Shear Nonsense…
A Critique of the ACI Shear Design Procedure for Post-Tensioned Beams

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ACI 318 Code Shear Equations

$V_n = V_c + V_s$ (Equation **22.5.1.1**)

For Non-Prestressed Concrete Beams,

$V_c = (2\sqrt{f_c'})b_w d$ (Equation **22.5.5.1**)

<u>Anywhere</u> in the beam span

ACI 318 Code Shear Equations

For Prestressed Concrete,

1) $V_{cn} = (0.6\lambda\sqrt{f_c'} + 700\frac{V_u d_p}{M_u})b_w d$ (Section **22.5.8.2**)

2) $V_{ci} = 0.6\lambda\sqrt{f_c'}b_w d_p + V_d + \frac{V_i M_{cre}}{M_{max}}$ (Section **22.5.8.3.1**)

3) $V_{cw} = \left(3.5\lambda\sqrt{f_c'} + 0.3f_{pc}\right)b_w d_p + V_p$ (Section **22.5.8.3.2**)

Larger → V_c

Smaller

The results of these equations vary based upon location along the span

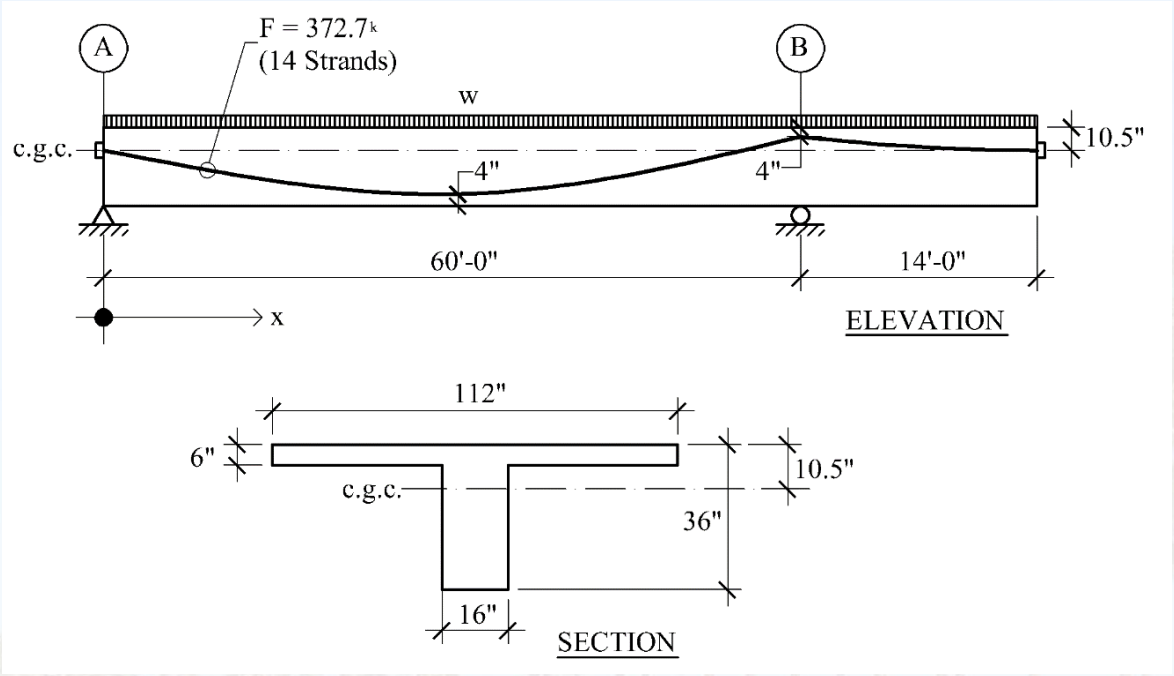
ACI Prestressed Concrete Shear Equations

In order to calculate the concrete shear ***capacity***, V_c, the following must be calculated at EVERY location……

- Dead Load ***Moment***
- Live Load ***Moment***
- Factored Load ***Moment***
- Cracking ***Moment***
- Balanced Load ***Moment***
- Dead Load ***Shear*** (circular ?)
- Factored Load ***Shear***
- Depth of Prestressing, d_p

This Would All Be Fine If……

We got answers that made sense.



