STRUCTURAL ENGINEERING REPORT

Structural issues observed at

Tauhara College
Invergarry Road
Taupo 3330

Prepared for

Ministry of Education – Bay of Plenty
c/- Cove Kinloch
PO Box 426
Tauranga 3144

SHL5495 – 1 July 2021

STRUCTURAL ENGINEERING REPORT – SHL5495

REVISION HISTORY

REVISION NUMBER	PREPARED BY	DESCRIPTION	DATE
0	J PERKINS	PRELIMINARY OPINION: *PENDING IN-SITU TESTING TO OCCUR APRIL 2021*	16 Dec. 20
1	J PERKINS	FINAL REPORT: *FOLLOWING DESKTOP ANALYSIS OF CEBUS MK4 BUILDINGS*	1 Jul. 21

Executive summary

On 26 November 2020, Sullivan Hall were notified by Cove Kinloch of structural issues at Tauhara College. Sullivan Hall were engaged by the Ministry of Education to address and investigate the issues. Over the course of three site visits Sullivan Hall observed structural damage and dilapidation across numerous buildings.

Through a series of qualitative and quantitative assessments Sullivan Hall were able to assemble a suitable array of data to form an opinion on the issues. It is also intended that in-situ load testing of the CEBUS buildings be undertaken, scheduled for mid-2021. Commentary on the testing is outside the scope of Sullivan Hall's engagement however we believe it will assist with a greater level of understanding around the performance of the buildings in subject.

Along with several architectural issues relating to the school buildings, the following structural issues were noted;

1. Deficiencies with typical timber portal frames for the following reasons;
    a. R Block; lack of capacity in portal members and connections resulting in 58% NBS strength in the transverse bracing direction for the ULS wind case,
    b. Exposed (wet in service) structural timber connections inadequately maintained resulting in an assumed reduced structural capacity,
    c. High serviceability limit state deflections under gravity and lateral loading potentially causing failure to the fabric of the building and therefore weathertightness.
2. Evidence of timber decay in wall and ceiling spaces across multiple buildings.
3. Fire damage to B block structural elements.

It is the professional opinion of Sullivan Hall that due to the inferred deficiencies:

- **Blocks A, B, C, D and R should undergo a process of maintenance and repairs, namely to the exposed structural timber connections.**

This is an opinion based on quantitative and qualitative analysis. The scheduled in-situ load testing may demonstrate the buildings have inherent strength and stiffness unaccounted for in the desktop analyses.

Sullivan Hall's opinion is that the remaining buildings observed (Gym and Hall) appear to be adequately fit for purpose, based on Sullivan Hall's qualitative assessments, and walk-throughs of these buildings.

Contents

Introduction

Sullivan Hall Limited has been engaged by the Ministry of Education to provide a Structural Engineering Report with respect to issues observed within several buildings at Tauhara College, Taupo.

Sullivan Hall was notified by Cove Kinloch on 26 November 2020 that there were alleged structural issues at Tauhara College. Sullivan Hall staff undertook multiple site visits between 26.11.2020 and 2.12.2020. This report aims to provide our professional engineering opinion on the issues observed.

Our expertise is in the field of structural engineering only and therefore our assessment highlights those issues solely. Experts in the other relevant fields should provide comment on all other aspects.

Blocks A, B, C, D, R

Structural issues observed

These buildings consist of slightly different typologies however are of a similar construction methodology and a comparable level of apparent degradation. It is considered that Blocks A, B, C and D fall under a common design methodology utilised by the Ministry of Education, known as 'CEBUS' buildings. Block R is not considered to be a CEBUS building.

Timber portal frames;

The buildings include timber portal frames that run the width of the classroom spaces. Sullivan Hall have concerns with the state of these portal frames that form the primary structure for these spaces and should provide a significant amount of the gravity support as well as the lateral building capacity transverse direction.

