EWCE-311

Structural Analysis And Design-I

Moving load analysis for moment

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Maximum 'Moment' and Greatest Maximum Moment

<u>Maximum 'Moment' for Wheel Loads</u>

Fig. 1 (i) and (ii) demonstrate transition from $W2$ to $W3$ to obtain the maximum moment at a section that splits the influence line into two lengths, a and b. If i = maximum ordinate of the influence line, the change in bending moment due to the transition can be obtained as

$\square M = (P2\ d1 + P\square\ e)\ (i/b) - (P1\ d1 + P0\ e0)\ (i/a)$ …………………………….. (3)

where $P2$ = Load remaining on the right (increasing) portion during wheel movement,

$P1$ = Load remaining on the left (decreasing) portion during wheel movement, $d1$ = Shift of the wheels,

$P\square$ = New load moving a distance e within the influence line,

and $P0$ = Load moving off the influence line from a distance $e0$ inside.

Maximum ‘Moment’ and Greatest Maximum Moment

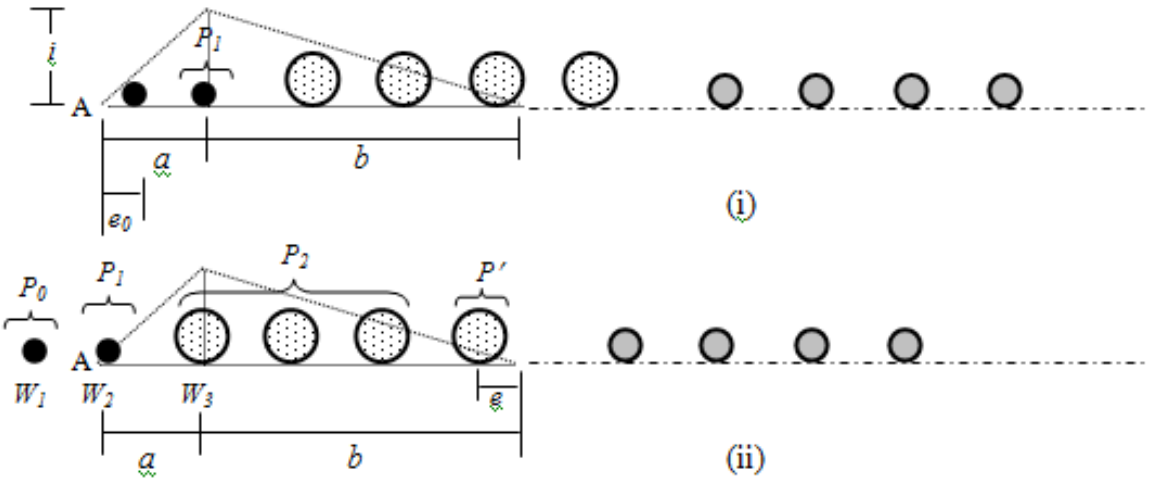
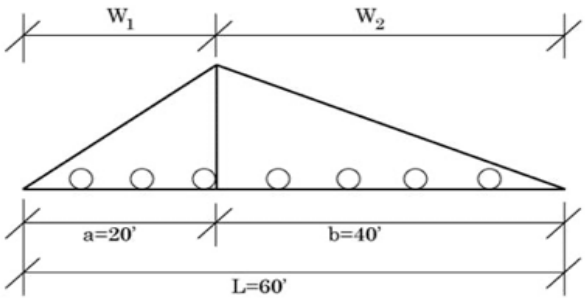


