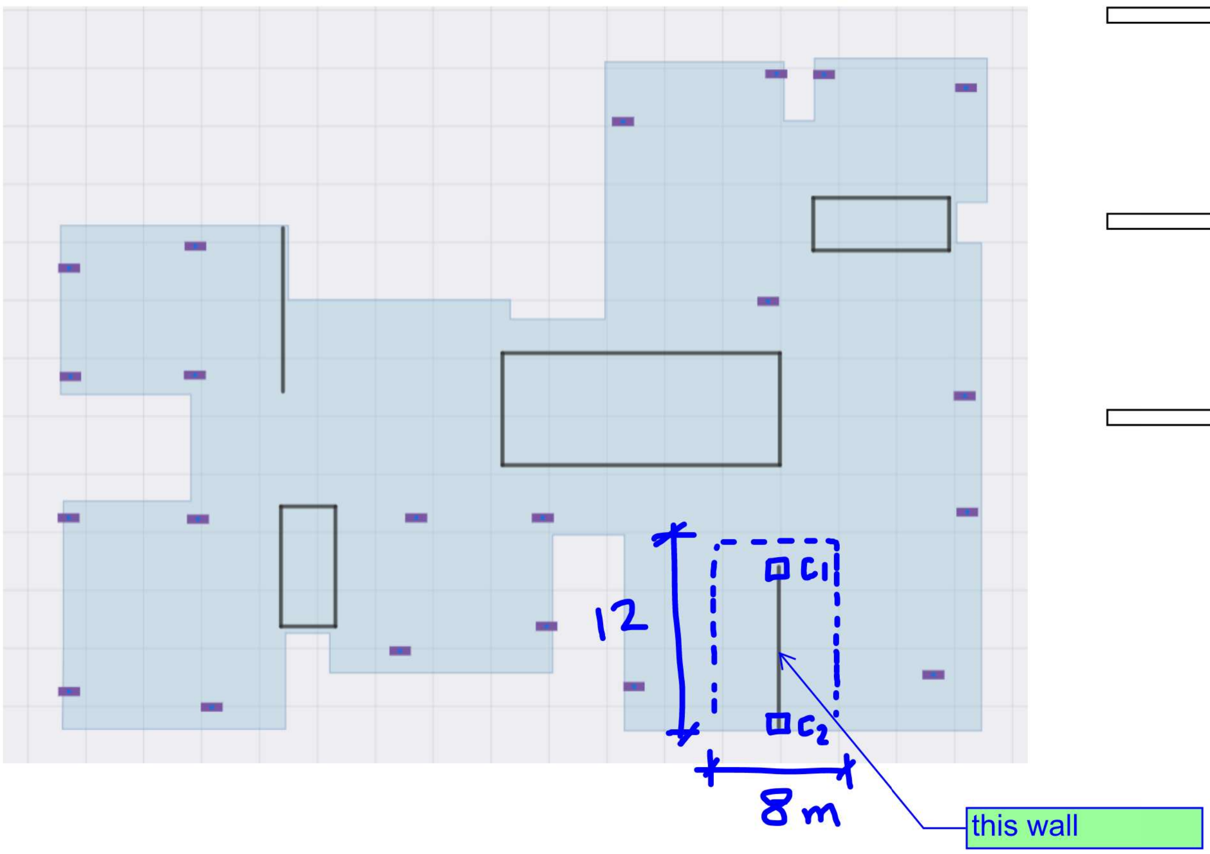
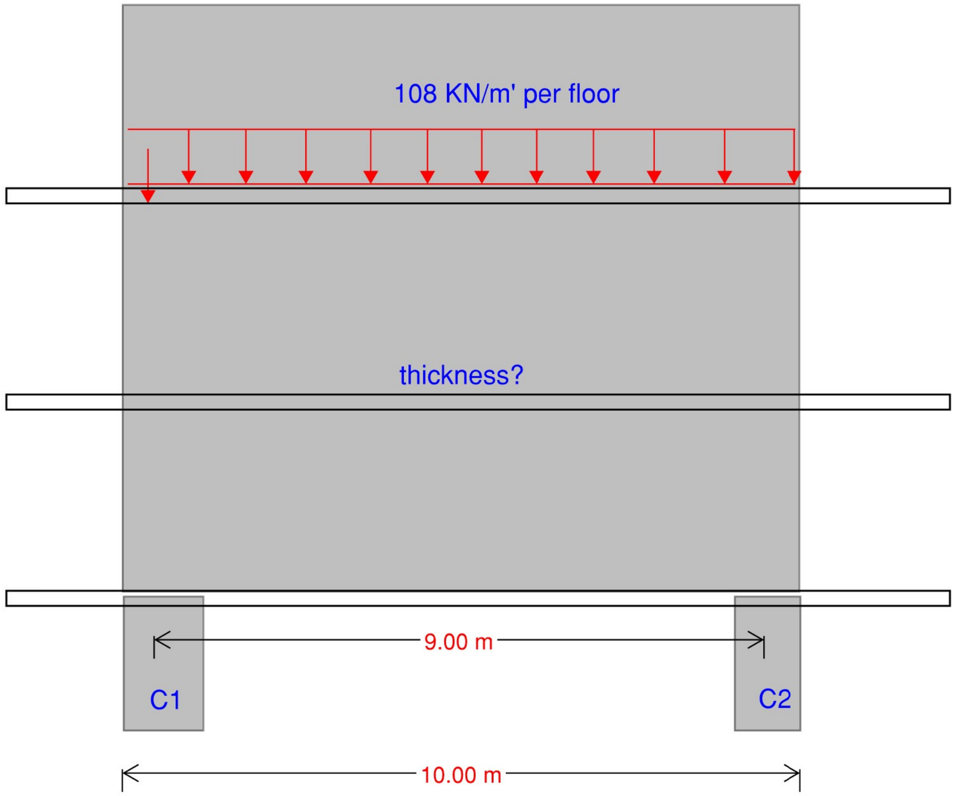
# Shear wall on Columns - STM

## Sample Structure

Wall is supporting 20 storey building and has a tributary width (into page) of 8 meters, see plan below.