As is typical with the CEBUS system, the legs of these frames are external to the building fabric and therefore exposed to the weather. Some of the legs do not appear to have been well maintained over their circa 40+ years of life. Splitting and checking of the timber is common. The bases of these legs do not appear to have been sealed and in some cases are very decayed. In places the bases of the legs are very close to ground. The connections of the portal rafter to the legs at eaves level, as well as the legs to the posts/bearers at floor level consist of steel gangnail plates. Corrosion of the steel on these is common. In some locations the gang nail plates have separated from the members, indicating a loss of strength in the connection. In some locations the legs appear to be bearing on a very small area (~50mm x 50mm).

While observing the roof lines of these building typologies by eye from the exterior, it was apparent that the ridge lines have sagging in a pattern that suggests the portal frames have potentially experienced significant long term creep deflections. Sullivan Hall's opinion is that this is due to several factors including design, and gradual slip / decay of the connections as the timber and steel gang nail plates have each deteriorated.

As these portal frames are the primary gravity and lateral structural elements for these buildings, Sullivan Hall suggests the existing timber structural members and connectors are individually assessed and remediated where necessary.

Figure 1: Example of portal leg near ground with gang nail plate separation at Block R

Figure 2: Example of portal leg with decayed timber and minimal bearing at Block B

Decayed timber in wall and ceiling spaces

From the sample of structural elements observed in wall and ceiling cavities, decaying timber was evident in numerous locations.

August Millard Building Consultants were engaged to assess these issues and prepared a detailed weathertightness report (job 20068, Dec 2020) which investigated various timber samples from numerous buildings around the school. The findings and suggestions of those investigations should be followed including replacement of unsound timber where recommended.

Fire damage

Fire damage and charring was noted on a timber column in Block B. We are unclear on the extent of this damage beyond what was exposed at the time of our visits. In our opinion, the structural capacity of the column has been compromised and if the building is to remain, any structure with fire damage exceeding a charring rate of ~10% of the cross-sectional area would likely need replacing.

Figure 3: Fire damage to structural column at Block B

Ground conditions

A brief review of a preliminary Geotechnical Investigation Report by BCD Group (19-0430 date 13.08.2019) found that despite hot ground hazard areas are covering roughly 50% of the occupied footprint of the school, typical shallow foundations were deemed acceptable.

The majority of standard piles supporting floors throughout the school would likely therefore be deemed acceptable upon engineering analysis.

Isolated footings with larger point loads from portal frames may be undersized, and if a strengthening process is undertaken these elements should be assessed.

Gym

While weathertightness issues are evident, the structural integrity of this building generally appears to be good. The main gym area consists of steel portal frames and light steel purlins. These appear to have been well maintained.

External and internal linings to the timber framed lean-to portions of the building should be removed and wall framing and roof framing to these areas should be assessed and replaced as needed.

An Opus International Consultants Initial Seismic Assessment was completed in July 2015 with a 80% NBS score given.

Figure 4: Gym interior

Library

This building also appears to have suffered from ongoing issues with weathertightness in the roof. Previous recent repairs to internal linings were evident. As with the classroom blocks, the sample of structural roof members observed suggests decaying timber is an issue for the roof structure of this building.

Given the numerous roof plane angles, junctions and internal gutters, the issue is likely to continue even if the decayed structural elements are replaced. Sullivan Hall's recommendation would be that the roof is redesigned and reconstructed to rationalise the roof planes / gutters, which in the process would replace the roof structure.

Ultimately the findings and suggestions within the August Millard report should form the basis of a replacement schedule on the timber in this building.

Figure 5: Evidence of decaying roof structure at Library

Hall

The property file indicates that the building works were consented in early 2007. It is Sullivan Hall's opinion as structural engineers that the building visually appears to be undamaged structurally.

August Millard's weathertightness report highlights non-structural issues with this building.

Figure 6: Hall interior

Blocks E, G and Y, Caretakers facility, Special Needs block

These buildings did not form part of the assessment.

Technical Desktop Assessments

Following these site investigations Sullivan Hall engineers also conducted independent desktop assessments of the structural engineering design documentation for the R Block and the typical CEBUS Mk 4 buildings on site (Blocks A, B, C and D), with the intention of evaluating the design against the relevant building standards.

