

HIGH STRENGTH REINFORCEMENT FOR GRAVITY AND SEISMIC APPLICATION

STRUCTURAL ELEMENT	PURPOSE	GRADE 60 (Fe420) [ASTM A615 or A706]	GRADE 80 (Fe550) [ASTM A706]	GRADE 100 (Fe690) [ASTM A706 or A1035]
BEAM (IMRF)	Spacing of Stirrups in plastic region	8*Db(min)	8*Db(min)	For tension and compression only
COLUMN (IMRF)	Spacing of hoops in plastic region	8*Db(min)	6*Db(min)	For tension and compression only
BEAM (SMRF)	Maximum reinforcement %	2.5	2	Not allowed
BEAM (SMRF)	Spacing of Stirrups in plastic region	6*Db(min)	5*Db(min)	Not allowed
COLUMN (SMRF)	Spacing of hoops in plastic region	6*Db(min)	5*Db(min)	Not allowed
COLUMN (SMRF)	Minimum column dimension	20*Db(max)	26*Db(max)	Not allowed
WALLS (SPECIAL/DUCTILE), COUPLING BEAMS	For resisting Moment, shear & axial forces	Allowed	Allowed	Allowed
BOUNDARY ELEMENT OF WALLS (SPECIAL/DUCTILE)	Spacing of hoops within the greater of ℓ_w and $M_u/4V_u$ above and below critical sections.	Minimum of 6*Db(min) & 150 mm	Minimum of 5*Db(min) & 150 mm	Minimum of 4*Db(min) & 150 mm
	Other locations	Minimum of 8*Db(min) & 200 mm	Minimum of 6*Db(min) & 150 mm	Minimum of 6*Db(min) & 150 mm
BEAM & COLUMN (IMRF)	Minimum concrete grade (cylindrical)	17	17	Not allowed
BEAM & COLUMN (SMRF)	Minimum concrete grade (cylindrical)	21	21	Not allowed
WALLS (SPECIAL/DUCTILE), COUPLING BEAMS	Minimum concrete grade (cylindrical)	21	21	35
ALL	Development length modification factor	1	1.15	1.3
RC FLAT SLAB / PLATE	Modulus of rupture for deflection	0.55*SQRT(Fck)	0.55*SQRT(Fck)	0.37*SQRT(Fck)
BEAM, COLUMN (SMRF), WALLS (SPECIAL/DUCTILE)	Location of Mechanical splice (coupler)	Any location	Not within 2D from member face	Not within 2D from member face
DIAPHRAGM (COLLECTOR)	Mechanical splice (coupler)	Allowed	Not allowed	Not allowed

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DESIGN ACTION	STRUCTURAL ELEMENT	REINFORCEMENT	Maximum fy (Mpa)
FLEXURE/ AXIAL FORCE/ SHRINKAGE/ TEMPERATURE	SMRF, IMRF, OMRF (BEAMS & COLUMNS)	LONGITUDINAL BARS	550
	SPECIAL (DUCTILE) WALLS & COUPLING BEAMS	LONGITUDINAL BARS	690 [#]
	GRAVITY /NON-SEISMIC FRAMES, ORDINARY, GRAVITY /NON-SEISMIC WALLS & COUPLING BEAMS.	LONGITUDINAL BARS	690 ^{##}
	DIAPHRAGM (COLLECTOR)	LONGITUDINAL BARS	420 ^{**}
LATERAL SUPPORT TO LONGITUDINAL BARS OR CONCRETE CONFINEMENT	SMRF (BEAMS & COLUMNS)	TIES-HOOPS-SPIRALS	690 ^{##}
	SPECIAL (DUCTILE) WALLS & COUPLING BEAMS	TIES-HOOPS-SPIRALS	690 ^{##}
	IMRF,OMRF, GRAVITY /NON-SEISMIC FRAMES, ORDINARY, GRAVITY /NON-SEISMIC WALLS & COUPLING BEAMS.	TIES-HOOPS	550 [*]
	IMRF,OMRF, GRAVITY /NON-SEISMIC FRAMES, ORDINARY, GRAVITY /NON-SEISMIC WALLS & COUPLING BEAMS.	SPIRALS	690 ^{##}
SHEAR	SMRF (BEAMS & COLUMNS)	STIRRUPS-TIES-HOOPS-SPIRALS	550 [*]
	SPECIAL (DUCTILE) WALLS & COUPLING BEAMS	STIRRUPS-TIES-HOOPS-SPIRALS	690 [#]
	COUPLING BEAMS OF SPECIAL (DUCTILE) WALLS	DIAGONAL BARS	550 [*]
	IMRF,OMRF, GRAVITY /NON-SEISMIC FRAMES, ORDINARY, GRAVITY /NON-SEISMIC WALLS & COUPLING BEAMS.	STIRRUPS-TIES-HOOPS-SPIRALS	420 [*]
	DIAPHRAGM AND FOUNDATIONS OF BUILDINGS WITH SMRF AND SPECIAL (DUCTILE) WALLS.	STIRRUPS-TIES-HOOPS-SPIRALS	550 [*]
	DIAPHRAGM AND FOUNDATIONS OF BUILDINGS WITH IMRF,OMRF, GRAVITY /NON-SEISMIC FRAMES, ORDINARY, GRAVITY /NON-SEISMIC WALLS.	STIRRUPS-TIES-HOOPS-SPIRALS	420 [*]
TORSION	SMRF (BEAMS & COLUMNS)	LONGITUDINAL-STIRRUPS-TIES-HOOPS-SPIRALS	420 [*]
	SPECIAL (DUCTILE) WALLS & COUPLING BEAMS	LONGITUDINAL-STIRRUPS-TIES-HOOPS-SPIRALS	420 [*]
	IMRF,OMRF, GRAVITY /NON-SEISMIC FRAMES, ORDINARY, GRAVITY /NON-SEISMIC WALLS & COUPLING BEAMS.	LONGITUDINAL-STIRRUPS-TIES-HOOPS-SPIRALS	420 [*]

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- ** Rebar having fy 550 Mpa may be used but in design (flexure/axial) fy shall be limited to specified value.
- * Rebar having fy more than specified value may be used but in design (shear/torsion/confinement) fy shall be limited to specified value.
- # Confirming to ASTM A706
- ## Confirming to ASTM A615 or ASTM A706 or ASTM A1035

TYPE	Carbon	Carbon	Carbon	Carbon	Low-alloy	Low-alloy	Low-alloy	Low-carbon Chromium
GRADE	GRADE 60	GRADE 60*	GRADE 80	GRADE 100	GRADE 60	GRADE 80*	GRADE 100**	GRADE 100
STANDARD	ASTM A615	ASTM A615	ASTM A615	ASTM A615	ASTM A706	ASTM A706	ASTM A706	ASTM A1035
Min. YS	420	420	550	690	420	550	690	690
Min. UTS	550	550	725	790	550	690	809	1030
Max. YS-Act/YS-Cha.		1.3					1.18	
Min. UTS-act/YS-act	1.1	1.25			1.25	1.25	1.17	
Min. Fracture elongation	6 to 9	10 to 14	6 to 7	6 to 7	10 to 14	10 to 12	10	6 to 7
Min. Uniform elongation		6 to 9			6 to 9	6 to 7	6	

- * For Longitudinal rebar in SMRF & Special/Ductile wall
- ** For Longitudinal & Transverse rebar in Special/Ductile wall