Unfactored Service Loads "w": f'_c = 4000 psi

dead = 2.20 klf (includes bm wt.)

live =1.0 klf

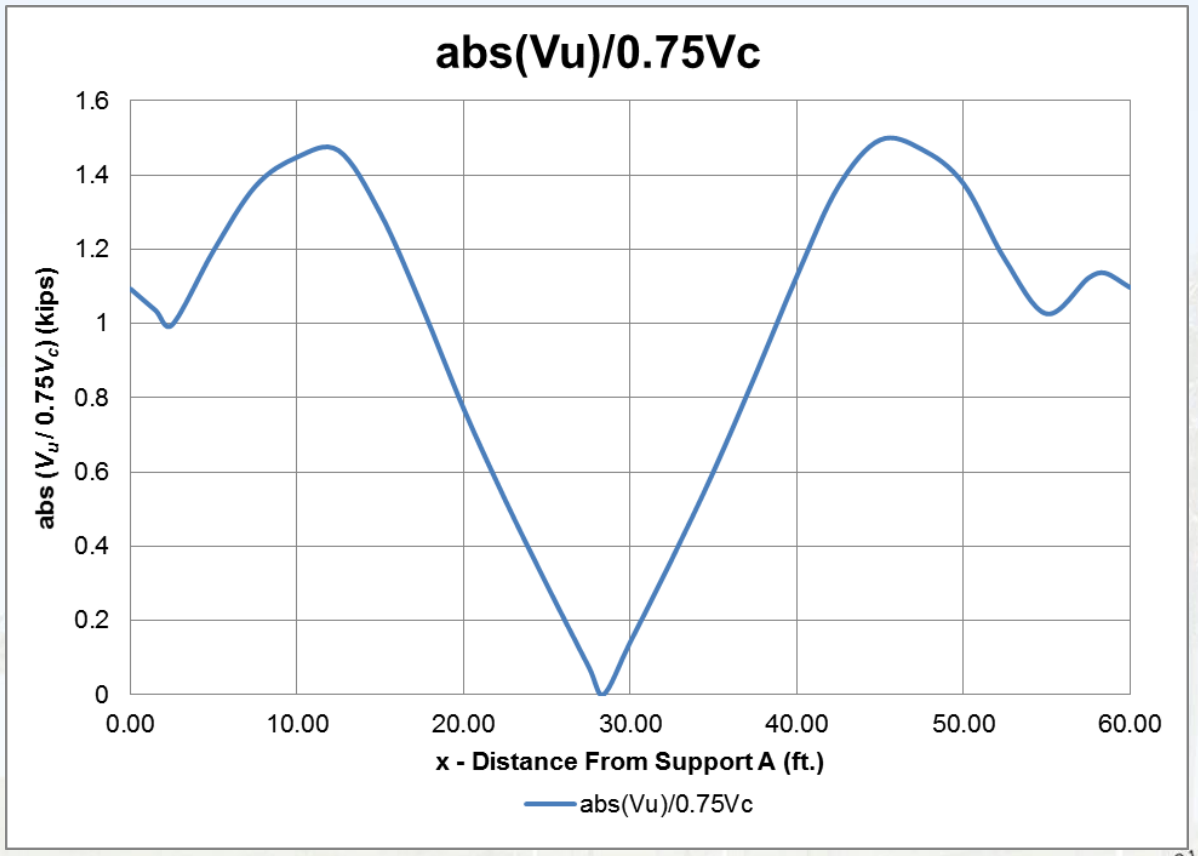
Parabolic Tendon Profile

f_{pu} = 270 ksi

f_y = 60 ksi

This Would All Be Fine If……

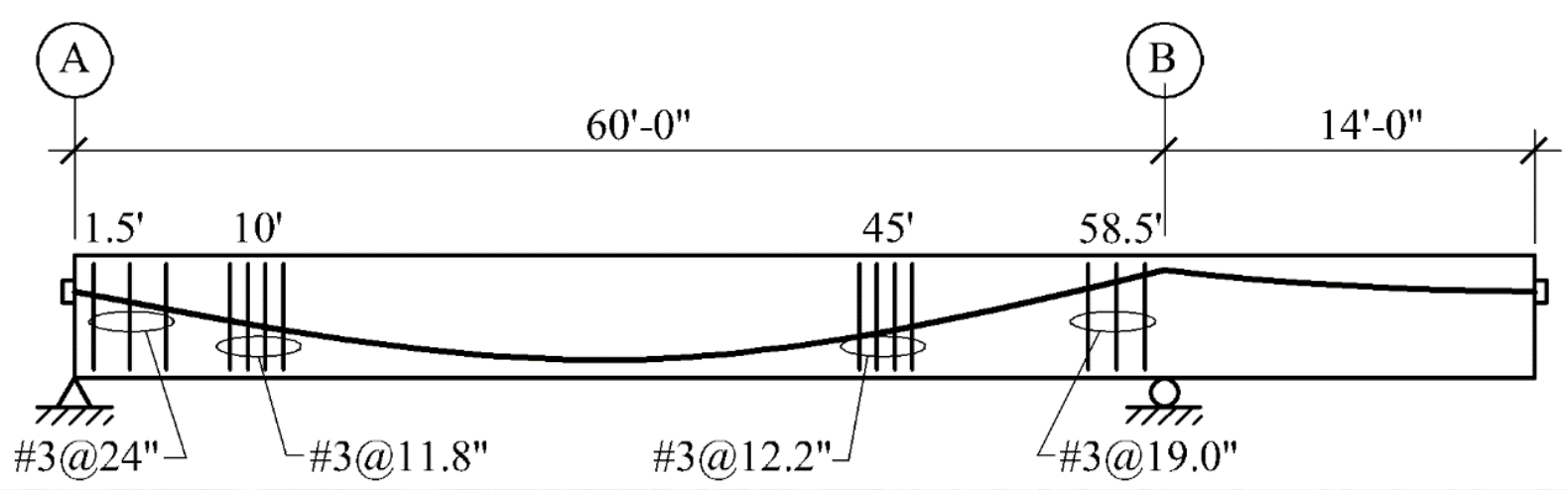
We got answers that made sense, but……..



