Module 6 : Influence Lines

Lecture 1 : Introduction: Variable Loadings

Objectives

In this course you will learn the following

- Introduction to variable loading on a structure.
- The problems of analyzing a structure for multiple loading cases.
- Introduction to the concept of infulence line as a solution to this problem.

6.1 Introduction: Variable Loadings

So far in this course we have been dealing with structural systems subjected to a specific set of loads. However, it is not necessary that a structure is subjected to a single set of loads all of the time. For example, the single-lane bridge deck in Figure 6.1 may be subjected to one set of a loading at one point of time (Figure 6.1a) and the same structure may be subjected to another set of loading at a different point of time. It depends on the number of vehicles, position of vehicles and weight of vehicles. The variation of load in a structure results in variation in the response of the structure. For example, the internal forces change causing a variation in stresses that are generated in the structure. This becomes a critical consideration from design perspective, because a structure is designed primarily on the basis of the intensity and location of maximum stresses in the structure. Similarly, the location and magnitude of maximum deflection (which are also critical parameters for design) also become variables in case of variable loading. Thus, multiple sets of loading require multiple sets of analysis in order to obtain the critical response parameters.

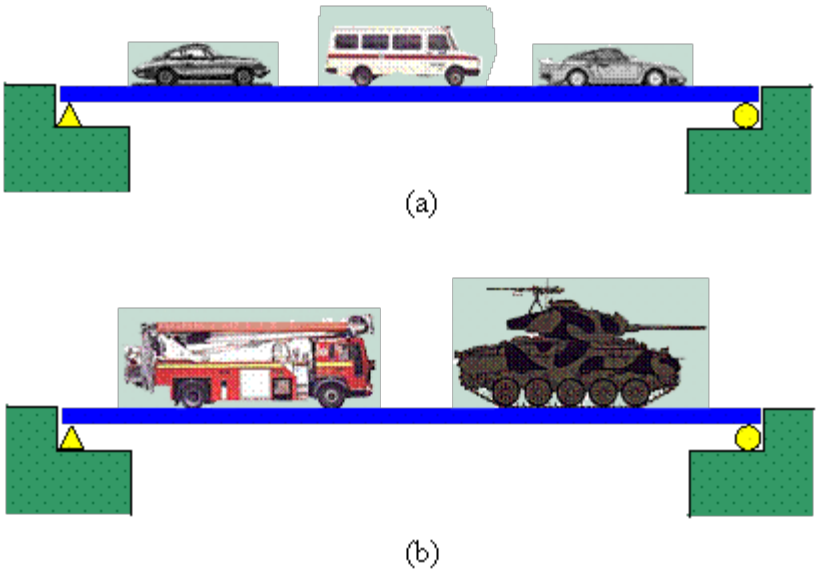

Figure 6.1 Loading condition on a bridge deck at different points of time

Influence lines offer a quick and easy way of performing multiple analyses for a single structure. Response parameters such as *shear force* or *bending moment at a point* or *reaction at a support* for several load sets can be easily computed using influence lines.

For example, we can construct influence lines for V_B (shear force at B) or M_C (bending moment at C) or R_D (vertical reaction at support D) and each one will help us calculate the corresponding response parameter for different sets of loading on the beam AD (Figure 6.2).

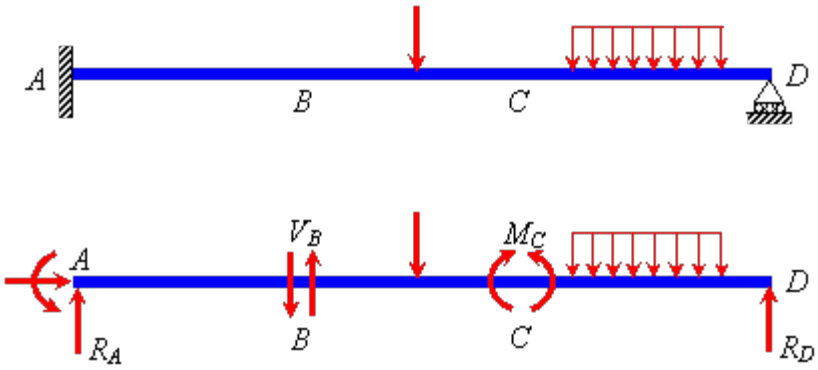

Figure 6.2 Different response parameters for beam *AD*

An influence line is a diagram which presents the variation of a certain response parameter due to the variation of the position of a unit concentrated load along the length of the structural member. Let us consider that a unit downward concentrated force is moving from point *A* to point *B* of the beam shown in Figure 6.3a. We can assume it to be a wheel of unit weight moving along the length of the beam. The magnitude of the vertical support reaction at *A* (R_A) will change depending on the location of this unit downward force. The influence line for R_A (Figure 6.3b) gives us the value of R_A for different locations of the moving unit load. From the ordinate of the influence line at *C*, we can say that $R_A = 0.5$ when the unit load is at point *C* .

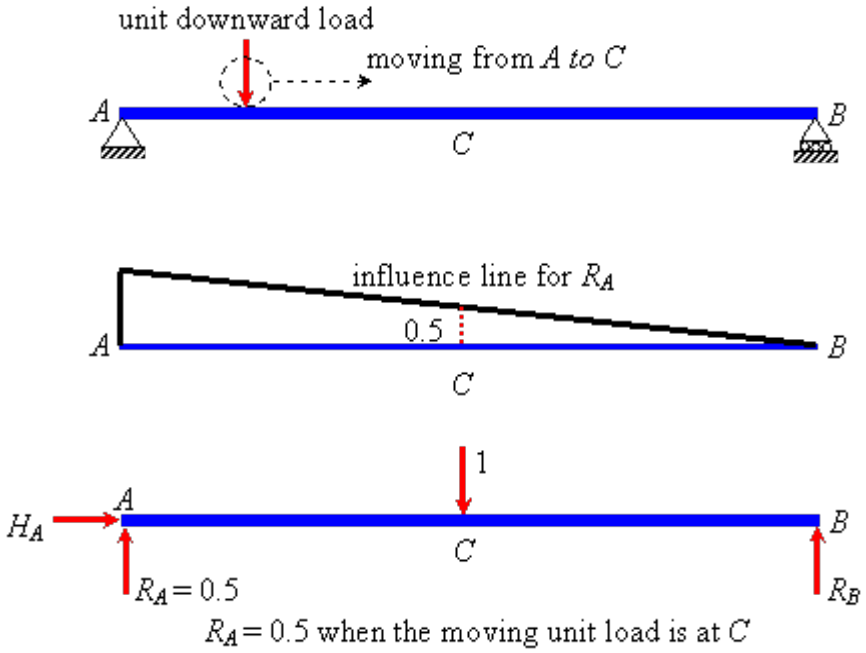

Figure 6.3b Influence line of R_A for beam *AB*

Thus, an influence line can be defined as a curve, the ordinate to which at any abscissa gives the value of a particular response function due to a unit downward load acting at the point in the structure corresponding to the abscissa. The next section discusses how to construct influence lines using methods of equilibrium.

Recap

In this course you have learnt the following

- Introduction to variable loading on a structure.

- The problems of analyzing a structure for multiple loading cases.

- Introduction to the concept of infulence line as a solution to this problem.