influence line for member force F_{L2U3}

Example 2:

Tabulate the influence line values for all the members of the bridge truss shown in Figure 40.7.

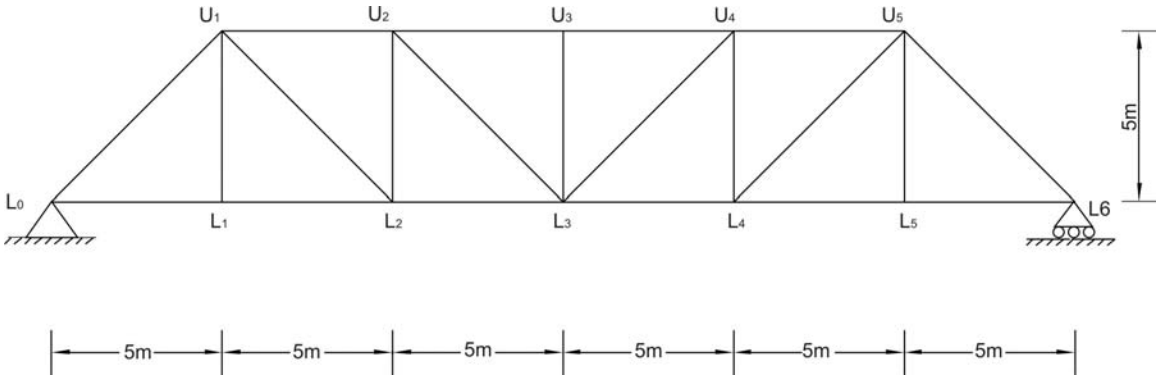


Figure 40.7: Bridge Truss (Example 2)

Solution:

Tabulate Values:

Here objective is to construct the influence line for all the members of the bridge truss, hence it is necessary to place a unit load at each lower joints and find the forces in the members. Typical cases where the unit load is applied at L_1, L_2 and L_3 are shown in Figures 40.8-10 and forces in the members are computed using method of joints and are tabulated below.

