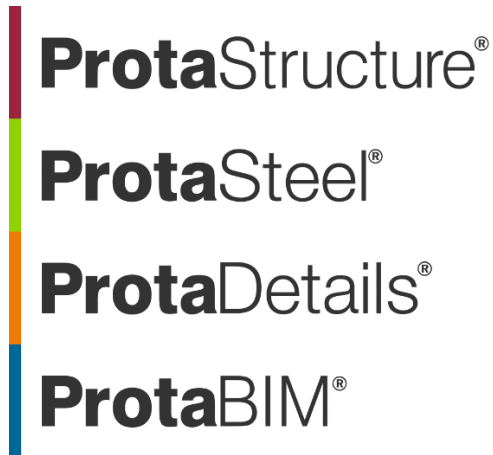




ProtaStructure Design Guide

Strong Column-Weak Beam Condition Check (ACI-318)

Version 2.0

9 April 2022

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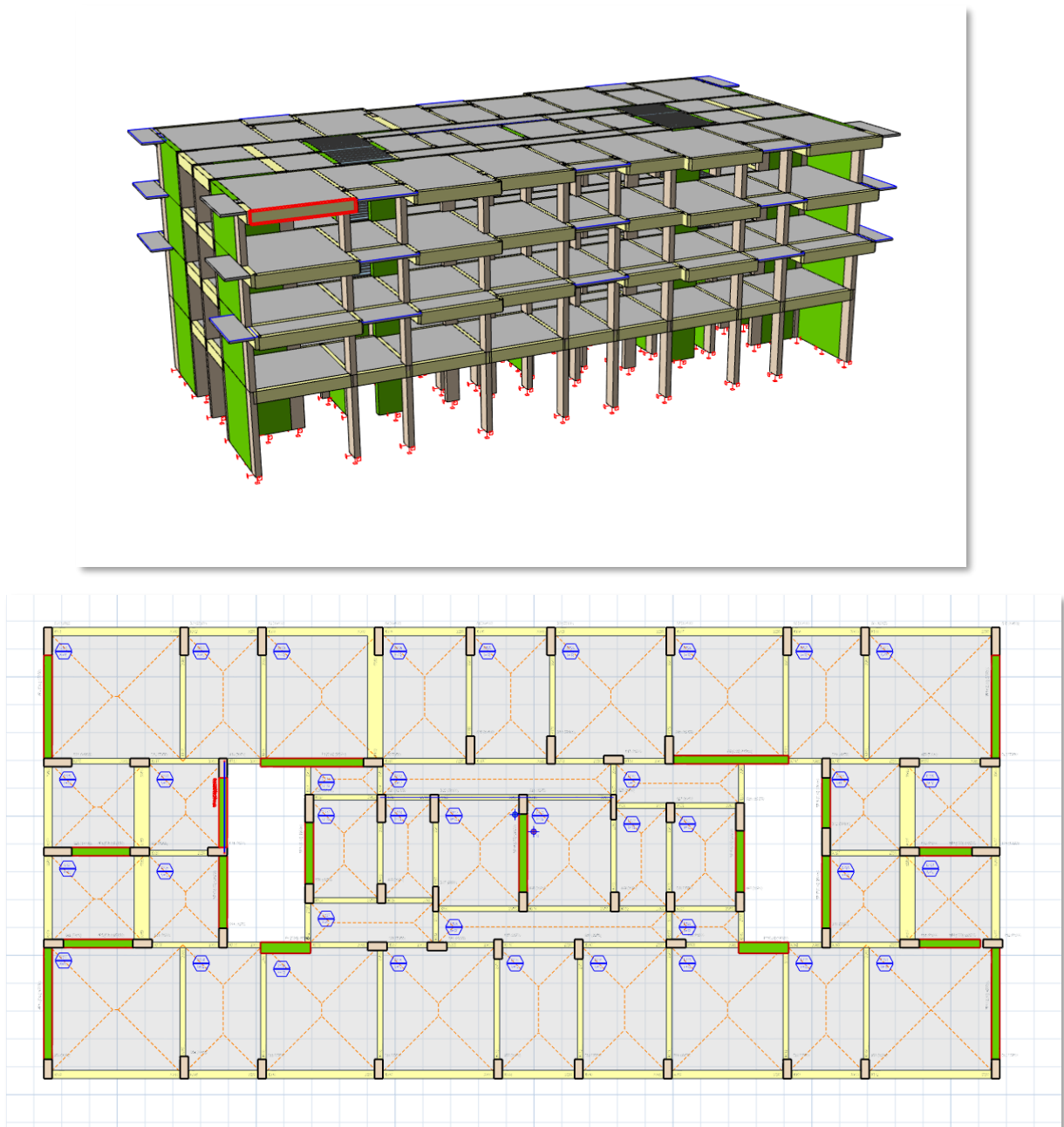
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Introduction

ProtaStructure checks global and local ductility conditions according to **ACI 318 18.7.3**. This document covers the calculation details of the strong column - weak beam condition checks.

