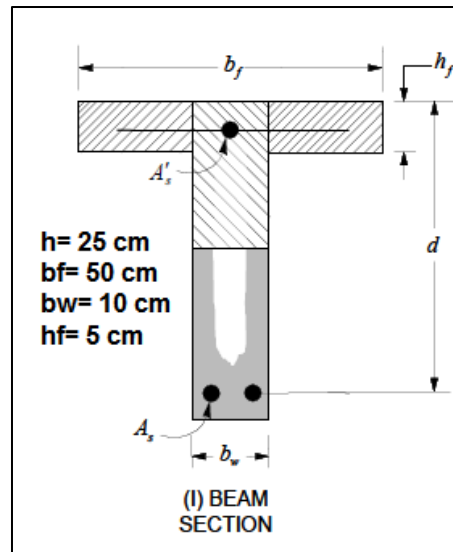


RIBBED SLAB – HAND VERIFICATION – ETABS 2016 v16.1.0

I modelled a ribbed slab as shell-thing and design it with Strips. The ribbed section is:



ETABS Results:

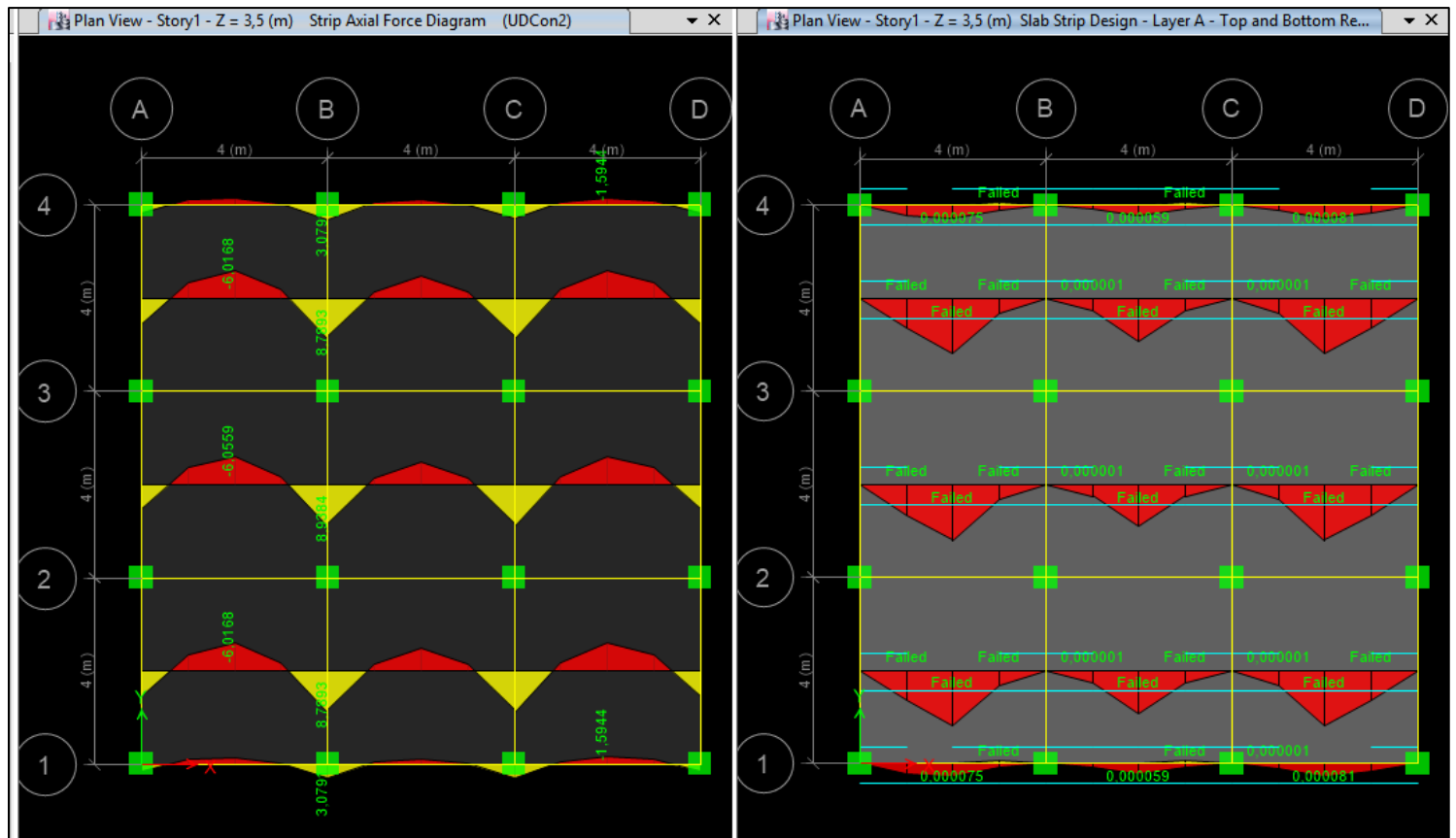


Image left shown moment diagram to the strip (the text said “Axial force...” is a bug program). **Maximum Tension Moment = 6 kN.m.**

Image Right shown required reinforcement. Majority of the trips fail to flexure.

Then I go to MathCAD as follow:

FLEXURE VERIFICATION RIBBED SLAB

$$F_y := 420 \cdot \text{MPa}$$

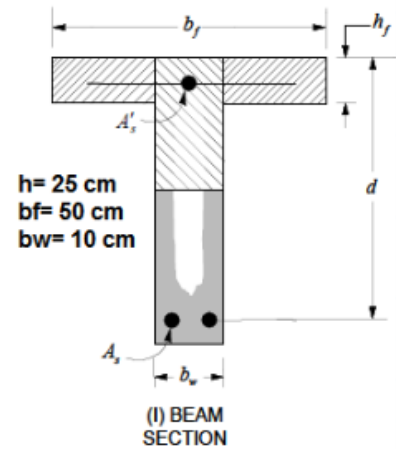
$$F_c := 25 \cdot \text{MPa}$$

$$\beta_1 := 0.85 \quad \text{to } F_c \leq 30 \text{ MPa}$$

$$\Phi := 0.90$$

$$b_f := 10 \cdot \text{cm}$$

$$d := 22 \cdot \text{cm}$$



$$\rho := 0.375 \cdot 0.85 \cdot F_c \cdot \frac{\beta_1}{F_y} = 0.016 \quad \text{Maximum Reinforcement Tension Controlled Section}$$

$$A_s := \rho \cdot b_f \cdot d = 3.548 \text{ cm}^2 \quad \text{Maximum Reinforcement}$$

$$M_u := \Phi \cdot \rho \cdot b_f \cdot F_y \cdot d^2 \cdot \left(1 - \frac{0.59 \cdot \rho \cdot F_y}{F_c}\right) = 24.789 \text{ kN} \cdot \text{m} \quad \text{Maximum Moment}$$