Wall thickness is decided at upper levels from building lateral scheme to achieve target period
and sway, however, thickness at lower levels needs to be confirmed at transfer level. and wall to be designed to AS3600-2018




Elevation of the Wall

## Gravity Loads

A - Dead Loads

1 - Typical slab thickness = 220 (5.5 KPa)

2 - Finishes (residential) = 1.5 KPa

3- Own weight of wall = 0.25 x 3 x 25 x 10 = 187.5 KN per level

SEE AS1170.1

B- Live Loads

1 - Live loads (residential) = 1.5 KPa

---

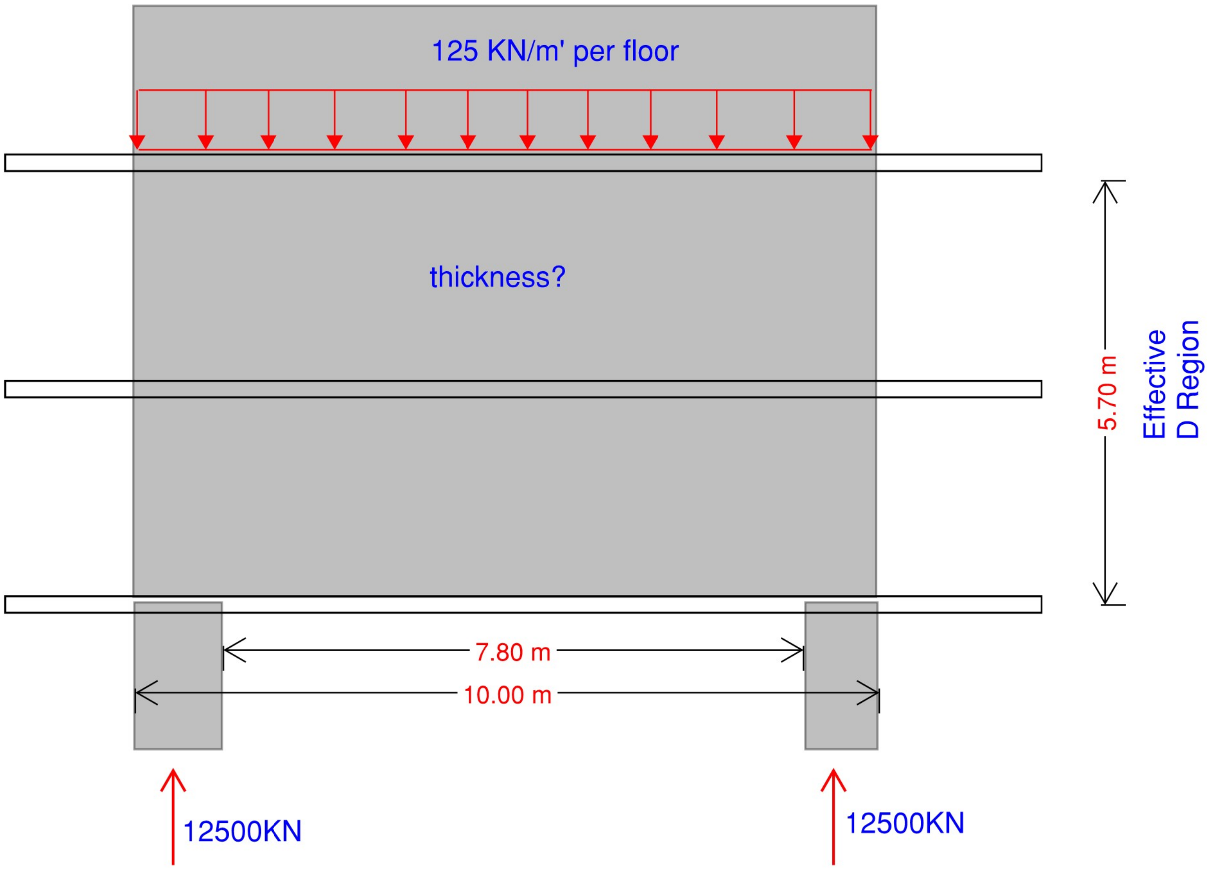
**Total line load on wall (Ultimate)**

1- Slabs = [1.2 x (5.5 + 1.5) + 1.5 x 1.5 ] x (8 x 12) x 20 Levels /10 = 2045 KN/m'

2- Wall self weight = 1.2 x (187.5 x 20) / 10 = 450 KN/m'

<u>therefore</u> total line load = 2495 , say 2500 KN/m' ULS (or 125KN/m' per level)

total load onto wall = 25 000 KN




## NOTES

Lateral loads are not likely to govern the design, ignored in this demonstration

for simplicity, will assume loading is uniform over the entire width of the wall, noting the northern column C1 takes more load for the bigger tributary area