Fig. 1: Wheel Loads with ‘Moment Type’ Influence Line



Greatest Maximum Moment

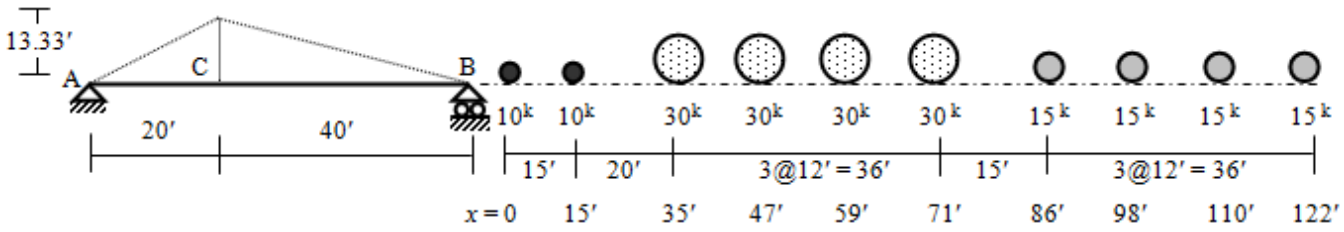
For a given group of wheel loads, it is often required to obtain the location of the maximum possible moment in a beam and also its value. This is called the 'Greatest Maximum Moment' (GMM) of the beam for the given loads, and for a simple span L under total load $\sum P$, it is possible to derive the value of GMM as

$M(Max) = (\sum P/L)\ (L/2 - a/2)2 - Pb$, located $a/2$ from the beam mid span ……..(4)

where a = Distance of the centroid of all loads from 'critical' load (often the load closest to centroid of loads),

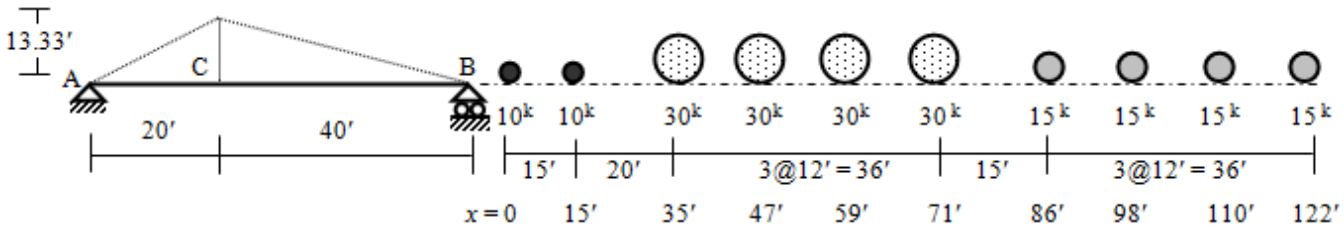
P = Load on the shorter side of the critical section, b = Distance of the centroid of load P from the 'critical' load.

Calculate the maximum value of *M*C for the wheel load arrangement shown below.



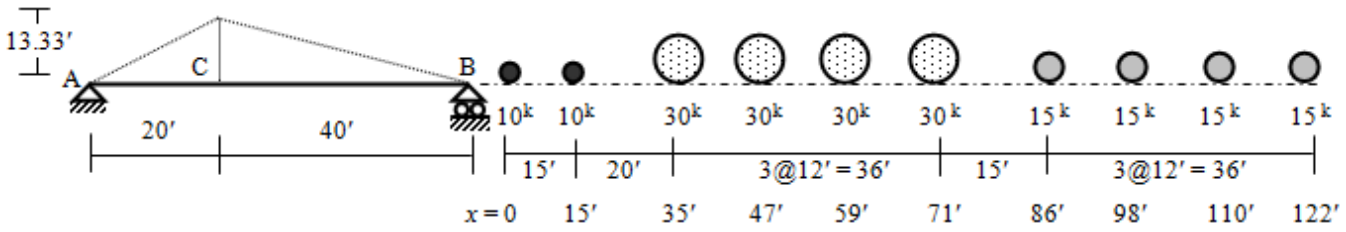
Between *W1* and *W2*

Calculate the maximum value of *M*C for the wheel load arrangement shown below.



Between W2 and *W3*,

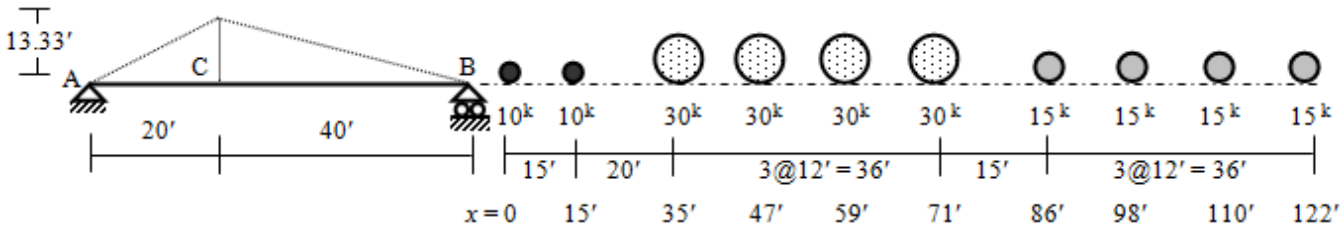
Calculate the maximum value of *M*C for the wheel load arrangement shown below.