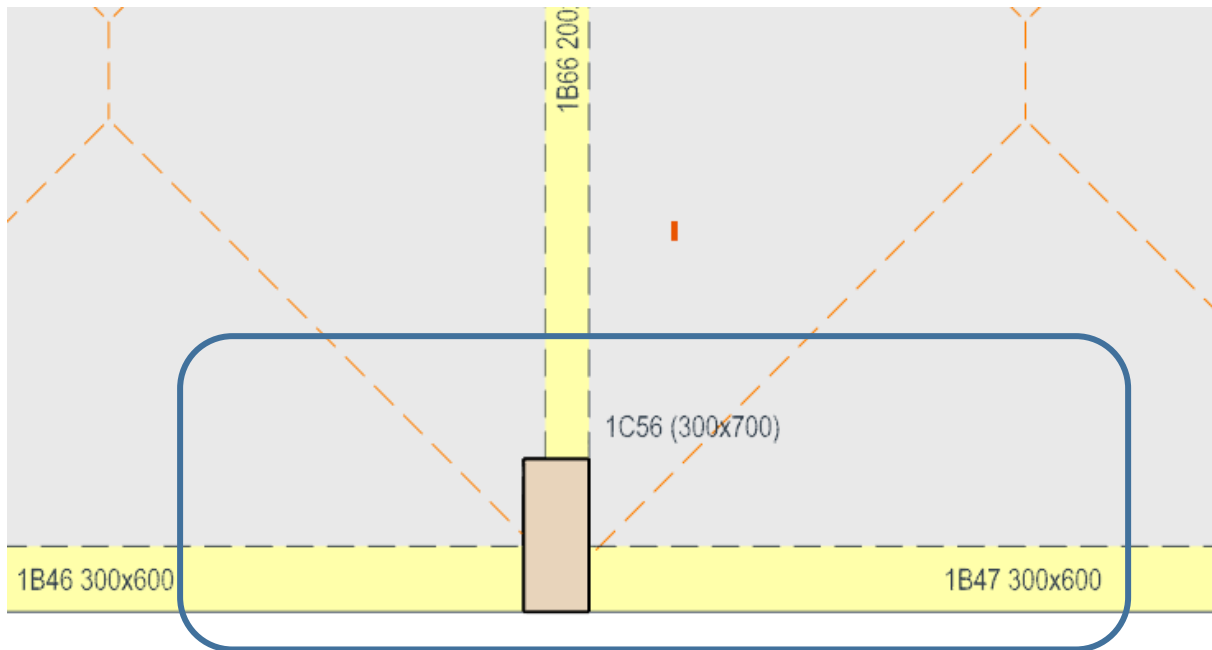
Building Model

The building model consists of 4 floors. 3D and typical story plan views are shown below.



3D and Typical Plan View of Building Model

Member Details



Column **1C56** at story one will be used for calculations. There are two beams in the X direction connected to column **1C56** and a beam in the Y direction.

Material Properties

Concrete

Concrete

C150
C173
C180
C208
C210
C240
C280
C300
C320
C350
C400
C500
C600
C700

Concrete

General

Material Name : C240
Material Color : 224, 224, 224

Mechanical Properties

Modulus of Elasticity : 23392.8 N/mm²
Shear Modulus : 9912.2 N/mm²
Poisson's Ratio : 0.18
Thermal Expansion Coeff. : 0.00001000 (1/°C)
Unit Weight : 23.540 kN/m³
Concrete Type: : Normalweight Concrete

Design Parameters

Characteristic Compressive Strength (Fck) : 24.00 N/mm²
Characteristic Tensile Strength (Fctk) : 3.10 N/mm²
Material Coeff : 1.50

