Placement of Loads on Influence Lines

Objectives of the materials covered: For a given influence line, the student should be able to determine where to place either concentrated or uniform live loads on simply supported beams to insure their maximum effect on reactions, internal shears and moments.

Placement of concentrated loads for maximum reactions: Once an influence line has been generated, it can be used to determine where to position live loads, when the loads can be positioned anywhere on the structure. Unlike “dead” or stationary loads, which are placed along the entire structure, “live” loads such as wheel loadings or lane loadings on bridge spans must be carefully positioned to produce the maximum possible effect. An influence line assists the engineer in determining where to position these loads to produce the maximum effect.

Load placement for maximum left reaction: For example, to determine the maximum possible value for the left reaction on a simple beam, the influence line for this reaction is first generated. This was accomplished in the previous section, and is repeated below:

![Influence Line for Reaction](image1)

The influence line summarizes the effect a concentrated load placed anywhere on the span would have on the reaction at A. In this case it is seen that loads placed on the left end of the structure will influence the reaction more than would loads placed farther to the right, because the height of the influence line is greater on the left end.

![Example Load Placement](image2)
it becomes obvious that the loads should be reversed in direction, such that the 20 kip load can be positioned over the reaction at A, with the 10 kip load positioned L/4 away from the reaction. The final positioning of the loads on the beam should then be as shown below.

![Figure 3](image)

This decision is evident since placing the largest load over the highest part of the influence line will cause the greatest influence on the reaction. This leaves the smaller load to be placed as close to the highest point on the diagram as possible, while not changing the fixed distance between the two wheel loads (the distance between axles on the truck.)

Note that you might say “No fair! This is a one-way bridge and you have the trucks going the wrong way.” But this accounts for the probability that the other bridge might be shut down at some time during its life, and require this bridge to be temporarily converted to two-way traffic, thus reversing the direction of travel shown.

**Placement of uniform loads for maximum reaction:** Influence lines can also be used to determine critical placement of uniform live loads by placing the loads over the highest sections. Thus the proper placement of a uniformly distributed load of unlimited length can be determined from the influence line of Figure 1. It tells us where to place the uniform load for maximum effect, namely across the entire length of the beam where the influence line is positive.
Figure 4

Placement of mixed loads for maximum shear:

To induce the maximum positive shear at the quarter-point of a simply supported doubly-overhanging beam, the influence line generated earlier is shown here:

Figure 5

For maximum positive shear, the loads are situated such that the highest loads are placed over the highest positive ordinates on the influence line, as follows:
For maximum negative shear, the loads are situated such that the highest loads are placed over the highest negative ordinates on the influence line, as follows:

![Figure 6](image)

Note that in both cases, the concentrated loads are placed such that the larger load is over the higher ordinate, and the uniform live loads are placed only in areas of positive (or negative) values.

**Placement of mixed loads for maximum moment:**

To induce the maximum positive moment at the quarter-point of a simply supported doubly-overhanging beam, the influence line generated earlier is shown here:
For maximum positive moment, the loads are situated such that the highest loads are placed only over the highest positive ordinates on the influence line, and not in the negative regions, as follows:

Note that the large wheel load is placed over the maximum positive ordinate of the influence line, while the smaller wheel load is placed to its right. This is because the influence line has a smaller slope, and descends more gradually to the right of the peak, than to the left of the peak, thus making that the higher ordinate at \( \frac{L}{4} \) from the peak.

To induce the maximum negative moment at the quarter-point of a simply supported doubly-overhanging beam, the influence line generated earlier is shown here:
Again, the large wheel load is placed at the maximum negative ordinate, with the smaller wheel load placed at L/4 away. The uniform live loads are placed continuously throughout all negative regions.