Between *W3* and *W4*, *P1* = 30 k, *P2* = 3 × 30 = 90 k, *d1* = 12□, *P*□ = 15 k, *e* = 1□, *P0* = 10 k, *e0* = 0

□*M34* = *i* {(90 × 12 + 15 × 1)/40 − (30 × 12 + 10 × 0)/20} = *i* {27.375 − 18} = + ve

Calculate the maximum value of *M*C for the wheel load arrangement shown below.



Between W4 and *W5*,

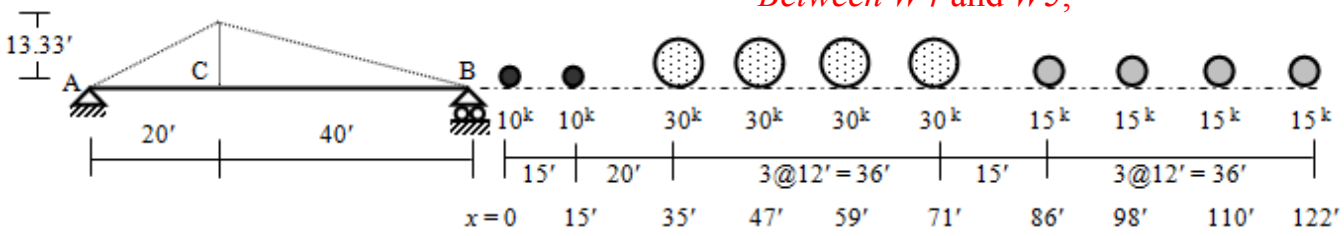
P1 = 30 k, *P2* = 2 × 30 + 15 = 75 k, *d1* = 12□, *P*□ = 15 k, *e* = 1□, *P0* = 30 k, *e0* = 8□

□*M45* = *i* {(75 × 12 + 15 × 1)/40 − (30 × 12 + 30 × 8)/20} = *i* {22.875 − 30} = − ve

□*MC is maximum when W4* is *at C, with i* = 13.33□

Calculate the maximum value of *M*C for the wheel load arrangement shown below.

Between W4 and *W5*,



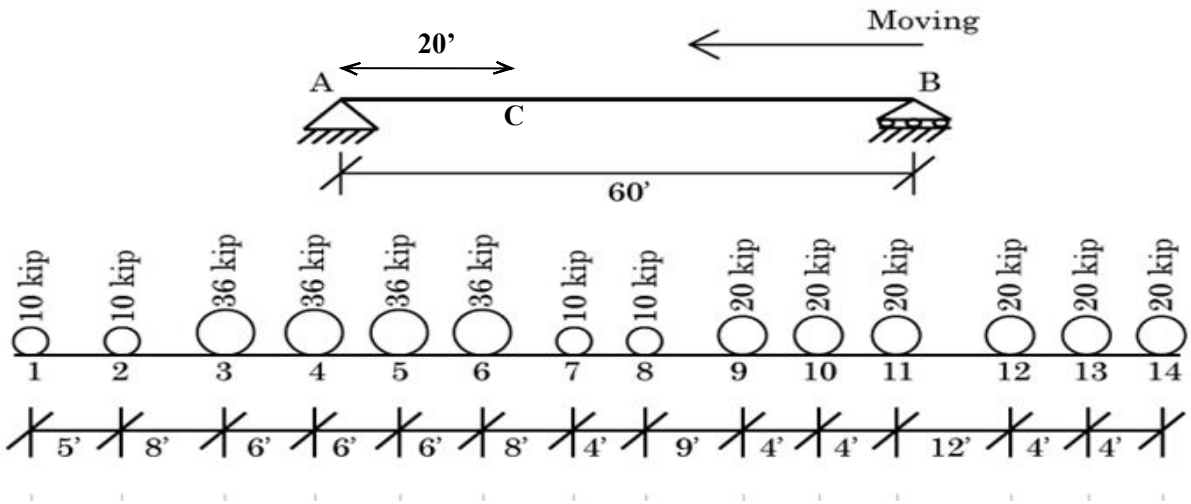
$\therefore M_C(\text{Max}) = 13.33\,[30 \times 8/20 + \{30 \times (40 + 28 + 16) + 15 \times 1\}/40] = 13.33\,[12 + 63.375] = 1005$ *k-ft*

