CALCULATION OF CRACK WIDTH IN BEAM DESIGN

Reference:Annex-F,IS 456-2000,Clause 35.3.2 Cracking

Description	**Input Data:**			
Beam No		B1		
Location		Mid-Bottom		
Width of Beam,B	B	450	mm	User Input
Depth Of beam	D	1100	mm	User Input
Bending Moment(un-factored)	BM	953.64	kN-m	User Input
Area of steel at compression side	Ast comp	0	sqmm	User Input
Effective depth of beam	deff	1045	mm	User Input
Clear Cover to Longitudinal Reinforcement	Cmin	25	mm	User Input
clear cover to reinf.comppression side	d',dcomp	55	mm	User Input
Modulus of elasticity of steel	Es	200000	N/sqmm	User Input
Grade of concrete	Fck	30	N/sqmm	User Input
Grade of reinforcement	Fy	415	N/sqmm	User Input
Ast required as per the current algo	Ast	5180.49	sqmm	User Input
No of bar at bottom most layer		4	Nos	User Input
Dia of bars in bottom layer	diam1	32	mm	User Input
Permissible Crack-width	Wcr,perm	**0.2**	mm	User Input
Permissible Bending Stress	σcbc	10	N/sqmm	table 21 of IS 456-2000
Calculating Neutral Axis depth				
c/c spacing between bars	sp	122.67	mm	Pillai menon book. Eq.10.30
				=(B-Cmin-Cmin-diam1)/(dia1-1)
modular Ratio,m	m	9.33		=280/(3*σcbc)
Steel Ratio, Ast/ (B * Deff)	pt	0.01102		=Ast/(B*deff)
Constant	k	0.36217		=(SQRT((2*pt*m)+(pt*m)^2))-(pt*m)
Neutral Axis	X	378.46	mm	=k*deff
Actual permissible Bending Stress	σcbc(actual)	12.19	N/sqmm	=BM*10^6/(B*X/2*(deff-(X/3)))
check for Section	check	Doubly reinforced		=IF(σcbc(actual)>σcbc,"Doubly reinforced","singly reinforced")
Permissible Bending Stress considered		10	N/sqmm	=IF(check="singly reinforced",σcbc(actual),σcbc)
Calculating Xact				
Constant	a	225		=B/2
Constant	b	48351.20533		=((1.5*m-1)*Astcomp)+(m*Ast)
Constant	c	-50527009.57		=((1.5*m-1)*Astcomp*(-dcomp))-(m*Ast*deff)
Neutral axis (Iteration-1)	X1	378.4637446	mm	=(-b+SQRT(b^2-(4*a*cc)))/(2*a)
Neutral axis (Iteration-2)	X2	-593.3579905	mm	=(-b-SQRT(b^2-(4*a*cc)))/(2*a)
Actual Neutral Axis	Xact	378.4637446	mm	=IF(check="singly reinforced",X,MAX(X1:X2))
Cracked Moment of Interia	Icr	29612395180	mm^4	=((B*(Xact)^3)/3)+(m*Ast*((deff-(Xact))^2))
Actual stress in steel	Fst	200.34	N/sqmm	=m*BM*10^6*(deff-Xact)/Icr
Permissible stress in steel	Fst,perm	228.25	N/sqmm	=0.55*Fy
Check for Permissible sress in steel		Ok		=IF(Fst<0.55*Fy,"Ok","revise")
Epsilon-deff,	ε1	0.001084366		=(Fst/(Es))*((D-Xact)/(deff-Xact))
Empsilon-m,	εm	0.000971287		=ε1-((width*(D-Xact)*(D-Xact))/(3*Es*Ast*(deff-Xact)))
Distance from the point considered to the	acr	57.78	mm	=(SQRT((spacing/2)^2+(Cmin+(diam1/2))^2))-(diam1/2)
surface of the nearest longitudinal bar				
Check for strain in tension reinforcement		Ok		=IF(ε1<(0.8*Fy/Es),"Ok","revise")
Crack-width	Wcr	0.1543	mm	=(3*acr*εm)/(1+((2*(acr-Cmin))/(D-Xact)))
Check		Ok		=IF(Wcr<=Wcrperm,"Ok","Exceeds Limit")

RCDC Output

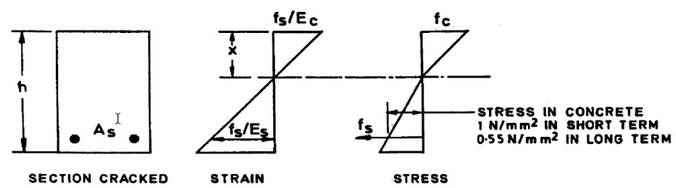
Group		:	**G1**	
Beam No		:	**B1**	
Analysis Reference (Member)	4.2m	:	4005	
Beam Length		:	8000	mm
Breadth (B)		:	450	mm
Depth (D)		:	1100	mm
Effective Depth (d)		:	1045	mm
Design Code		:	IS 456	
Beam Type		:	Regular Beam	
Grade Of Concrete (Fck)		:	M30	N/sqmm
Grade Of Steel		:	Fe415	N/sqmm
Clear Cover (Cmin)		:	25	mm
Es		:	2x10^5	N/sqmm

Crack width as per IS 456 + IS 13920 - 2016

	Beam Bottom			Beam Top		
	Left	**Mid**	**Right**	**Left**	**Mid**	**Right**
Critical L/C - RCDC	10001	10001	-	10001	-	10001
BM (Unfactored) (kNm)	144.4	953.64	0	601.02	0	936.72
Reinf. In 1st layer	4-T32	4-T32		4-T32		4-T32
sp (mm)	122.7	122.7		122.7		122.7
AstPrv (sqmm)	3217	5180.48		3217		4689.61
Xact (mm)	312.62	378.46		312.62		363.98
Icr (mm^4)	20687914418	29612369116		20687914418		27532958255
acr (mm)	57.78	57.78		57.78		57.78
Check for Stress in Concrete						
σ_{cbc} (N/sqmm)	2.18	10		9.08		10
$\sigma_{cbc(Actual)}$ (N/sqmm)	10	10		10		10
Check for Stress in Reinforcement						
Fst (N/sqmm)	47.71	200.34		198.58		216.25
FstPerm(N/sqmm)	228.25	228.25		228.25		228.25
Crack Width Check						
Epsilon-deff, ε1	0.000256	0.001084		0.001067		0.001169
Epsilon-m, εm	0.000059	0.000971		0.00087		0.001041
Wcr (mm)	0.0095	0.1543		0.1392		0.1657
WcrPerm(mm)	0.2	0.2		0.2		0.2

$$a_{cr} = \sqrt{(s/2)^2 + d_c^{\,2}} - d_b/2$$

$$\varepsilon_1 = \frac{f_{st}}{E_s}\,\frac{a'-x}{d-x}$$

$$\varepsilon_m = \varepsilon_1 - \frac{b\,(h-x)(a-x)}{3E_s A_s (d-x)}$$

$$W_{cr} = \frac{3\,a_{cr}\;\varepsilon_m}{1 + \dfrac{2(a_{cr}-C_{min})}{h-x}}$$