Fill in the blank(s) using the words (or whatever) below.

less  point  mid  shallow  indeterminate
algebraic  8  night  small  grueling  angles

1. The Moment-Area Method is good for when we have **point** loads.

2. To use the Method of Integration to solve for deflections, we pretty much need the load in terms of some **algebraic** expression.

3. Interestingly, for simple beams, even if the load is off center, maybe even way off center, the maximum deflection will occur pretty close to the **mid** span.

4. In general the deflections for beams with continuous spans and spans with fixed ends tend to be **less** than those for `simple` beams (beams with ends allowed to rotate).

5. For a circular section loaded axially, the load may not wander more than \( \frac{d}{8} \) from the center (centroid) if we are not to have reverse stress.

6. All of our beam deflection calculation stuff is based on the Euler – Bernoulli Beam Equation, which requires that the displacements of the beam are **small** and the **angles** involved are shallow.

7. This M.O.M. stuff is **grueling**, but it can also be kind of fun, as long as you don't try working on it too late at **night**.

8. The methods of Integration ans Superposition can be used for both statically determinate and statically **indeterminate** situations.

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10 points
9. Consider a footing that is 4 ft wide by 5 ft long. The resultant load perpendicular to the footing is 12,000 lb and it acts 1 ft off center each way. Determine the stresses (in psf) of footing acting on soil (or vice versa) at the four corners of the footing. (10 pts)

\[
\sigma = \frac{P e_1}{S_1} + \frac{P e_2}{S_2} + \frac{P}{A} + e = 0.25 \text{ each way}
\]

\[
S_1 = \left(\frac{4 \times 15}{6}\right)^2 = 16.67 \quad S_2 = \frac{(4)^2}{6} = 13.33
\]

\[
\sigma = \frac{12000(0.25)}{16.67} + \frac{(12000(0.25))}{13.33} + 5
\]

\[
= 600 + 180 + 225 = 1005
\]

\[
600 - 180 + 225 = 645
\]

\[
600 - 180 - 225 = 195
\]

\[
600 + 180 - 225 = 555
\]
10. A beam with EI of 1800,000,000 lb-in.\(^2\) simply spans 12 ft and carries 2 point loads of 5k each located at the 'third points of the beam (at 4 ft and 8 ft from the left end). Neglect the weight of the beam. Determine:

a) Max Shear (lb)
b) Max Moment (lb-ft)
c) Max Deflection (in.)

and, d) for 2 pts extra credit determine the angle in radians at the left support.

Disregard any limitations on deflection such as L/360, and so on.

**Strategy**

The load, \(R \times N\), \(V\), \(M\) Diag will be easy. The thing is \(L_{\text{nd}} \times N\) symmetric ... we'll use the second \(M - A\) theorem by the mid-span to either end to get the offset, which, since the mid-span will be the place of max deflection, will also give us \(\Delta\).

**Solution:**

\(V\), \(M\) Diagnos are easy. \(M\)

\[V_{\text{max}} = 5k\]

\[M_{\text{max}} = 20k - 5t\]

\[\Delta_{\text{peak}} = \Delta \equiv \frac{2(20)(4 + \frac{1}{2} \times 2)}{2}(\frac{3}{2} \times 4) = 306.7 \text{ k-ft}^3 / \epsilon I\]
\[ \Delta = \frac{306.7 \times 10^3 \text{ lb ft}^3 \times (12)^3 \text{ in}^3 / \text{ ft}^3}{18 \pi \times 10^6 \text{ lb-in}^2} = 0.2944 \text{ in} \]

Cool...

What about the angle?

\[ \Delta \Theta_{B \rightarrow C} = \text{area of WET between B and C}. \]

\[ 2(20) + \frac{1}{2}(4)(20) = \frac{80}{\pi} \text{ ft} \]

\[ \Delta \Theta_{C \rightarrow B} = \frac{80 \times 10^3 \text{ lb ft}^2 \times (12)^2 \text{ in}^2 / \text{ ft}^2}{18 \pi \times 10^6 \text{ lb-in}^2} = 0.0069 \text{ rad} \text{ at the right} \]

at the left...

- 0.0064 rad.

**Answer:**

1) Max shear = 5000 lb (5 k)

2) Max moment = 20,000 lb ft = 20 k-ft

3) \( \Delta = 0.29 \text{ in} \)

4) \( \Theta_f = -0.0064 \text{ rad} \)

Yeah!

Incidentally...

\[ \frac{0.29 \text{ in}}{12 \times 12 \text{ in}} = 0.0000 = \frac{1}{489} \]