Time Dependent Properties

Time Model : CEB FIB 90
Compressive Strength and Stiffness : 0.000
Creep : 0.000
Shrinkage : 0.000

☐ Apply to all members of this material class in this storey

OK

Cancel

Steel

Rebar

Rebar

- SD24 (Round Bar)
- SD30 (Deformed Bar)
- SD40 (Deformed Bar)
- SD50 (Deformed Bar)
- SBPDN 930/1080
- SBPDN 1080/1230
- SBPDN 1275/1420

General

Material Name : SD40 (Deformed Bar)

Material Color : 255, 0, 0

Mechanical Properties

Modulus of Elasticity : 204000.0 N/mm²

Shear Modulus : 76691.7 N/mm²

Poisson's Ratio : 0.33

Thermal Expansion Coeff. : 0.00001200 (1/°C)

Unit Weight : 77.010 kN/m³

Steel Bar Parameters

Minimum Yield Strength : 400.00 N/mm²

Ultimate Strength (Fu) : 0.00 N/mm²

Bearing Strength : 0.00 N/mm²

Material Coeff : 1.15

Rebar Symbol : DB

Rib Type : Type 2

Hook : ☐

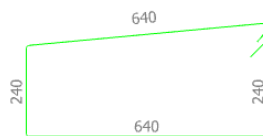
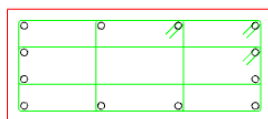
Prestressed : ☐

Rebar Diameters : [Edit...](#)