LEARNING CENTRE

# Shear wall on Columns - STM

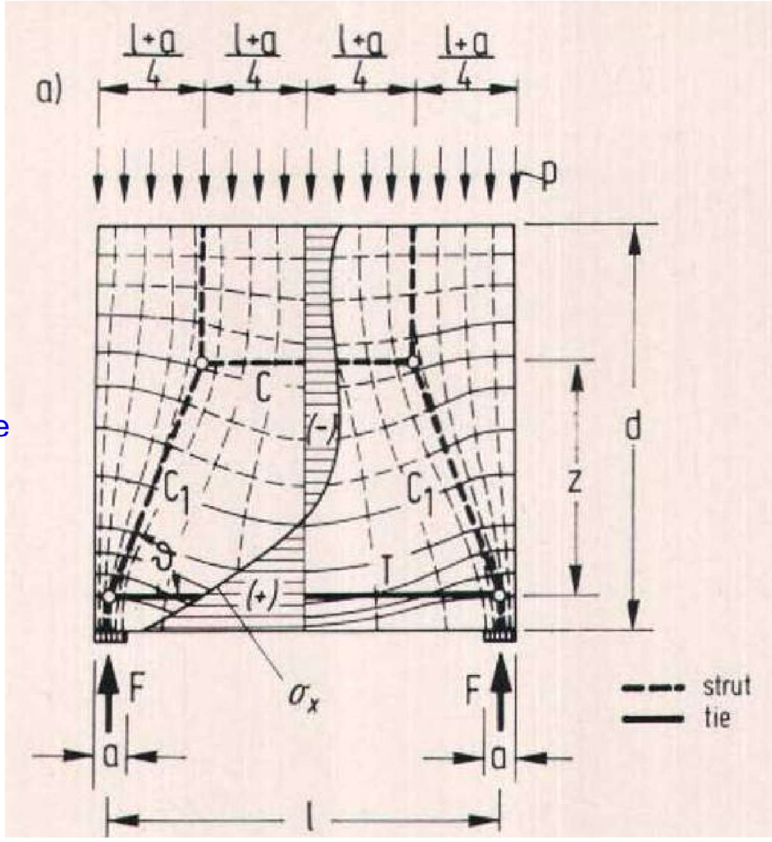
| By | RK |
|---|---|
| Sheet No. 3 | Date 6/26 |

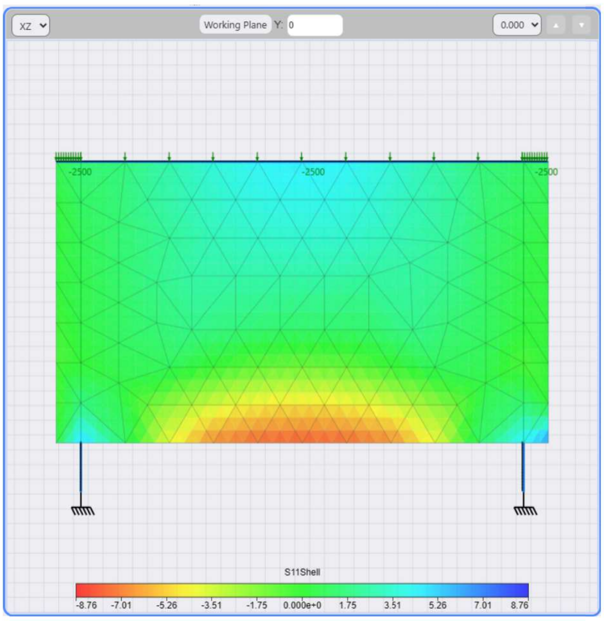
## Theory

Shear walls landing on columns experience uniform stresses until the D-Region, which is the vertical distance above the supports, roughly estimated at 0.8 of the clear span.

With concrete, elastic stress distribution will not hold correct past cracking capacity of concrete. (modulus of rupture at direct tension or at stress of 1 MPa to be conservative).
This will require rebar to be designed as area and anchorage to take the forces.

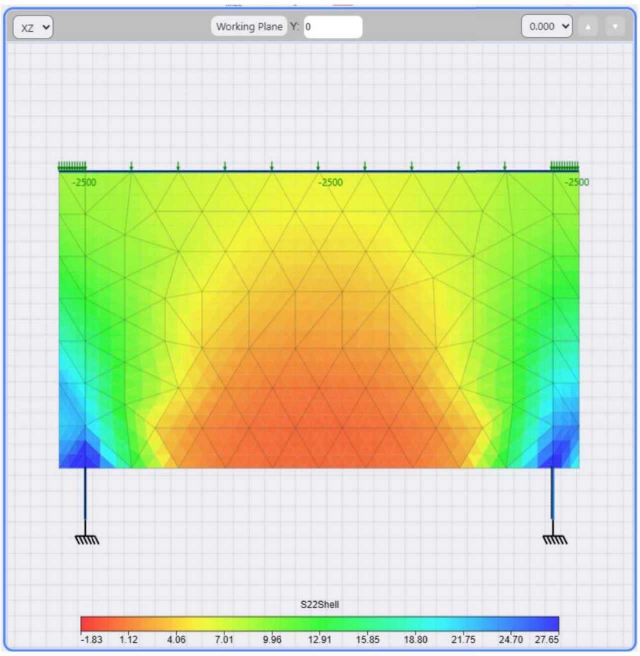
Wall bearing points must also survive compression stresses



