Structural Function Reference

Rebar Properties

Bars are in English units (#3 thru #11, #14, # 18). Omit "#" when entering bar size.

b_area(*bar_size***)** *returns the bar area in* in^2
b_dia(*bar_size***)** *returns the bar diameter in inches*
b_wt(*bar_size***)** *returns the bar weight in lbs/ft*
min_b_size(*area_req'd***)** *returns the smallest bar # with an area ≥ area_req'd*
area_req'd…… bar area in in^2

Examples:

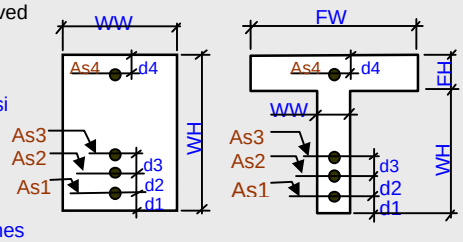
bar1 size # =	7	
bar1 area =	0.60	=b_area(C16)
#4 bar dia =	0.5	=b_dia(4)
bar1 wt =	2.044	=b_wt(C16)
req'd As =	5.67 in^2	
no. bars =	4	
min bar size =	11	=min_b_size(C20/C21)
As provided =	6.24 in^2	=C21*b_area(C22)

Analysis of the Reinforced Concrete Sections

This group of functions enable Strength and Working Stress Analysis of the rectangular and "T" shaped reinforced concrete sections. A maximum of 20 sections may be used in the workbook.
The analysis is performed in two steps:
step1 : Use **set_r_sect** or **set_t_sect** function to set up rectangular or T-section, respectively.
step2 : Use **rc_ult** and **rc_strs** functions to obtain Strength and Working Stress analysis results.
Each section is referred to by the unique index (idx) which is set in step 1. The index (idx) in the **rc_ult** and **rc_strs** functions must be a reference to a cell containing **set_r_sect** or **set_t_sect** (e.g. b12).

set_r_sect(*idx, WW, WH, Fy, F'c, n, As1, As2, As3, As4, d1, d2, d3, d4*) *sets up rectangular section and returns an index = idx*
set_t_sect(*idx, FW, FH, WW, WH, Fy, F'c, n, As1, As2, As3, As4, d1, d2, d3, d4*) *sets up T-section and returns an index = idx*

idx……	integer from 1 to 20 (21 & 22 reserved for this worksheet)
FW, FH, WW, WH…….	section dimensions in inches
Fy……..	reinforcing steel yield strength in ksi
F'c……..	concrete strength in ksi
n……..	=Es/Ec
As1, As2, As3, As4…….	reinforcement area in in^2
d1, d2, d3, d4……..	reinforcement location dim's in inches



set_r_sect can be entered via custom form - press **ALT+F8** and follow the instructions

set_t_sect can be entered via custom form - press **ALT+F9** and follow the instructions

Notes:
1. *As2, As3 and As4* reinforcement (and associated d-dimensions) are optional, except *As4 is* required for sections in full tension.
2. *Fy* and *F'c* are required for strength analysis.
3. n is required for working stress analysis.
4. Use "0" in place of input parameter that isn't used (optional input field can be left blank in the custom form).

rc_ult*(idx, Pu, ϕ, output_code)* *returns the strength analysis parameter specified by the output_code*

idx..... section No. - must be a reference to a cell containing **set_r_sect** or **set_t_sect** (e.g. b12).

Pu..... factored axial load in kips (+ compression; - tension)

ϕ..... resistance (strength reduction) factor

output_code..... single code enclosed in quotations marks that specify returned parameter

Output Codes	Returned Parameters
"mcap".....	moment resistance (capacity) in k-ft
"c".....	distance to the neutral axis from the section top in inches
"strain1".....	reinforcement *As1* strain
"cg".....	distance to the section center gravity from the bottom in inches

rc_ult can be entered via custom form - press **ALT+F10** and follow the instructions

rc_strs*(idx, P, M, output_code)* *returns working stress analysis parameter specified by the output_code*

idx..... section No. (must be a reference to a cell containing **set_r_sect** or **set_t_sect** (e.g. b12)).

P..... service axial load in kips (+ compression; - tension)

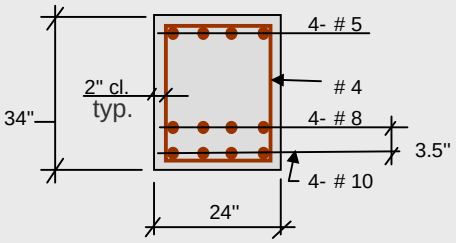
M..... service moment in k-ft (moment causes tension at the section bottom; moment sign is ignored)

output_code..... single code enclosed in quotations marks that specify returned parameter

Output Codes	Returned Parameters
"c".....	distance to the neutral axis from the section top in inches
"fs1".....	stress in *As1* in ksi (+ compression; - tension)
"fs2".....	stress in *As2* in ksi (+ compression; - tension)
"fs3".....	stress in *As3* in ksi (+ compression; - tension)
"fs4".....	stress in *As4* in ksi (+ compression; - tension)
"fc".....	compressive stress in the concrete at the section top in ksi
"fc2".....	compressive stress in the concrete at the section bottom in ksi (applicable for sections in full compression)
"cg".....	distance to the section center gravity from the bottom in inches

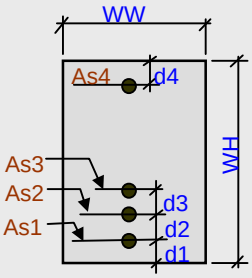
rc_strs can be entered via custom form - press **ALT+F10** and follow the instructions

Examples:



F'c =	3	ksi	
Fy =	60	ksi	
Mu =	345	k-ft	(strength)
Ms =	214	k-ft	(service)

As1 =	5.08	in^2	*=4*b_area(10)*
As2 =	3.16	in^2	*=4*b_area(8)*
As4 =	1.24	in^2	*=4*b_area(5)*
d1 =	3.125	in	*=2+b_dia(4)+b_dia(10/2)*
d2 =	6.625	in	*=3.125+3.5*
d4 =	2.8125	in	*=2+b_dia(4)+b_dia(5)/2*



Consider two cases:
Case 1: include compression bars (As4)
Case 2: ignore compression bars (As4)

Set up data for two cases:

Case 1 =set_r_sect(21,B124,C124,D124,E124,F124,G124,A126,B126,C126,D126,E126,F126,G126)

Sect. No.	WW (in)	WH (in)	Fy (ksi)	F'c (ksi)	n = Es/Ec	As1 (in^2)
21	24	34	60	3	8	5.08
As2 (in^2)	As3 (in^2)	As4 (in^2)	d1 (in)	d2 (in)	d3 (in)	d4 (in)
3.16	0	1.24	3.125	6.625	0	2.8125

Case 2 =set_r_sect(22,B130,C130,D130,E130,F130,G130,A132,B132,C132,D132,E132,F132,G132)

Sect. No.	WW (in)	WH (in)	Fy (ksi)	F'c (ksi)	n = Es/Ec	As1 (in^2)
22	24	34	60	3	8	5.08
As2 (in^2)	As3 (in^2)	As4 (in^2)	d1 (in)	d2 (in)	d3 (in)	d4 (in)
3.16	0	0	3.125	6.625	0	0

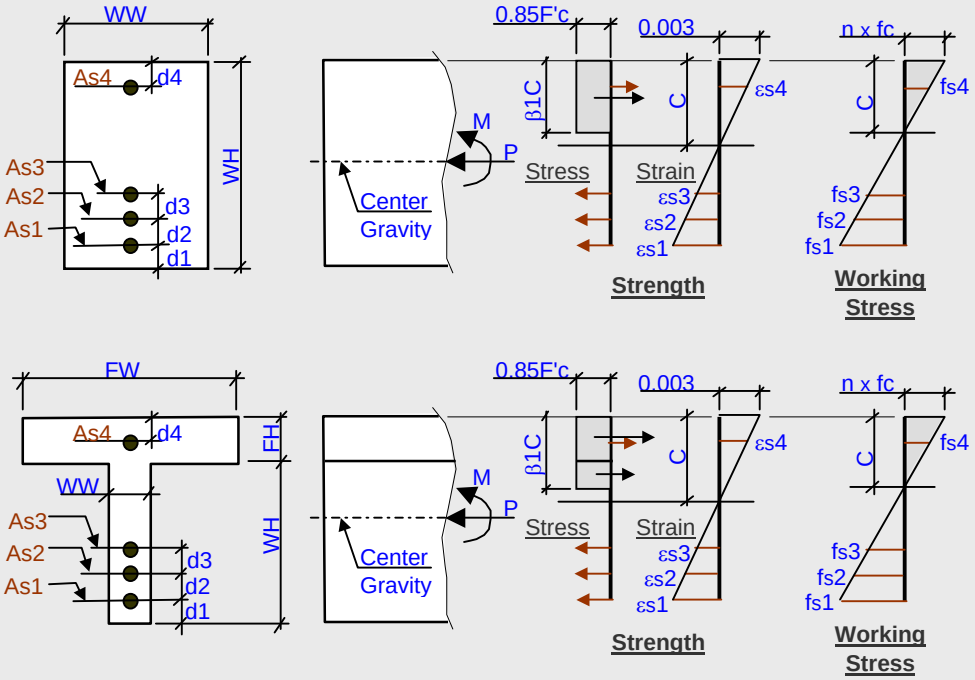
Strength

ϕ =	0.9		
Case 1 Mcap =	925.7	k-ft	=rc_ult(A124,0,C135,"mcap")
Case 2 Mcap =	900.9	k-ft	=rc_ult(A130,,C135,"mcap")
Case 1 As1 strain =	-0.0084		=rc_ult(A124,0,C135,"strain1")
Case 2 As1 strain =	-0.0067		=rc_ult(A130,0,C135,"strain1")

Stress

Case 1 fs1 =	-13.82	ksi	=rc_strs(A124,,F103,"fs1")
Case 1 fs4 =	4.58	ksi	=rc_strs(A124,,F103,"fs4")
Case 2 fs1 =	-13.89	ksi	=rc_strs(A130,0,F103,"fs1")

Reinforced Concrete Section Analysis - Technical Reference



- Strength analysis is based on an equilibrium and stress/strain compatibility as outlined in the ACI and AASHTO Codes.

- The tensile strength of the concrete is neglected.

- In strength analysis stress in reinforcement = 29000 $\varepsilon s \leq$ Fy.

- $\beta 1 = 0.85$; F'c $\leq$ 4.0 ks;
  $\beta 1 = 0.85 - 0.05(F'c-4) \geq 0.65$; F'c > 4.0 ksi

Tension Axial Load (Pu < 0) Note:
To determine moment resistance (Mr), the spreadsheet uses formula: Mr = Mo(1-Pu/Po) for cases where a center of gravity of the reinforcement is not coincidental with the center of gravity of the concrete section.
Mo – moment resistance corresponding to Pu=0
Po - axial tensile resistance corresponding to Mu=0 (Po is based on a portion of the specified reinforcement that has the same center of gravity as the concrete section)