R Block

Sullivan Hall engineers based the R Block desktop assessment on the design documentation retrieved from the Taupo District Council property file, namely the Cheal Hindess Battersby & Norrie Limited drawing referenced 26-211-02 - *Art Block – Elevations Frame Plans – Tender Issue*.

This building appears structurally similar to the typical CEBUS system however it has a number of differences. The key structural difference is in the portal leg-bearer detailing. Where the typical CEBUS connection detailing introduces a moment couple between two gangnail plate pairs (allowing moment transfer from the leg to the bearer), the equivalent connection in R Block at Tauhara College has only a single gangnail plate pair as a 'pinned' connection. This discrepancy results in a reduced structural performance, as the 'box' portal frame synonymous with the CEBUS buildings is missing and replaced with a 'pinned' connection at the base of the leg.

This loss of rotational restraint increases the member moments at ULS, and deflections at SLS.

Figure 7: Portal leg-bearer connection - R Block

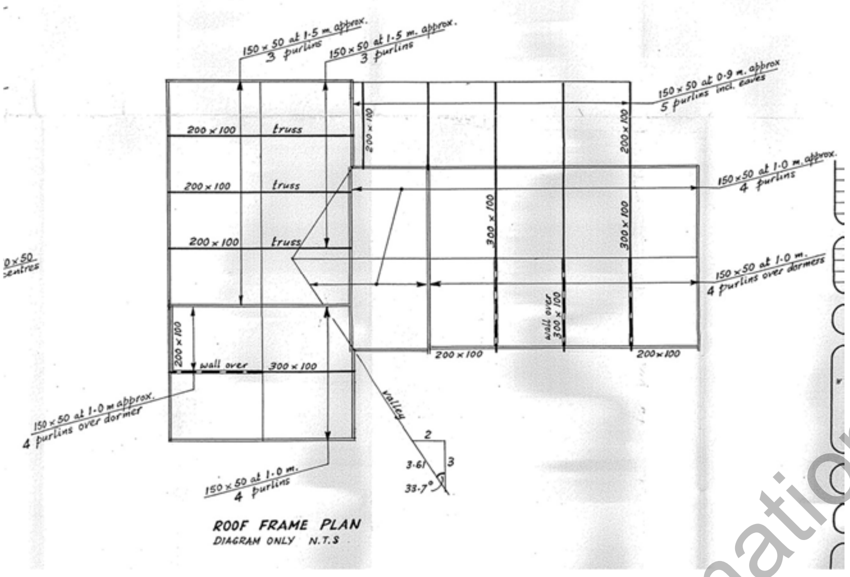


Figure 8: Roof framing plan from CHB&N dwg 96 – 211 – 02

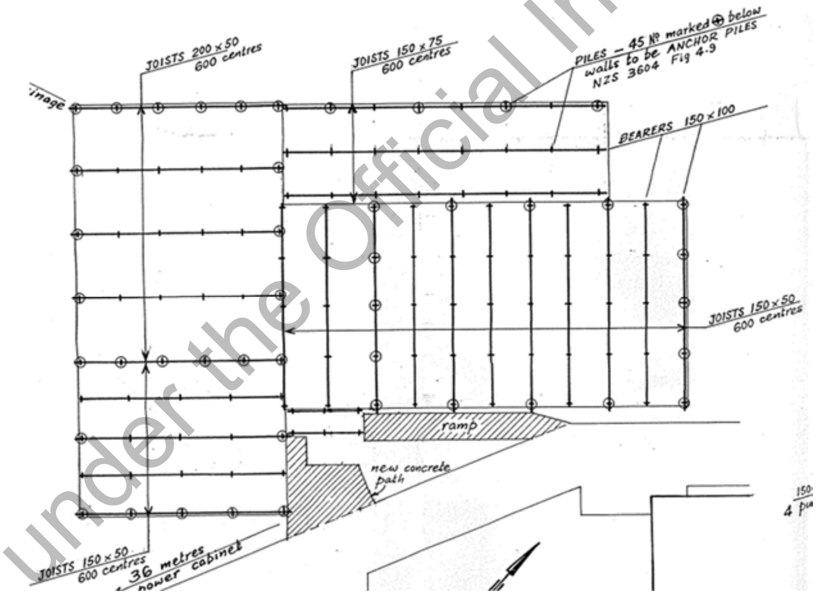


Figure 9: Floor framing plan from CHB&N dwg 96 – 211 - 02

Elements analysed

For this report, only the timber portal frames were analysed. These were deemed to be the most critical elements for assessment following the Sullivan Hall site visits.

Design parameters

The following design parameters have been used by Sullivan Hall. The parameters are either an assumption drawn from the relevant building standards, or, where possible, as taken from the design documentation.

Loading data		
Type		***Reference***
Permanent roof load	0.35 kPa	Corrugated iron, standard rafter/purlin framing, insulation, Pinex ceilings
Imposed roof load	0.25 kPa	NZS1170.1 : 2002
Basic wind pressure, ULS	0.99kPa	NZS1170.2 : 2011
Seismic coefficient, Cd(T)	0.368	NZS1170.5 : 2004
Structural parameters		
Timber (wet) – Youngs Modulus	5450 MPa	NZS3603 for double members
Timber (dry) – Youngs Modulus	8000 MPa	NZS3603 for double members

Gangnail plates

