	Project:	**Project**
	Location:	**Location**
	Client:	**Client**
	Job No.:	1
	Subject:	Beam

ANALYSIS & DESIGN OF RC BEAM AS PER ACI 318

INPUT DATA

MATERIAL PROPERTIES

f_c'	=	41	Mpa	CONCRETE STRENGTH
f_y	=	414	Mpa	REBAR YIELD STRESS
f_{ys}	=	414	Mpa	LINKS YIELD STRESS
E_s	=	200,000	Mpa	Steel Modulus of Elasticity
E_c	=	30,095	Mpa	E_c = 4700*SQRT(f'$_c$)

DIMENSIONS

L	=	3.15	m	BEAM LENGTH
B	=	200	mm	BEAM WIDTH
H	=	400	mm	BEAM HEIGHT
C_t	=	40	mm	COVER TO TOP REINFORCEMENT
C_c	=	40	mm	COVER TO BOTTOM REINFORCEMENT
C_s	=	40	mm	COVER TO SIDE BARS

STEEL REINFORCEMENT

LEFT SUPPORT

TOP REINFORCEMENT

layer 1		layer 2		layer space
no.	mm	no.	mm	
3	Ø 25	6	Ø 20	25

BOTTOM REINFORCEMENT

layer 1		layer 2		layer space
no.	mm	no.	mm	
2	Ø 25	2	Ø 25	25

HOOPS

no.	spacing	no.	spacing
1	50	11	85

MIDSPAN

TOP REINFORCEMENT

layer 1		layer 2	
no.	mm	no.	mm
2	Ø 25	3	Ø 25

BOTTOM REINFORCEMENT

layer 1		layer 2	
no.	mm	no.	mm
3	Ø 25	2	Ø 16

STIRRUPS

legs	mm	spacing
2	Ø 10	350

APPLIED FORCES

LEFT SUPPORT

Mu	=	200.00	kN-m
Ma	=	50.00	kN-m
Vu	=	150.00	kN
Tu	=		kN-m
Pu	=		kN-m

MIDSPAN

Mu	=	150.00	kN-m
Ma	=	25.00	kN-m

OUTPUT RESULTS

FLEXURAL CAPACITY CHECKS

LEFT SUPPORT

β1	=	0.757142857		β1 = max. of: 0.85-(0.05*(f'c-28)/7) and 0.65
c	=	153.14	mm	Solve for "c" in: As*fy = 0.85*f'c*b1*c*b+A's*(c-d')
a	=	115.95	mm	a = β1*c
ρ	=	0.0523		ρ = As/(b*d)
$\rho_{(min)}$	=	0.0039		ρ(min) >= 0.25*SQRT(f'c)/fy >= 1.4/fy
ρb	=	0.0377		ρb = 0.85*β1*f'c/fy*(600/(600+fy)
ρg	=	0.0665		ρg = (As+A's)/(b*h)
$\rho_{(max)}$	=	N.A.		ρ(max) = As(max)/(b*d)
$As_{(min)}$	=	248.11	mm^2	As(min) = ρ(min)*b*d
$As_{(max)}$	=	2,546.2	mm^2	As(max) = (0.85*f'c*β1*c*b+A's*(c-d')/c*εc*Es)/fy f
ε_c	=	0.003		εc = 0.003 (assumed concrete strain)
ε'_s	=	0.0015		ε's = εc*(c-d')/c < fy/Es, f's d
f's	=	296.35	Mpa	f's = ε's*Es
As2	=	1405.52	mm^2	As2 = A's*f's/fy for f's > 0
As1	=	1952.06	mm^2	As1 = As-As2 for f's > 0
εt	=	0.0033		εt = εc*(d-c)/c = (fy/Es+εc)/(ρ/ρb)-εc
ϕ	=	0.75		ϕ = 0.65+0.25*(εt-fy/Es)/(0.005-fy/Es) <= 0.90
ϕMn	=	266.82	kN-m	> Mu = 200 kN-m, O.K.

