RC Rectangular Beam Moment Capacity (Stress Block)

Nominal and design moment capacity of a singly reinforced rectangular concrete beam by the rectangular stress block, with neutral axis depth and steel strain.

Method: Equivalent rectangular stress block with strain compatibility

Input parameters

Unit system: SI

Parameter	Value	Unit
Concrete strength	30.000	MPa
Steel yield strength	420.00	MPa
Beam width	300.00	mm
Effective depth	500.00	mm
Tension steel area	1,500.0	mm²
Stress block intensity factor	0.85000	
Stress block depth factor	0.85000	
Ultimate concrete strain	0.003000	
Steel modulus	200.00	GPa
Strength reduction factor	90.000	%

Calculated results

Parameter	Value	Unit
Neutral axis depth	96.886	mm
Stress block depth	82.353	mm
Steel strain	0.012482	
Steel stress	420.00	MPa
Nominal moment capacity	289.06	kN·m
Design moment capacity	260.15	kN·m
Steel ratio A_s/bd	1.0000	%
Balanced steel ratio	3.0357	%

Notes for this case

• Whitney stress block: compression α₁f'_c·b·β₁c balances A_s·f_s, with f_s from strain compatibility. Factors α₁, β₁, φ and minimum and maximum steel come from the design code you use.

Formula and method

$$\alpha_1 f'_c b \beta_1 c = A_s f_s, \quad f_s = \min\left(f_y, E_s \varepsilon_{cu} \frac{d-c}{c}\right), \quad M_n = A_s f_s \left(d - \frac{\beta_1 c}{2}\right)$$

Variables

f'_c	Concrete strength	Pa
f_y	Steel yield strength	Pa
b	Beam width	m
d	Effective depth	m
A_s	Tension steel area	m²

α_1	Stress block intensity factor	-
β_1	Stress block depth factor	-
ε_{cu}	Ultimate concrete strain	-
E_s	Steel modulus	Pa
ϕ	Strength reduction factor	-
c	Neutral axis depth	m
a	Stress block depth	m
ε_s	Steel strain	-
f_s	Steel stress	Pa
M_n	Nominal moment capacity	N·m
ϕM_n	Design moment capacity	N·m
ρ	Steel ratio A_s/bd	-
ρ_b	Balanced steel ratio	-

Method and standards

Stress block.

Assumptions and limits

- Singly reinforced rectangular section; no compression steel.

References

Equivalent rectangular stress block with strain compatibility

Report details

Report reference	FCC-KGQ1-VF06 (the same inputs always give the same reference)
Generated	23 November 2026, 18:09 UTC
Calculator	RC Rectangular Beam Moment Capacity (Stress Block)
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/civil/concrete/rc-beam-moment-capacity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.