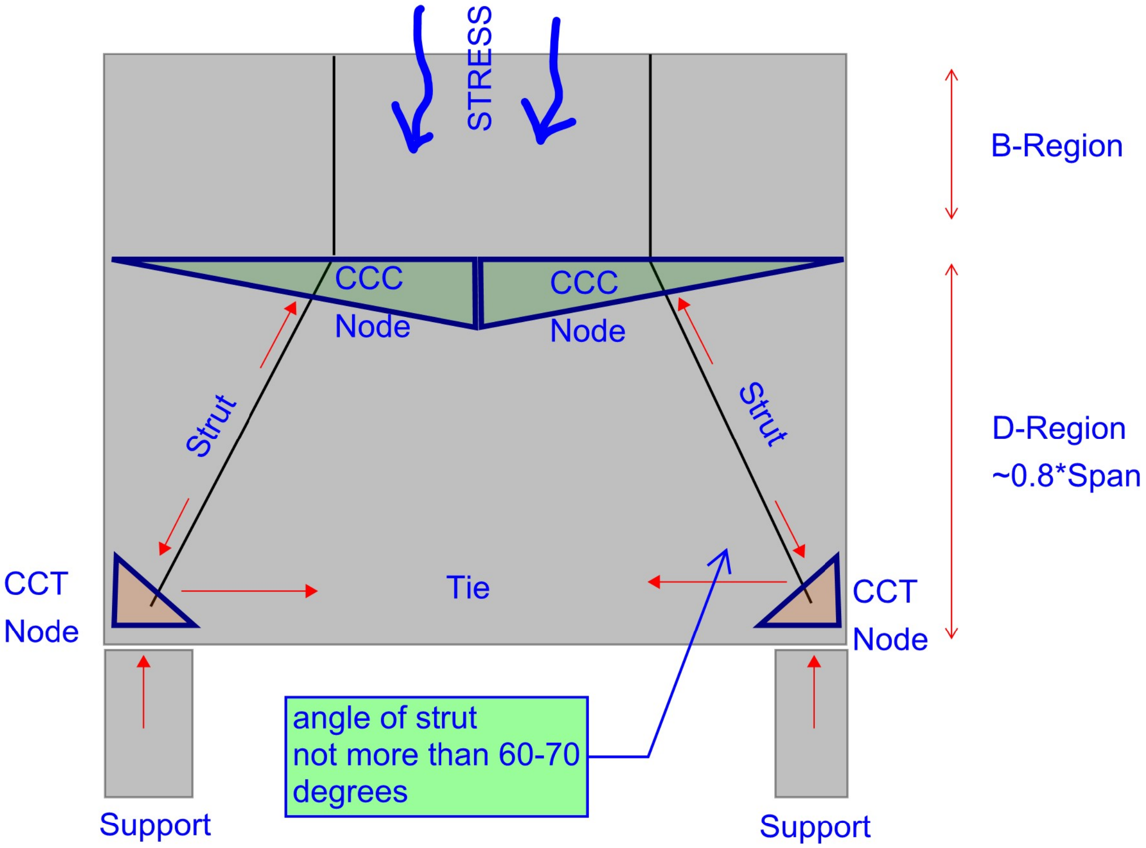

See elastic stresses distribution (FEAKalc 3D analysis - S11 horizontal)

See elastic stresses distribution (FEAKalc 3D analysis - S22 vertical)



## Theory

Blow is idealisation of strut and tie model, which is lower bound that takes all of the load in tension through rebar




Codes of practice provided guide on how to pass stresses through concrete, depending on element taking the load:

1- Nodes (being CCC, CCT, CTT)

2- Struts (Fan or uniform struts, including their inclination angles)

3- Rebar anchorage and stress limits

# Theory

**General rules to follow:**

1. The concrete structure is basically divided into either B (Bernoulli) regions where the beam theory applies and stress distribution is linear within the section, or D (Disturbed) regions where it doesn't.

2. Within the D regions, truss analogy can be applied by following the load path lines (principal stresses) and representing them as straight struts (compression members - concrete) and ties (tension members - reinforcement) intersect in nodes (concrete)

3. The angle between diagonal Struts and horizontal line is feasible between 25º and 65º

4. Equilibrium must be maintained while developing the STM model, and concrete must not fail before the steel reinforcement yields