MIDSPAN

β1	=	0.757142857		β1 = max. of: 0.85-(0.05*(f'c-28)/7) and 0.65
c	=	99.47	mm	Solve for "c" in: As*fy = 0.85*f'c*b1*c*b+A's*(c-d')
a	=	75.31	mm	a = β1*c
ρ	=	0.0278		ρ = As/(b*d)
$\rho_{(min)}$	=	0.0039		ρ(min) >= 0.25*SQRT(f'c)/fy >= 1.4/fy
ρb	=	0.0377		ρb = 0.85*β1*f'c/fy*(600/(600+fy)
ρg	=	0.0541		ρg = (As+A's)/(b*h)
$\rho_{(max)}$	=	N.A.		ρ(max) = As(max)/(b*d)
$As_{(min)}$	=	261.18	mm^2	As(min) = ρ(min)*b*d
$As_{(max)}$	=	2,854.5	mm^2	As(max) = (0.85*f'c*β1*c*b+A's*(c-d')/c*εc*Es)/fy f
ε_c	=	0.003		εc = 0.003 (assumed concrete strain)
ε'_s	=	0.0005		ε's = εc*(c-d')/c < fy/Es, f's d
f's	=	102.36	Mpa	f's = ε's*Es
As2	=	606.81	mm^2	As2 = A's*f's/fy for f's > 0
As1	=	1267.93	mm^2	As1 = As-As2 for f's > 0

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εt	=	0.0072		εt = εc*(d-c)/c = (fy/Es+εc)/(ρ/ρb)-εc
ϕ	=	0.90		ϕ = 0.65+0.25*(εt-fy/Es)/(0.005-fy/Es) <= 0.90
ϕMn	=	199.48	kN-m	> Mu = 150 kN-m, O.K.

RIGHT SUPPORT

β1	=	0.757142857		β1 = max. of: 0.85-(0.05*(f'c-28)/7) and 0.65
c	=	114.52	mm	Solve for "c" in: As*fy = 0.85*f'c*b1*c*b+A's*(c-d')
a	=	86.71	mm	a = β1*c
ρ	=	0.0387		ρ = As/(b*d)
$\rho_{(min)}$	=	0.0039		ρ(min) >= 0.25*SQRT(f'c)/fy >= 1.4/fy
ρb	=	0.0377		ρb = 0.85*β1*f'c/fy*(600/(600+fy)
ρg	=	0.0614		ρg = (As+A's)/(b*h)
$\rho_{(max)}$	=	N.A.		ρ(max) = As(max)/(b*d)
$As_{(min)}$	=	245.53	mm^2	As(min) = ρ(min)*b*d
$As_{(max)}$	=	2,610.0	mm^2	As(max) = (0.85*f'c*β1*c*b+A's*(c-d')/c*εc*Es)/fy f
ε_c	=	0.003		εc = 0.003 (assumed concrete strain)
ε'_s	=	0.0008		ε's = εc*(c-d')/c < fy/Es, f's d
f's	=	167.76	Mpa	f's = ε's*Es
As2	=	994.57	mm^2	As2 = A's*f's/fy for f's > 0
As1	=	1459.80	mm^2	As1 = As-As2 for f's > 0
εt	=	0.0053		εt = εc*(d-c)/c = (fy/Es+εc)/(ρ/ρb)-εc
ϕ	=	0.90		ϕ = 0.65+0.25*(εt-fy/Es)/(0.005-fy/Es) <= 0.90
ϕMn	=	236.20	kN-m	> Mu = 159 kN-m, O.K.

SHEAR CAPACITY CHECKS

@ 2H for Seismic Provision for transverse Reinforcements per Sec.21.5.3.2

S(max)= smallest of ==>

				S(max) = d/4
				S(max) = $8d_b$ (smallest longitudinal bar)
S(max)	=	80.21	mm.o.c.	S(max) = $24d_b$ (diameter of hoop bar)
		< 85mm, N.G.		S(max) = 300mm

For Shear Reinforcements

ϕVc	=	52.39	kN	ϕVc = 0.17*λ*SQRT(f'c)bd
ϕVs	=	44.71	kN	ϕVs = ϕ*fy*d*Av(stirrup)/s >= 0
ϕVn	=	97.09	kN	<Vu =150 kN, not O.K.
$\phi Vs_{(max)}$	=	203.38	kN	>= Vu-(phi)Vc = 97.61 kN, O.K.
$Av_{(prov)}$	=	157.08	mm^2	
$Av_{(req'd)}$	=	388.97	mm^2	> Av(prov) = 157.08 , N.G.
$Av_{(min)}$	=	67.12	mm^2	<= Av(prov) = 157.08 mm^2, O.K.
$s_{(max)}$	=	160.42	mm	< s = 350 mm, N.G.