Assuming W3 to *W7* to be on the beam for greatest maximum moment under *W5*, their CG is at a distance

$a = [120 \times 6 - 15 \times 27]/135 = 2.33$ *from W5*

$\Delta M(\text{Max}) = (135/60)\,[(60-2.33)/2]2 - 30 \times 12 - 15 \times 27 = 1105.56$ *k-ft, at* $(60 - 2.33)/2 = 28.83$ *from either side.*

Example 2: Find maximum RA, Vc and MC(Max)



$\square R = \{\sum P\ d1 + P\square e\}/L$

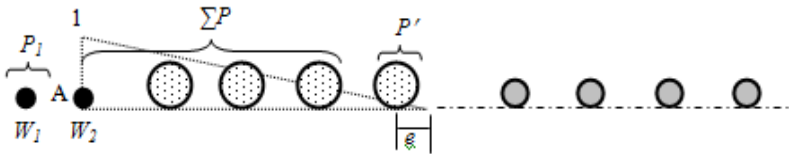
$- P1$

$\square V = \{\sum P\ d1 + P\square e + P0$

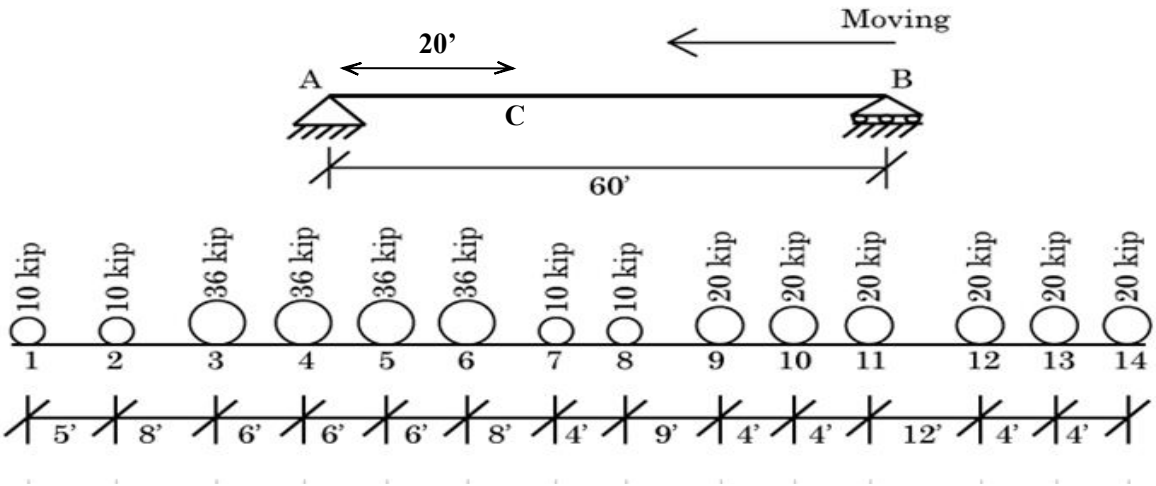
$e0\}/L - P1$

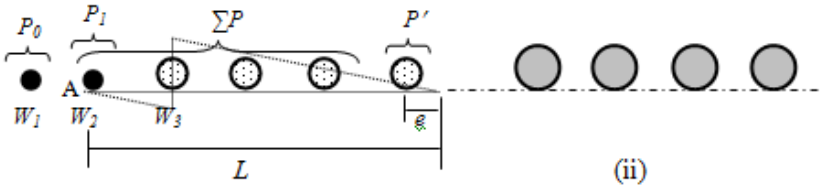
$\square M = (P2\ d1 + P\square e)\ (i/b) - (P1\ d1 + P0\ e0)$

(i/a)



$\square R = \{(\sum P)\, d1 + P \square e\}/L - P1$





(ii)

$$\Delta V = \{(\sum P)\, d1 + P\Delta e + P0\, e0\}/L - P1$$