This Would All Be Fine If……

We got answers that made sense.

Summary of stirrup design:



Why is this now becoming clearer?

- Most designs are typically controlled by minimum shear stirrup requirements
- The maximum allowable tensile stress for Class U designs increased from $6\sqrt{f_c'}$ to $7.5\sqrt{f_c'}$ in the 2008 Code. This, along with using Class T & C allowable stresses leads to more shear controlled designs
- Heavier loading (fire truck, soil/landscaping, podium) will produce shear controlled members

What About the Unfortunate Instructor Who Has to Teach This?

- The number of Prestressed Concrete Design courses has dramatically decreased in the past decade. Instructors are not interested in teaching the course, and students are not interested in taking the course.
- According to PTI, approximately only 22 universities in the US currently offer a course dedicated to prestressed concrete.
- Many of us believe that the Shear Design portion of the course is largely responsible

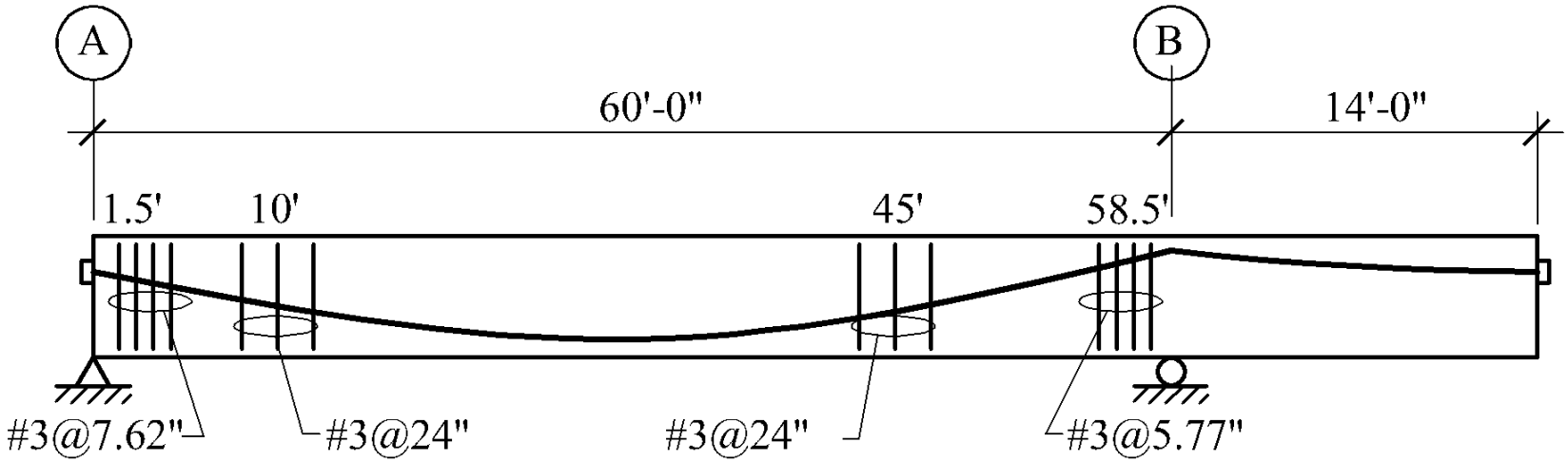
Proposed Alternate Equation for V_c for Post-Tensioned Beams

$$V_c = (2.0\sqrt{f_c'} + 0.15 f_{pc}) b_w d_v$$

Where d_v is measured from the compression face to the centroid of the nonprestressed longitudinal tension reinforcing, as it is in nonprestressed concrete beams.

Proposed Alternate Equation for V_c for Post-Tensioned Beams

Stirrup design with proposed procedure:



Thank You!

Questions ?

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