According to the hand calculation, the maximum allowed moment to tension controlled section (single reinforcement section) is 24,79 kN.m.

But ETABS shown as flexure failure with 6 kN.m moment.

Even according the ETABS Slab Design Manual maximum reinforcement is 0,04 of gross cross-sectional area:

2.5.1.3 Minimum and Maximum Slab Reinforcement

The minimum flexural tension reinforcement required for each direction of a slab is given by the following limits (ACI 7.6.1.1, 8.6.1.1):

$$A_{s,\min} = 0.0020 \, b h \text{ for } f_y < 60 \text{ ksi} \quad (\text{ACI Table 7.6.1.1, Table 8.6.1.1})$$

$$A_{s,\min} = 0.0018 \, b h \text{ for } f_y = 60 \text{ ksi} \quad (\text{ACI Table 7.6.1.1, Table 8.6.1.1})$$

$$A_{s,\min} = \frac{0.0018 \times 60000}{f_y} b h \text{ for } f_y > 60 \text{ ksi} \quad (\text{ACI Table 7.6.1.1, Table 8.6.1.1})$$

In addition, an upper limit on both the tension reinforcement and compression reinforcement has been imposed to be 0.04 times the gross cross-sectional area.

If I use the value of 0,04 "Area Section" the maximum moment will be even greater.

I pointed that this error does not happen when using ETABS 2016 v16.0.3. Only with v16.1.0.