For Torsion Reinforcements

Tc	=	2.13	kN-m	< 0.00 kN-m, torsion need not to be considered!
Tu_{max}	=	N.A.	kN-m	
At_{prov}	=	N.A.	mm^2	(Av+t(used)-Av(req'd))/2
$At_{req'd}$	=	N.A.	mm^2	
At_{min}	=	N.A.	mm^2	
$Al_{req'd}$	=	N.A.	mm^2	
Al_{min}	=	N.A.	mm^2	
Al_{prov}	=	1,963.50	mm^2	add'l web bars are not required!

Total (Av+t)	=	N.A.	mm^2
$Total\ (Av+t)_{min}$	=	N.A.	mm^2

CRACK CONTROL

Es	=	200,000	MPa	Steel Modulus of Elasticity
Ec	=	30,095	MPa	E_c = 4700*SQRT(f'_c)
n	=	6.65		n = Es/Ec

LEFT SUPPORT

fs	=	1,834.20	MPa	fs = Ma/(As*d*(1-(SQRT(2*As/(b*d)*n+(As/(b*d)*n)^2)-
$fs_{(used)}$	=	276.00	MPa	fs(used) = minimum of: fs and 2/3*fy
s(max)	=	260.51	mm	s(max) = minimum of: 380*280/fs(used)-2.5*Cc and 3
s(min)	=	25.00	mm	
s(act)	=	33.33	mm	s(min) <= s(act) <= s(max), O.K.!

MIDSPAN

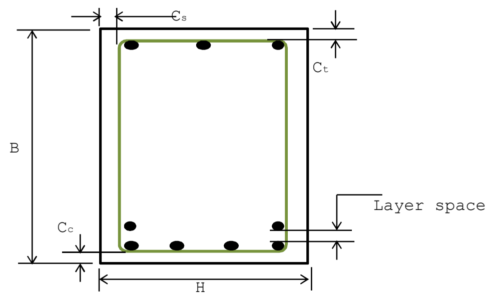
fs	=	655.14	MPa	fs = Ma/(As*d*(1-(SQRT(2*As/(b*d)*n+(As/(b*d)*n)^2)-
$fs_{(used)}$	=	276.00	MPa	fs(used) = minimum of: fs and 2/3*fy
s(max)	=	260.51	mm	s(max) = minimum of: 380*280/fs(used)-2.5*Cc and 3
s(min)	=	25.00	mm	
s(act)	=	33.33	mm	s(min) <= s(act) <= s(max), O.K.!

RIGHT SUPPORT

fs	=	1,016.80	MPa	fs = Ma/(As*d*(1-(SQRT(2*As/(b*d)*n+(As/(b*d)*n)^2)-
$fs_{(used)}$	=	276.00	MPa	fs(used) = minimum of: fs and 2/3*fy
s(max)	=	260.51	mm	s(max) = minimum of: 380*280/fs(used)-2.5*Cc and 3
s(min)	=	25.00	mm	
s(act)	=	50.00	mm	s(min) <= s(act) <= s(max), O.K.!

Calc. by:	RCF	Checked by:	RCF
Date:	26-Mar-11	Revision:	-

-08



RIGHT SUPPORT

TOP REINFORCEMENT

layer space
25

layer 1		layer 2		layer space
no.	mm	no.	mm	
2	Ø 25	3	Ø 25	25

BOTTOM REINFORCEMENT

layer space
25

layer 1		layer 2		layer space
no.	mm	no.	mm	
2	Ø 25	3	Ø 25	25

ADDITIONAL LONGITUDINAL BARS

no.	mm
4	Ø 10

RIGHT SUPPORT

Mu	=	159.00	kN-m
Ma	=	43.00	kN-m
Vu	=	76.00	kN
Tu	=		kN-m
Pu	=		kN-m

/c*ec*Es

or c = εc*d/(εc+0.005)

loes not yield

Transition section

/c*ec*Es

or c = εc*d/(εc+0.005)

loes not yield

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>= 0.005, Tension-controlled

/c*ec*Es

or c = εc*d/(εc+0.005)

does not yield

>= 0.005, Tension-controlled

As/(b*d)*n)/3))

00*280/fs(used)

As/(b*d)*n)/3))

00*280/fs(used)

As/(b*d)*n)/3))

00*280/fs(used)