☐ Apply to all members of this material class in this storey

OK Cancel

Column Section and Reinforcement

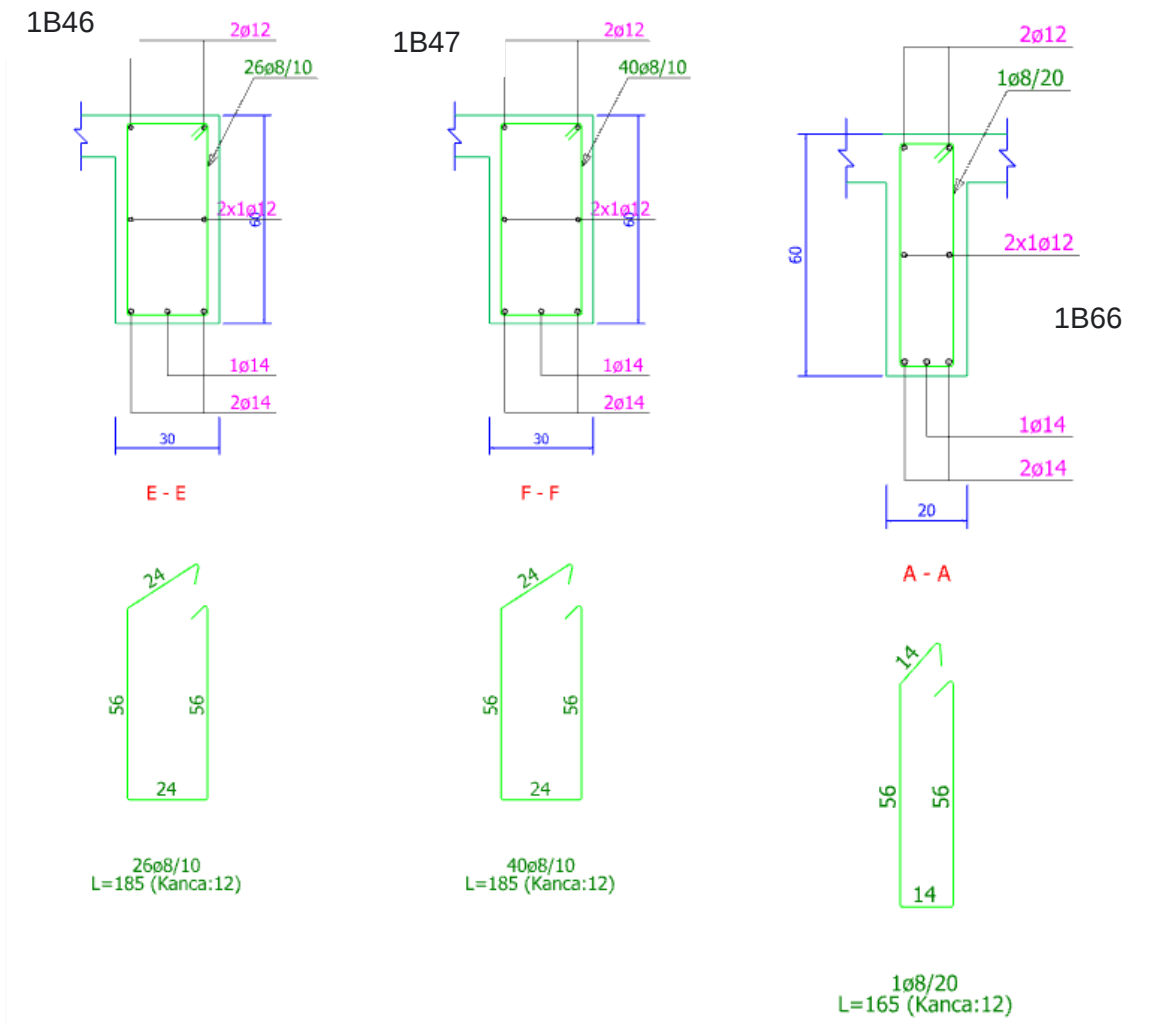


39H10-150-100 L=2050 (Hook :140) 39H10-150-100 L=1250 (Hook :140)

39H10-150-100 L=1750 (Hook :140)

1C56
(300x700)

Beam Section and Reinforcement



Details of the Calculation

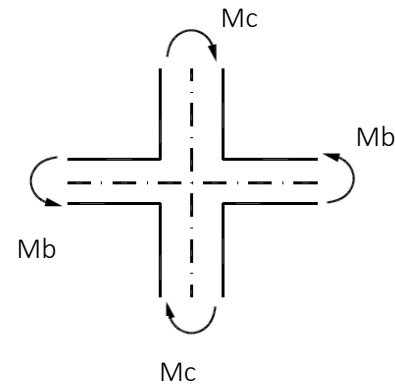
According to **ACI 318 18.7.3.1**, "Columns shall satisfy **18.7.3.2** or **18.7.3.3**, except at connections where the column is discontinuous above the connection, and the column factored axial compressive force: P_u under load combinations including earthquake effect, E, is less than $A_g f'_c / 10$ "

According to **ACI 318 18.7.3.1**, "The flexural strengths of the columns shall satisfy the condition below.

$$\sum M_{nc} \geq (6/5) \sum M_{nb} \quad (4.29)$$

$\sum M_{nc}$: sum of nominal flexural strengths of columns framing into the joint, evaluated at the faces of the joint. Column flexural strength shall be calculated for the factored axial force, consistent with the direction of the lateral forces considered, resulting in the lowest flexural strength

$\sum M_{nb}$: sum of nominal flexural strengths of the beams framing into the joint, evaluated at the faces of the joint. In T-beam construction, where the slab is in tension under moments at the face of the joint, slab reinforcement within an effective slab width defined per 6.3.2 shall be assumed to contribute to $\sum M_{nb}$, provided that the slab reinforcement is developed at the critical section for flexure.



Axial Force Check

According to **ACI 318 18.7.3.1**, axial force on the column member will be checked

$$P_u \leq A_g f_c / 10$$

$$P_u = 310.80 \text{ kN}$$

$$P_{lim} = 504 \text{ kN}$$

P_u is lower than the limit axial force. Therefore, the flexural strengths of the column no need to satisfy **18.7.3.2**

