

Use of prototype Sheet for Element Design

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Use of formula in spreadsheet

- Take a example: find out shear strength of concrete τ_c based on percentage of reinforcement
- $\tau_c = \frac{.85}{6\beta} \sqrt{(0.80\sigma_{ck})(\sqrt{1+5\beta}-1)}$
- $\beta = \frac{.8\sigma_{ck}}{6.89p_t} > 1$
- If $P_t = 0.78$, And Concrete is M20,
- then $\beta = 2.977 > 1$, then $\beta=2.977$
- $\tau_c = 0.57$

Use of spread sheet with formula

	A	B	C	D	E
28					
29					
30					
31					
32					
33	Concrete strength	20			
34	Percentage of rebar	0.78			
35	β	2.9771873	2.977187302		
36	τ_c	0.57			
37					
38					
39					
40					
41					
42					
43					
44					

Step 1
=0.8*B33/(6.89*B34)

Step 2
=IF(B35<1,1,B35))

Step 3
=0.85*SQRT(0.8*B33)*(SQRT(1+5*C35)-1)/(6*C35)

Use of table to find the Design shear strength

Pt of Ast	Design Shear Strength of concrete					
	Tc N/mm ²					
	M20	M25	M30	M35	M40	
0.15	0.28	0.29	0.29	0.29	0.29	0.3
0.25	0.36	0.36	0.37	0.37	0.37	0.38
0.5	0.48	0.49	0.5	0.5	0.5	0.51
0.75	0.56	0.57	0.59	0.59	0.59	0.6
1	0.62	0.64	0.66	0.67	0.67	0.68
1.25	0.67	0.7	0.71	0.73	0.73	0.74
1.5	0.72	0.74	0.76	0.78	0.78	0.79
1.75	0.75	0.78	0.8	0.82	0.82	0.84
2	0.79	0.82	0.84	0.86	0.86	0.88
2.25	0.81	0.85	0.88	0.9	0.9	0.92
2.5	0.82	0.88	0.91	0.93	0.93	0.95
2.75	0.82	0.9	0.94	0.96	0.96	0.98
3	0.82	0.92	0.96	0.99	0.99	1.01

Prototype commands to read any 3 dimensional table

Method of finding data from a table

Example - finding design shear strength of concrete

Concrete Mark	NOTE: Concrete mark Lower value 1, 2, 3, 4 and 5 denotes Higher value and 40	Pt of Ast	Design Shear Strength (Tc N/mm ²)
M20	25, 30, 35	0.62	0.15
M25	30, 35	0.67	0.28
M30	35	0.75	0.48
M35		1.0	0.75
M40		1.25	1.0

Popular formula for calculation of Rebar area in singly reinforcement element

$$M_u = .87\sigma_y A_t \left(d - \frac{\sigma_y A_t}{\sigma_{ck} b} \right)$$

Mu: Moment of Resistance

The equation forms a quadratic equation, solving which gives area of steel in singly reinforcement flexural element

$$M_u = .87\sigma_y A_t \left(d - \frac{\sigma_y A_t}{\sigma_{ck} b} \right)$$

• Or $.87\sigma_y^2 / (\sigma_{ck} b) A_t^2 - .87\sigma_y d A_t + M_u = 0$

• or $ax^2 - bx + c = 0$

• $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Spreadsheet for Steel Area Calculation

Calculation of Area of Steel in Singly Reinforcement member	
σ_y	500
σ_{st}	20
M_u	5.40E+07
B	230
D	500
d'	45
d	455
a	47.2826087
b	-197925
c	54000000
Ast	293.394478

Callouts:

- $.87\sigma_y^2 / (\sigma_{ck} b)$
- $-.87\sigma_y d$
- M_u
- $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
- $=(0.87\sigma_y d - \sqrt{0.7569\sigma_y^2 d^2 - M_u \cdot 3.48\sigma_y^2 / (F_c b)}) / (1.74\sigma_y^2 / (F_c b))$

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