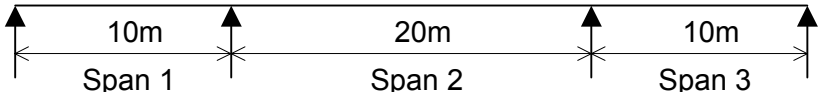
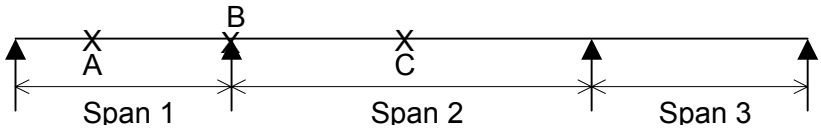
Influence Line Tutorial for HA UDL and HB Loading Bending Effects

Example: 3 Span deck with continuity over pier supports.

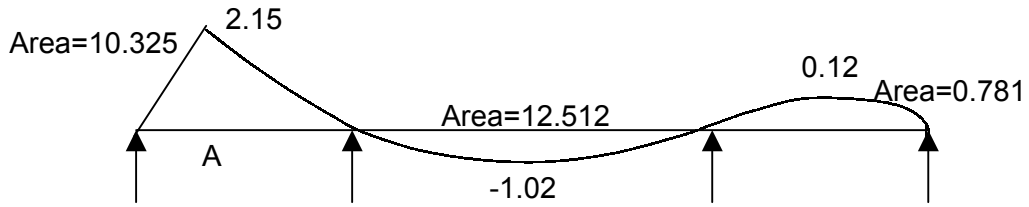


Step1 Determine the position of the point of maximum bending moment in each element for a single point load:

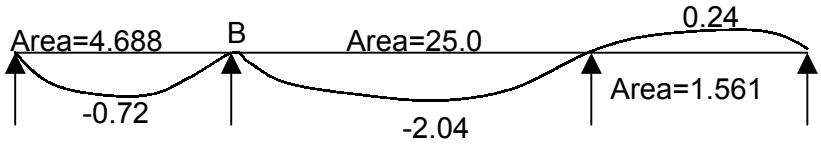


Point A – maximum sagging moment in span 1
Point B – maximum hogging moment over pier 1
Point C – maximum sagging moment in span 2
Note: as end spans are equal then critical points over pier 2 and in span 3 can be obtained from point A and B by symmetry.

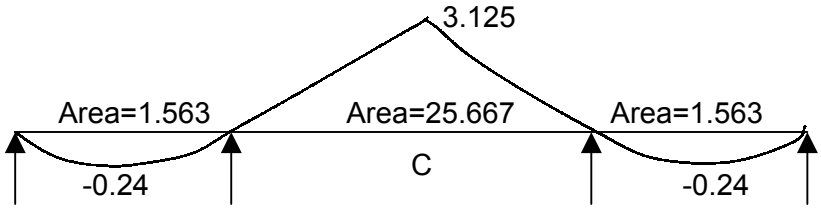
Step 2 Determine influence line diagram for point A:



Step 3 Determine influence line diagram for point B:



Step 4 Determine influence line diagram for point C:



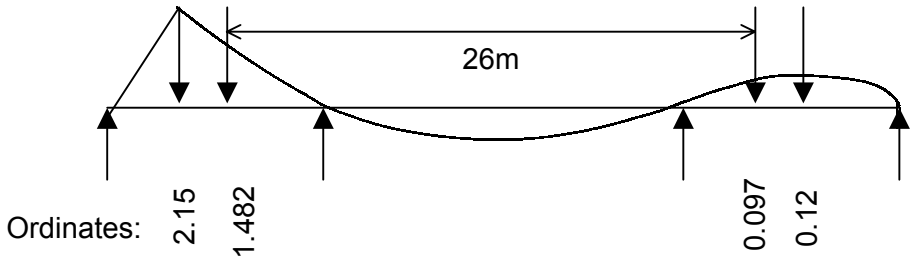
Step 5: Determine loading for critical cases:

Point A

The maximum sagging moment is achieved by loading spans 1 and 3, however we need to check HA UDL for loading in span 1 only.