5. Tension is neglected in concrete, and forces in struts are uniaxial

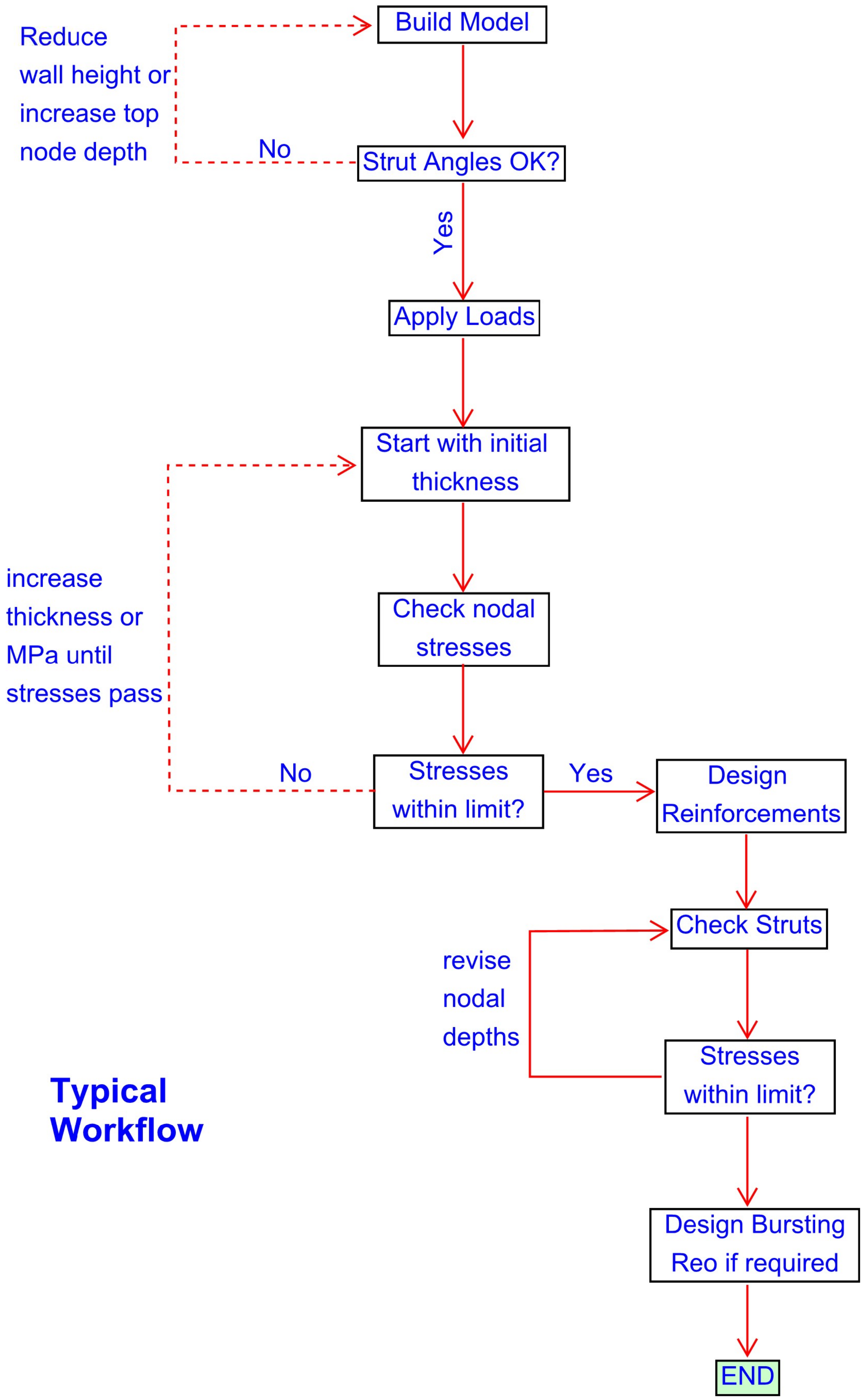
6. Anchorage and detailing are essential

7. There is no exact STM model; however, there are poor and good models.

8. Struts can be categorized into prism, bottle, and fan

9. Nodes (concrete) are categorized into 4 types: CCC, CCT, CTT, TTT (C stands for compression, and T stands for tension):

10. Stresses within struts, ties, support and under load regions must be within allowable code limits.




**Typical Workflow**

Build Model

## Inputs

**Materials**

| | |
|---|---|
| f'c (N/mm²) | 65 |
| fy (N/mm²) | 500 |
| fys (N/mm²) | 250 |

**Geometry (Units mm)**

| | |
|---|---|
| Wall Height | 5700 |
| Wall Width | 10000 |
| Wall Thickness | 350 |
| Width of Applied Load | 10000 |
| Location of Applied Load | 5000 |
| Width of Support 1 | 1200 |
| Width of Support 2 | 1200 |
| Centre of Top Node | 300 |
| Centre of Bottom Nodes | 250 |

Apply Loads

**Vertical Loads**

| | |
|---|---|
| Ultimate (KN) | 25000 |
| Service (KN) | 19230 |

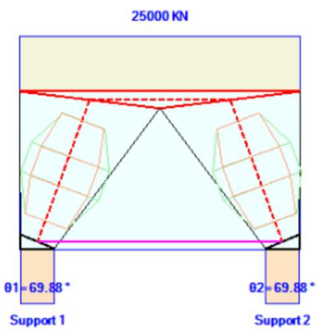
To Cloud ShareKALC

## Analysis & REO

| | |
|---|---|
| Span/Depth | 1.75 |
| Reaction1 | 12500 |
| Reaction2 | 12500 |
| Tie Force | 4579 |
| REO mm² | 10775 |
| Strut1 Force | 13312 |
| Strut1 Angle | 69.9 |
| Strut2 Force | 13312 |
| Strut2 Angle | 69.9 |

5700 is the height that results in 70 degrees user may alter this if looking for less angle

## Preview

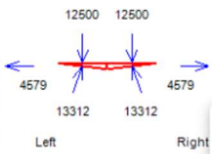



## Nodes

Top Node-Left | Top Node-Right

Nodal Stressess

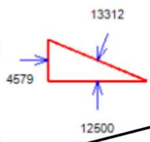
| | | | |
|---|---|---|---|
| Width (mm) | 5000 | Top Stress | 7.14 |
| Height (mm) | 600 | Side Stress | 21.81 |
| Hypo (mm) | 5035.87 | Incl. Stress | 7.35 |
| Strut/Node Angle | 13.28 | Shear Stress | 1.73 |
| Applied (MPa) | 21.81 | Allowed MPa | 38.03 |




