Given Information:
For Steel, $E = 29000$ ksi, $G = 11200$ ksi

$$\rho_{\text{max}} = 0.75\beta_1 \frac{0.85f'_c}{f_y} \frac{87000}{87000+f_y}$$ (units must be psi)

$\beta_1$ depends on the strength of the concrete, as follows:
If $f'_c < 4$ ksi, $\beta_1 = 0.85$
If $f'_c > 8$ ksi, $\beta_1 = 0.65$
If $f'_c$ is between 4 and 8 ksi, then $\beta_1 = 0.65 + 0.05(8-f'_c)$ (units are ksi)

<table>
<thead>
<tr>
<th>Bar size designation</th>
<th>Nominal cross section area, sq. in.</th>
<th>Weight, lb per ft</th>
<th>Nominal diameter, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3</td>
<td>0.11</td>
<td>0.376</td>
<td>0.375</td>
</tr>
<tr>
<td>#4</td>
<td>0.20</td>
<td>0.668</td>
<td>0.500</td>
</tr>
<tr>
<td>#5</td>
<td>0.31</td>
<td>1.043</td>
<td>0.625</td>
</tr>
<tr>
<td>#6</td>
<td>0.44</td>
<td>1.502</td>
<td>0.750</td>
</tr>
<tr>
<td>#7</td>
<td>0.60</td>
<td>2.044</td>
<td>0.875</td>
</tr>
<tr>
<td>#8</td>
<td>0.79</td>
<td>2.670</td>
<td>1.000</td>
</tr>
<tr>
<td>#9</td>
<td>1.00</td>
<td>3.400</td>
<td>1.128</td>
</tr>
<tr>
<td>#10</td>
<td>1.27</td>
<td>4.303</td>
<td>1.270</td>
</tr>
<tr>
<td>#11</td>
<td>1.56</td>
<td>5.313</td>
<td>1.410</td>
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<tr>
<td>#14</td>
<td>2.25</td>
<td>7.650</td>
<td>1.693</td>
</tr>
<tr>
<td>#18</td>
<td>4.00</td>
<td>13.600</td>
<td>2.257</td>
</tr>
</tbody>
</table>

Bonus Questions (0.1 points)

1. What NHL hockey player played from the 1946/1947 season until retiring at the end of the 1970/1971 season, then came back and played the 1979/1980 season at the age of 52?

2. What NHL hockey player has the record for most career goals in the regular season?

3. What institution of higher learning has won the greatest number of Division I Ice Hockey National Championships?

4. Spell the last name of the Head Men’s Basketball Coach from Duke University.

5. The expression “to pull out all of the stops” comes from a musical instrument for which one pulls out all of the stops in order to maximize its volume. Name the musical instrument.

6. Name the world famous structure built in 1650 by the Emperor Shah Jehan in India as a mausoleum for his wife?

7. Within 10%, what is the current estimated world population of humans?

8. List the 6 US States that border Oklahoma.

9. Is structural steel design more like bacon or more like scrapple? Justify your answer.
1. (30 points) Use the ASD method to select the **lightest possible** A992 W section for a **typical interior girder**, assuring that it is adequate for moment and deflection (live load deflection not to exceed L/360). All beams support a 3” thick slab, cast on metal deck that is welded to the top flanges of the beams. All connections are simple.

**Loads:**
- Slab: Normal Weight Concrete (150 pcf)
- Fill beams weigh 30 plf
- Live Load = 100 psf

Do not worry about shear, as it clearly will not control

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Plan View – Framing Plan
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Final Answer:

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2. (25 points) Determine the maximum span length L that the reinforced concrete beam can span safely, using the ACI requirements and methods.

Given:
- Uniformly distributed dead load \( w_D = 1 \text{ kip/ft} \) (includes the self-weight of the beam)
- Uniformly distributed load \( w_L = 0.5 \text{ kip/ft} \)
- Concrete Compressive Strength \( f'c = 3000 \text{ psi} \)
- Reinforcing Steel Yield Strength \( f_y = 60000 \text{ psi} \)
- Reinforcing Steel: 6 #4 bars, as shown.

\[
\begin{align*}
L &= \text{You Determine} \\
 w_D &= 1 \text{ kip/ft}, \ w_L = 0.5 \text{ kip/ft} \\
\text{6 #4 Bars} \\
\end{align*}
\]

Answer

Max Span, L: \___________________ \text{ feet} \\
(report 3 digits of precision)
3. (45 points) Determine the maximum axial compression $P$ that may be safely applied per ASD to the A992 W18x35 shape.

Second order effects: assume that the second order moment magnifier $B_i$ is 1.05.

Given: The 10'-long A992 W18x35 shape is simply supported with lateral bracing at the supports, only. It is subjected to strong-axis bending due to a uniformly distributed load $w=2$ kip/ft, which already includes self-weight. It is also subjected to axial compression, $P$.

Answer
Max $P$: ___________ kips
(report 3 digits of precision)