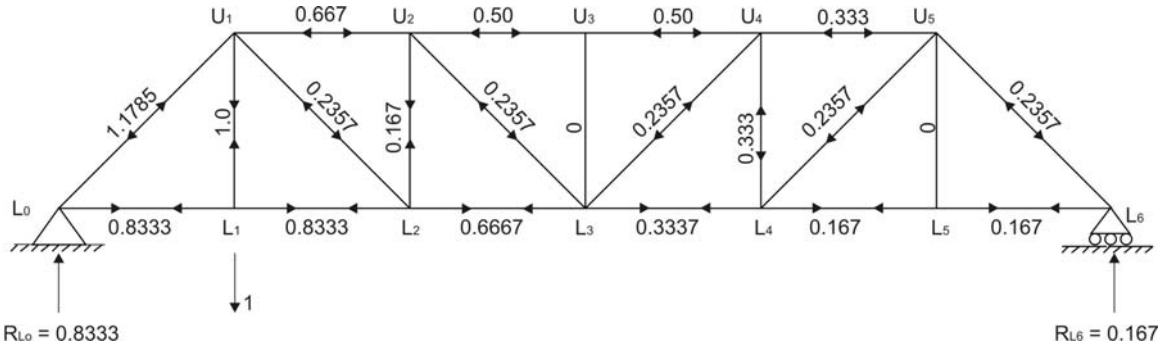


Figure 40.8: Member forces calculation when unit load is applied at L_1

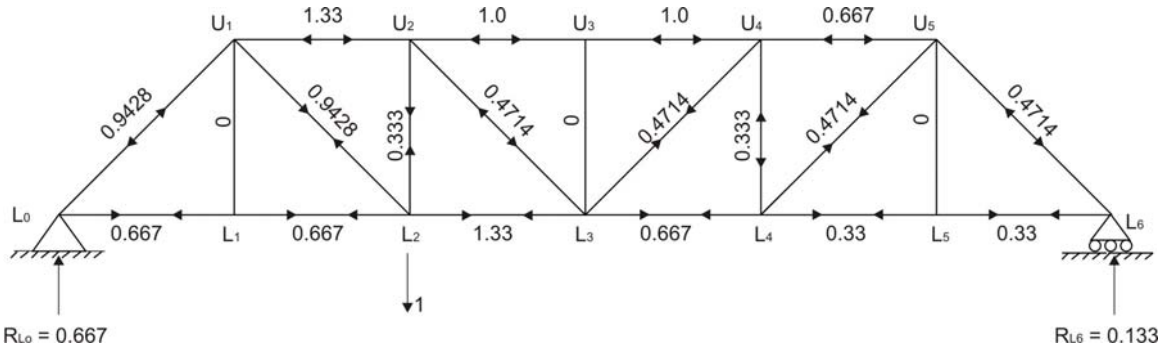


Figure 40.9: Member forces calculation when unit load is applied at L_2

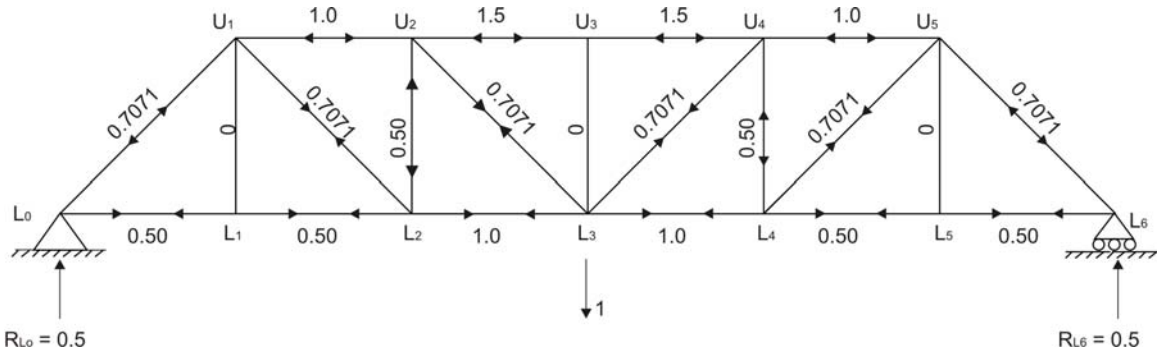


Figure 40.10: Member forces calculation when unit load is applied at L_3

Member	Member force due to unit load at:						
	L_0	L_1	L_2	L_3	L_4	L_5	L_6
L_0L_1	0	0.8333	0.6667	0.5	0.3333	0.1678	0
L_1L_2	0	0.8333	0.6667	0.5	0.3333	0.1678	0
L_2L_3	0	0.6667	1.3333	1.0	0.6667	0.3336	0
L_3L_4	0	0.3336	0.6667	1.0	1.3333	0.6667	0
L_4L_5	0	0.1678	0.3333	0.5	0.6667	0.8333	0
L_5L_6	0	0.1678	0.3333	0.5	0.6667	0.8333	0
U_1U_2	0	-0.6667	-1.333	-1.0	-0.6667	-0.333	0
U_2U_3	0	-0.50	-1.000	-1.5	-1.0	-0.50	0
U_3U_4	0	-0.50	-1.000	-1,5	-1.0	-0.50	0
U_4U_5	0	-0.333	-0.6667	-1.0	-1.333	-0.6667	0
L_0U_1	0	-1.1785	-0.9428	-0.7071	-0.4714	-0.2357	0
L_1U_1	0	1	0	0	0	0	0
L_2U_1	0	-0.2357	0.9428	0.7071	0.4714	0.2357	0
L_2U_2	0	0.167	0.3333	-0.50	-0.3333	-0.3333	0
L_3U_2	0	-0.2357	-0.4714	0.7071	0.4714	0.2357	0
L_3U_3	0	0	0	0	0	0	0
L_3U_4	0	0.2357	0.4714	0.7071	-0.4714	-0.2357	0
L_4U_4	0	-03333	-0.3333	-0.50	0.3333	0.167	0
L_4U_5	0	0.2357	0.4714	0.7071	0.9428	-0.2357	0
L_5U_5	0	0	0	0	0	1	0
L_6U_5	0	-0.2357	-0.4714	-0.7071	-0.9428	-1.1785	0

Influence lines:

Using the values obtained in the above given table, the influence line can be plotted very easily for truss members.

40.5 Closing Remarks

In this lesson we have studied how the loads are transferred in bridge truss floor system. Further, we found that there is similarity between the influence line of

support reactions for simply supported beam and truss structures. Finally we studied the influence line for truss member forces. It was essential to know the method of sections and method of joints for the analysis of trusses while drawing influence lines.

Suggested Text Books for Further Reading

- Armenakas, A. E. (1988). *Classical Structural Analysis – A Modern Approach*, McGraw-Hill Book Company, NY, ISBN 0-07-100120-4

- Hibbeler, R. C. (2002). *Structural Analysis*, Pearson Education (Singapore) Pte. Ltd., Delhi, ISBN 81-7808-750-2

- Junarkar, S. B. and Shah, H. J. (1999). *Mechanics of Structures – Vol. II*, Charotar Publishing House, Anand.

- Leet, K. M. and Uang, C-M. (2003). *Fundamentals of Structural Analysis*, Tata McGraw-Hill Publishing Company Limited, New Delhi, ISBN 0-07-058208-4

- Negi, L. S. and Jangid, R.S. (2003). *Structural Analysis*, Tata McGraw-Hill Publishing Company Limited, New Delhi, ISBN 0-07-462304-4

- Norris, C. H., Wilbur, J. B. and Utku, S. (1991). *Elementary Structural Analysis*, Tata McGraw-Hill Publishing Company Limited, New Delhi, ISBN 0-07-058116-9