Mohr Circle

**Left Node**

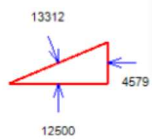
| | | | |
|---|---|---|---|
| Width (mm) | 1200 | Base Stress | 29.76 |
| Height (mm) | 500 | Side Stress | 26.17 |
| Hypo (mm) | 1300 | Incl. Stress | 29.23 |
| Strt./Nd. Ang | 2.5 | Shear Stress | 1.28 |
| Applied (MPa) | 29.76 | Allowed MPa | 30.42 |




Mohr Circle


**Right Node**

| | | | |
|---|---|---|---|
| Width (mm) | 1200 | Base Stress | 29.76 |
| Height (mm) | 500 | Side Stress | 26.17 |
| Hypo (mm) | 1300 | Incl. Stress | 29.23 |
| Strt./Nd. Ang | 2.5 | Shear Stress | 1.28 |
| Applied (MPa) | 29.76 | Allowed MPa | 30.42 |




Mohr Circle

Non-Hydrostatic node with shear stress check

# Shear wall on Columns - STM

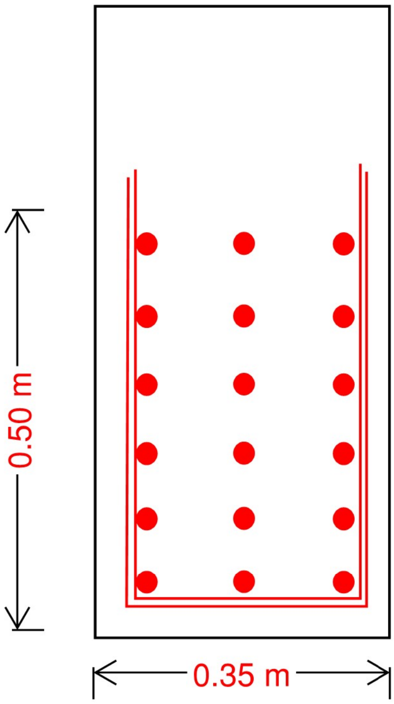
| By | RK |
|---|---|
| Sheet No. 8 | Date 6/26 |

## Design Reinforcements

spread rebar over the Node depth

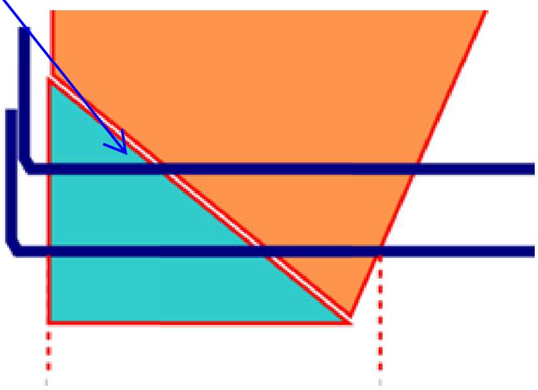
10775 =
18N28

spread over 6 layers of 3 bars




Anchor reinforce ment

See standard



## Analysis & REO

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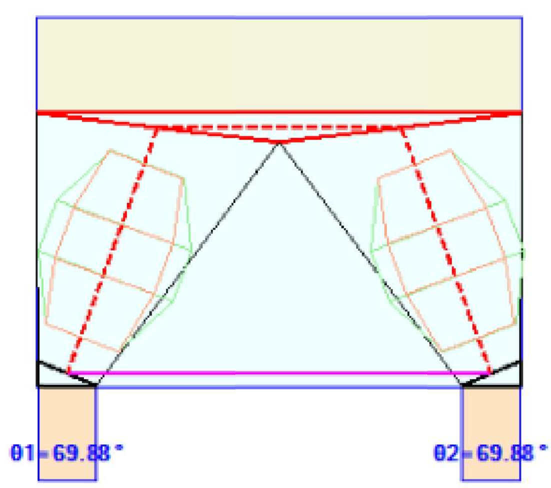
## Preview



Check Struts

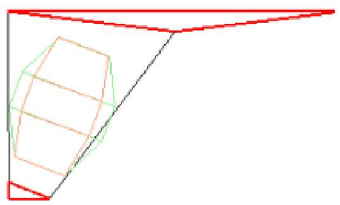
| | Left Strut | Right Strut |
|---|---|---|
| Min Width | 1300 | 1300 |
| Max Width | 5036 | 5036 |
| Average Dc (mm) | 3168 | 3168 |
| Length | 5378 | 5378 |
| Lb | 2210 | 2210 |
| Strut Angle | 69.88 | 69.88 |
| Efficiency Factor | 0.92 | 0.92 |
| **Strut Force KN** | 13312 | 13312 |
| Applied σ (MPa) | 29.26 | 29.26 |
| Allowed σ (MPa) | 34.93 | 34.93 |
| f'ct (MPa) | 2.9 | 2.9 |
| Tb,cr Bursting (KN) | 1572 | 1572 |
| SLS* Burst. (KN) | 5120 | 5120 |
| ULS* Burst. (KN) | 2662 | 2662 |
| Hor.REO Total Both Faces mm | 15963 | 15963 |
| Vert. REO Total Both Faces mm | 15963 | 15963 |
| ULS Burst. Capacity | 10240 | 10240 |
| SLS Burst. Capacity | 5120 | 5120 |
| Strut Situation | OK | OK |