HA Span 1 only: loaded length = 10m hence udl = 71.8 kN/m (BD37-table 13)
HA Span 1 and 3: loaded length = 20m hence udl = 45.1 kN/m (BD37-table 13)
KEL: = 120 kN (BD37- Clause 6.2.2)

HB loading will produce worst sagging moment with an axle at the maximum ordinate (2.15). Any one of the 4 axles can be located at this position; the vehicle is however positioned with the other 3 axles to achieve the maximum total ordinates:



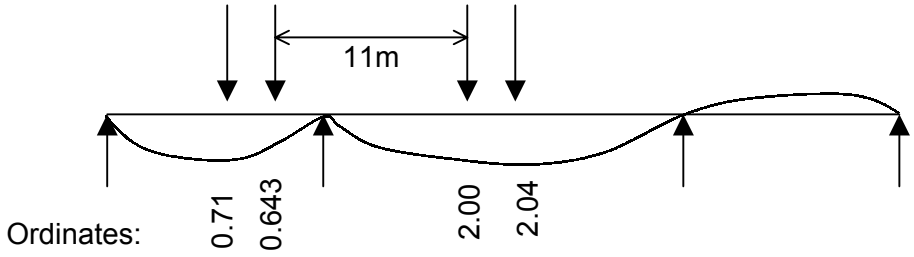
Note: The HB vehicle has a range of spacings between the centre axles, in this case the 26m spacing gives the worst effect.

Point B

The maximum hogging moment is achieved by loading spans 1 and 2, however we need to check HA UDL for loading in span 2 only.

HA Span 2 only: loaded length = 20m hence udl = 45.1 kN/m (BD37-table 13)
HA Span 1 and 2: loaded length = 30m hence udl = 34.4 kN/m (BD37-table 13)
KEL: = 120 kN (BD37- Clause 6.2.2)

HB loading will produce worst hogging moment with an axle at the maximum ordinate (2.04). Any one of the 4 axles can be located at this position; the vehicle is however positioned with the other 3 axles to achieve the maximum total ordinates:



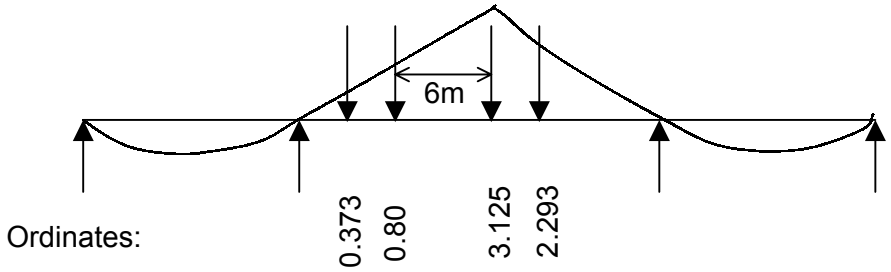
Note: The HB vehicle has a range of spacings between the centre axles, in this case the 11m spacing gives the worst effect.

Point C

The maximum sagging moment is achieved by loading span 2.

HA Span 2 only: loaded length = 20m hence udl = 45.1 kN/m (BD37-table 13)
KEL: = 120 kN (BD37- Clause 6.2.2)

HB loading will produce worst sagging moment with an axle at the maximum ordinate (3.125). Any one of the 4 axles can be located at this position; the vehicle is however positioned with the other 3 axles to achieve the maximum total ordinates:



Note: The HB vehicle has a range of spacings between the centre axles, in this case the 6m spacing gives the worst effect.

Step 6: Determine load effects on deck. Assumptions made to demonstrate principles of influence lines:

- Assume loads applied to 1 notional lane width of deck (3.65m wide).
- Assume ultimate limit state hence use load factor γ_{fL} of 1.5 for HA loading and 1.3 for HB loading.
- Assume 30 units of HB.

Span 1

Maximum sagging moment due to HA loading at point A:
Case 1 – Span1 loaded

M = 1.5 x (71.8 x 10.325 + 120 x 2.15) = 1499 kNm (critical HA)

Case 2 – Span1 and 3 loaded

M = 1.5 x [45.1 x (10.325 + 0.781) + 120 x 2.15] = 1138 kNm

Maximum sagging moment due to HB loading:

M = 1.3 x 30 x 10 x (2.15 + 1.482 + 0.097 + 0.12) = 1501 kNm

Pier 1

Maximum hogging moment due to HA loading at point B:
Case 1 – Span 2 loaded

M = 1.5 x (45.1 x 25.0 +120 x 2.04) = 2058 kNm (critical HA)

Case 2 – Span1 and 2 loaded

M = 1.5 x [34.4 x (25.0 + 4.688) + 120 x 2.04] = 1899 kNm

Maximum hogging moment due to HB loading:

M = 1.3 x 30 x 10 x (2.04 + 2.0 + 0.643 + 0.71) = 2423 kNm

Span 2

Maximum sagging moment due to HA loading at point C:
Case 1 – Span 2 loaded

M = 1.5 x (45.1 x 25.667 + 120 x 3.125) = 2299 kNm

Maximum sagging moment due to HB loading:

M = 1.3 x 30 x 10 x (3.125 + 2.293 + 0.8 + 0.373) = 2570 kNm

Note: HB loading is shown to be critical for all cases, however if the loads are distributed using a computer analysis, such as a grillage analysis, then the HB moments will be reduced considerably.