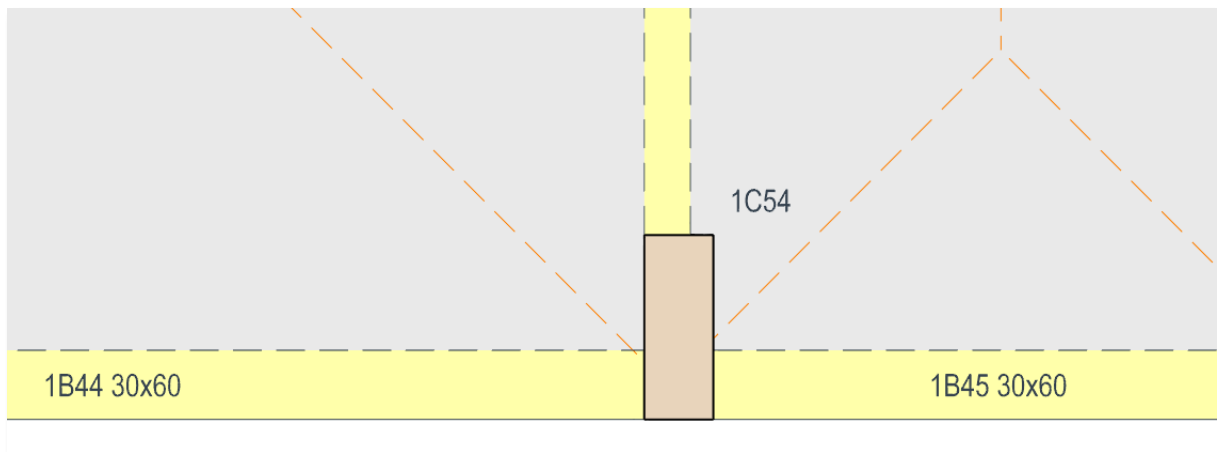
X-Direction

Joint	Member	Section (cm)	Axial Force, N (kN)	Moment Capacity, $M_c(+)$ (kN.m)	Moment Capacity, $M_c(-)$ (kN.m)
2C56	2C56 - Storey:2	30.0/70.0	260.10	143.3	143.3
1B46 + 1B47	1C56 - Storey:1	30.0/70.0	307.86	146.7	146.7
1C56	1B46	30.0/60.0		126.9	106.1
	1B47	30.0/60.0		106.1	126.9

Column Axial Loads 310.80 kN < 0.1 $A_g f_c$ (504.00 kN) **Sufficient** ✓

Column 1C56 does not exceed the axial force limit.

The detailed calculations will be shown for another column, 1C54. The plan view is given below.



X-Direction

In X Direction, 1B44 and 1B45 are connected to the 1C54 column. Strong column check calculations are given as follows;

Right Beam (1B45) Moment Capacity : 106.1 kN.m

Left Beam (1B44) Moment Capacity : 126.9 kN.m

Top Column (C54-Storey:2) Moment Capacity : 178.8 kN.m

Bot Column (C54-Storey:1) Moment Capacity : 200.1 kN.m

$$M_{RC} = 378.9 \text{ kN.m}$$

$$M_{Rb} = 233.0 \text{ kN.m}$$

$$\frac{M_{RC}}{M_{Rb}} = 1.6 \geq 1.2 \checkmark$$

X-Direction

Joint	Member	Section (cm)	Axial Force, N (kN)	Moment Capacity, $M_{c(+)}$ (kN.m)	Moment Capacity, $M_{c(-)}$ (kN.m)
2C54	2C54 - Storey:2	30.0/80.0	270.39	178.8	178.8
1B44 + 1B45	1C54 - Storey:1	30.0/80.0	569.66	200.1	200.1
1C54	1B44	30.0/60.0		126.9	106.1
	1B45	30.0/60.0		106.1	126.9

$$M_{nc} / M_{nb} = 378.9 \text{ kN.m} / 233.0 \text{ kN.m} = 1.6 > 1.2 \text{ Sufficient } \checkmark$$

Y-Direction

Only 1B58 is connected to the 1C54 column at the right side in Y Direction. Strong column check calculations are given as follows;

Right Beam (1B58) Moment Capacity : 96.5 kN.m

Top Column (C54-Storey:2) Moment Capacity : 549.1 kN.m

Bot Column (C54-Storey:1) Moment Capacity : 607.3 kN.m

$$M_{RC} = 1156.4 \text{ kN.m}$$

$$M_{Rb} = 96.5 \text{ kN.m}$$

$$\frac{M_{RC}}{M_{Rb}} = 12.0 < 1.2 \times$$

Y-Direction

Joint	Member	Section (cm)	Axial Force, N (kN)	Moment Capacity, M(+) (kN.m)	Moment Capacity, M(-) (kN.m)
2C54	2C54 - Storey:2	30.0/80.0	270.39	549.1	549.1
+ 1B58	1C54 - Storey:1	30.0/80.0	569.66	607.3	607.3
1C54	1B58	20.0/60.0		83.0	96.5

$$M_{rc} / M_{rb} = 1156.4 \text{ kN.m} / 96.5 \text{ kN.m} = 12.0 > 1.2 \text{ Sufficient } \checkmark$$

Summary

This document explains strong column-weak beam condition checks of beam-column connections according to ACI 318 18.7.3.

Thank You

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