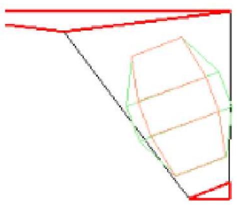
Horizontal Reo
15963 =
7982 mm² per face

divide by height = 5.7
this becomes
1400mm²/m
Provide
N20-200=1570mm²

Vertical Reo
15963 =
7982 mm² per face

divide by span = 10
this becomes
799mm²/m
Provide
N16-200=1005mm²





STM Wall | Analysis & Nodes | Struts | Calculations | **My Walls** | Watch & Learn | Hello, RKALC ! | You have 0 Messages

Your Design Package is valid until 30/03/2030 10:44:38 PM

# Inputs

**Materials**

| | |
|---|---|
| f'c (N/mm²) | 65 |
| fy (N/mm²) | 500 |
| fys (N/mm²) | 250 |

**Geometry (Units mm)**

| | |
|---|---|
| Wall Height | 5700 |
| Wall Width | 10000 |
| Wall Thickness | 350 |
| Width of Applied Load | 10000 |
| Location of Applied Load | 5000 |
| Width of Support 1 | 1200 |
| Width of Support 2 | 1200 |
| Centre of Top Node | 300 |
| Centre of Bottom Nodes | 250 |

**Vertical Loads**

| | |
|---|---|
| Ultimate (KN) | 25000 |
| Service (KN) | 19230 |

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RKALC Assistant New

# Analysis & REO

| | |
|---|---|
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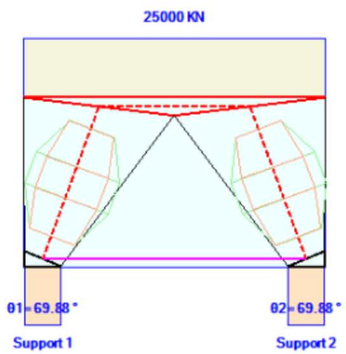


# Nodes

**Top Node-Left** | Top Node-Right

| | | | |
|---|---|---|---|
| Width (mm) | 5000 | Top Stress | 7.14 |
| Height (mm) | 600 | Side Stress | 21.81 |
| Hypo (mm) | 5035.87 | Incl. Stress | 7.35 |
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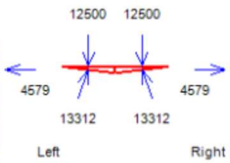


Mohr Circle

**Left Node**

| | | | |
|---|---|---|---|
| Width (mm) | 1200 | Base Stress | 29.76 |
| Height (mm) | 500 | Side Stress | 26.17 |
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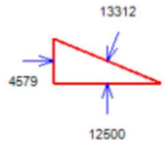


Mohr Circle

**Right Node**

| | | | |
|---|---|---|---|
| Width (mm) | 1200 | Base Stress | 29.76 |
| Height (mm) | 500 | Side Stress | 26.17 |
| Hypo (mm) | 1300 | Incl. Stress | 29.23 |
| Strt./Nd. Ang | 2.5 | Shear Stress | 1.28 |
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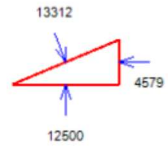



Mohr Circle

## RKALC Assistant

**You:** how is wall doing in your opinion?

**RKALC:** Based on the current wall analysis, the utilization of the left bottom node and right bottom node is at 98%, indicating high stress on these nodes. However, the utilization of the top node (both left half and right half) is at 57%, which is relatively lower. The required tie reinforcement is calculated to be 10775 sq.mm. The strut angles for both the left and right sides are at 69.9 degrees, indicating compliance with STM guidelines.

how is wall doing in your opinion?

Speak

Voice | Clear | Close

## Introduction

This document provides analysis of non-flexural element design in accordance with the Australian Standard AS3600-2018. It covers both the ultimate and service conditions, addressing the following aspects:

- Flexural Reinforcement
- Nodal Stresses and compliance with the Standard
- Strut Checks, including bursting

The design ensures structural integrity and compliance with the standard under the specified loading conditions. For detailed guidelines and requirements, refer to the relevant sections of AS3600-2018-A2.

This calculation can be reproduced and checked independently. For more details, refer RKALC website.

## Material Properties

Concrete Strength f'c = 65 MPa

Rebar fy = 500 MPa

SLS Rebar stress fys = 250 MPa

## Geometry

Wall Height = 5700 mm

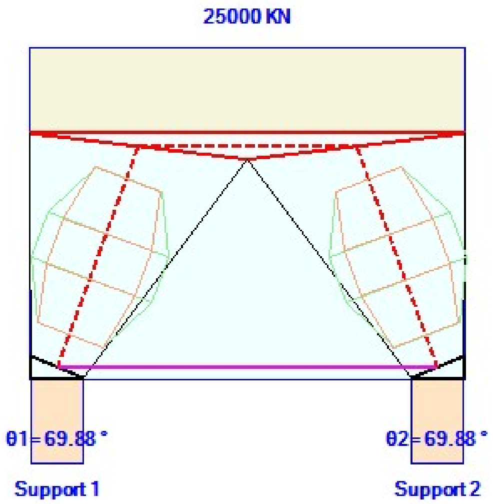
Wall Width = 10000 mm

Wall Thickness = 350 mm

Width of Left Support = 1200 mm

Width of Right Support = 1200 mm

Width of Applied Load = 10000 mm




## Applied Loads

Ultimate Load = 25000 KN

Service Load = 19230 KN

Width of Applied Load = 10000 mm

Centre of Applied Load (from left edge of the wall) = 5000 mm

---

**Nodal Assumptions**

- Top Node

The node at the top is recieving the load, width of which equal to the node's width. Node is essentailly divided into two triangulated nodes (left and right), these have widths constructed from the shares of load they take

