

CHAPTER 5

5. Influence Lines for Indeterminate Structures

5.1. Introduction

An influence line represents the variation of the reaction, shear, moment, or deflection at a specific point in a member as a concentrated force or uniform loads moves over the member. Moreover, the magnitude of the associated reaction, shear, moment, or deflection at the point can be calculated from the ordinates of the influence-line diagram.

The procedure for constructing influence lines for statically indeterminate structures essentially involves computing the values of the response function of interest for various positions of a unit load on the structure. Since the influence lines for forces and moments of determinate structures consist of straight-line segments, such influence lines were constructed by evaluating the ordinates for only a few positions of the unit load and by connecting them with straight lines.

However, the influence lines for indeterminate structures are generally curved lines. Thus, the construction of influence lines for indeterminate structures requires computation of many more ordinates than necessary in the case of determinate structures.

5.2. Influence lines by the method of consistent deformations

Procedure for Analysis

The procedure for constructing influence lines for statically indeterminate structures by the method of consistent deformations can be summarized as follows:-

- Determine the degree of indeterminacy of the structure and select redundant.
- Select a number of points along the length of the structure at which the numerical values of the ordinates of the influence lines will be evaluated.
- To construct the influence lines for the redundants, place a unit load successively at each of the points selected in step 2; and for each position of the unit load, apply the method of consistent deformations to compute the values of the redundants.
- Plot the values of the redundant thus obtained as ordinates against the position of the unit load as abscissa, to construct the influence lines for the redundants.
- Once the influence lines for the redundants have been determined, the influence lines for the other force and/or moment response functions of the structure can be obtained through equilibrium considerations.

5.3. *Qualitative Influence Lines By Muller- Breslau's Principle*

In many practical applications, such as when designing continuous beams or building frames subjected to uniformly distributed live loads, it is usually sufficient to draw only the qualitative influence lines to decide where to place the live loads to maximize the response functions of interest. As in the case of statically determinate structures, Muller-Breslau's principle provides a convenient means of establishing qualitative influence lines for indeterminate structures.

The influence line for a force (or moment) response function is given by the deflected shape of the released structure obtained by removing the restraint corresponding to the response function from the original structure and by giving the released structure a unit displacement (or rotation) at the location and in the direction of the response function, so that only the response function and the unit load perform external work.

Procedure for Analysis

The procedure for constructing qualitative influence lines for indeterminate structures is essentially involves:

- removing from the given structure the restraint corresponding to the response function of interest to obtain the released structure;
- applying a small displacement (or rotation) to the released structure at the location and in the positive direction of the response function; and
- drawing a deflected shape of the released structure consistent with its support and continuity conditions. The influence lines for indeterminate structures are generally curved lines.

Once a qualitative influence line for a structural response function has been constructed, it can be used to decide where to place the live loads to maximize the value of the response function. The value of a response function due to a uniformly distributed live load is maximum positive (or negative) when the load is placed over those portions of the structure where the ordinates of the response function influence line are positive (or negative).