Top Node Width (total) = 10000 mm

Top Node Depth = 600 mm

Node Thickness = 350 mm

- Left Node

Left Node Width = 1200 mm

Left Node Depth = 500 mm

Node Thickness = 350 mm

- Right Node

Right Node Width = 1200 mm

Right Node Depth = 500 mm

Node Thickness = 350 mm

---

**Analysis and Required Reinforcement**

Span-Depth Ratio of the STM Model = 1.75

Left Node Reaction= 12500 KN

Right Node Reaction = 12500 KN

Resulting Tie Force = 4579 KN

Required REO = 10775 mm²

Left Strut Force = 13312 KN

Left Strut Angle = 69.88 Degrees

Right Strut Force = 13312 KN

Right Strut Angle = 69.88 Degrees

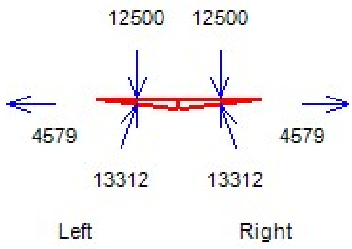
*Ensure the reinforcement is reasonable, not heavy. spread so the centre of bars is passing by the centre of the nodes at the bottom*

---

**Nodal Capacity Check**

**Top Node**

- Left part




Width (Based on Share of Load Taken) = 5000 mm

Base stress = 350 N/mm²

Side stress = 21.81 N/mm²

Inclined stress = 7.35 N/mm²

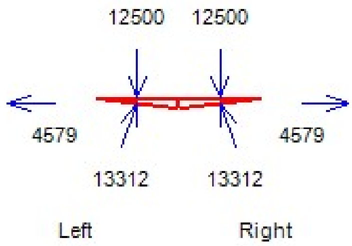
Shear stress = 1.73 N/mm²

Allowed Stress (CCC Node) = 38.03 N/mm²

Status = Pass

---

- Right part

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Base stress = 350 N/mm²

Side stress = 21.81 N/mm²

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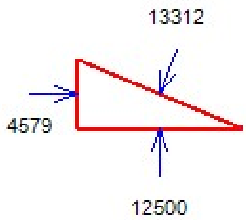
Shear stress = 1.73 N/mm²

Allowed Stress (CCC Node) = 38.03 N/mm²

Status = Pass

---

**Bottom-Left node**




Base stress = 29.76 N/mm²

Side stress = 26.17 N/mm²

Inclined stress = 29.23 N/mm²

Shear stress = 1.28 N/mm²

Allowed Stress (CCT Node) = 30.42 N/mm²

Status = Pass

**Bottom-Left node**

Base stress = 29.76 N/mm²

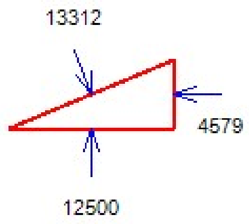
Side stress = 26.17 N/mm²

Inclined stress = 29.23 N/mm²

Shear stress = 1.28 N/mm²

Allowed Stress (CCT Node) = 30.42 N/mm²

Status = Pass




**Left Strut**

Average Dc = 3168 mm

Lb = 2210 mm

Angle = 69.88 Degrees

Efficiency Factor = 0.92

Applied MPa = 29.26

Allowed MPa = 34.93

fct = 2.9 MPa

Tb,cr Bursting = 1572 MPa

SLS* Bursting = 5120 KN

ULS* Burst = 2662 KN

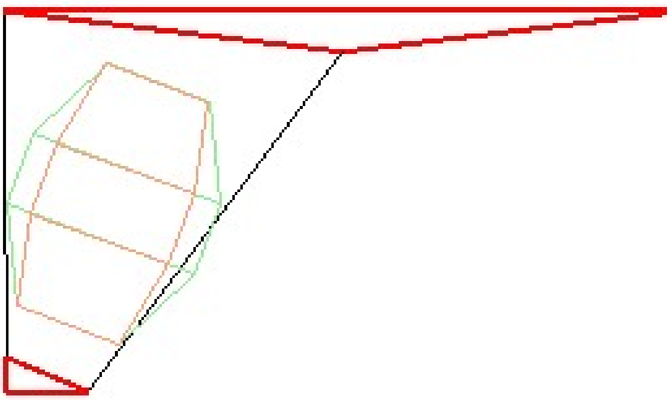
Hor.REO Total Both Faces mm = 15963 mm²

Vert.REO Total Both Faces mm = 15963 mm²

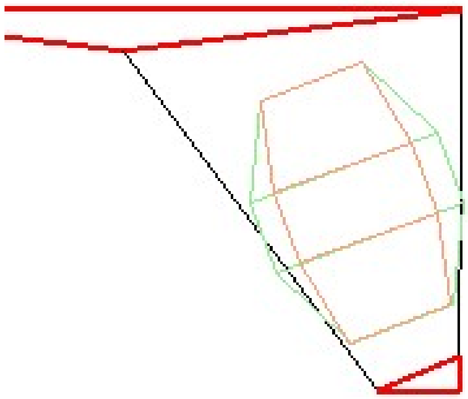
ULS Burst. Capacity = 10240 KN

SLS Burst. Capacity = 5120 KN

Strut Status = OK



**Left Strut**



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