Durability issues in relation to the steel timber connectors were noted on site. Where maintenance has not been regularly attended to it has likely resulted in a reduced capacity in these connections. During the assessment process, Sullivan Hall contacted technical staff at Mitek with respect to the strength and adequacy of gangnail plates in 'wet' timber. The opinion from Mitek was that is it not recommended gangnail plates be used in 'wet' timber, for the main reason that seasonal shrinking and swelling of the timber may cause the teeth to 'walk' out of the timber. During conversations on site with David Brunsdon (Kestrel), he suggested a potential clamping remediation to resolve this issue. For this theoretical assessment, we have assumed the nail teeth are fully embedded into the timber and that durability is not an issue. This is considered an acceptable assumption on the condition that loosening gangnail plates across the school are remediated with the clamping system mentioned above and all corroded gangnail plates are removed and replaced with stainless steel products. These remediations should be designed by a suitable Chartered Professional Engineer.

Ultimate Limit State flexural strength assessment of documented design

The parameters above were used to assess the portal structures using a Spacegass 2D analysis model and the equivalent static method (NZS1170.5). The foundations were not assessed.

(See calculations in appendix)

The results of the ULS checks are noted below by way of %NBS – we note that while "%NBS" terminology is reserved for seismic cases, for simplicity of comparison in this report the terminology also includes a capacity corresponding to the wind ULS cases:

Table 1: R BLOCK - ULS RESULTS

Load case	Members	Connections
1.2G + 0.4Q + Wu – *worst case wind event*	63% NBS	58% NBS
G + 0.4Q + Eu – *worst case seismic event*	97% NBS	84% NBS

Deflection analysis of documented design

Under serviceability loading, the following deflections were noted:

Table 2: R BLOCK - SLS RESULTS

Load case	Calculated deflection	AS/NZS1170.0 deflection limit
2G + 0.4Q – long term *permanent load + imposed loading*	40mm (ridge span / 75)	Span / 300 = 10mm
G + 0.4Q + Ws – permanent, imposed + serviceability wind loading	73mm (bay width / 41)	Bay width / 200 = 15mm

The deflections from the analysis far exceed the guidance provided in this Standard and could provide insight into the ongoing weathertightness issues at the school.

Findings of technical desktop assessment on R Block

Based on the findings above from the information available and reviewed, it is the professional opinion of Sullivan Hall that the design does not meet the requirements of the current New Zealand Building Code. The building however does not classify as earthquake-prone and is in line with the Ministry of Education's medium-term goal that all school buildings are at or above 67% NBS for seismic load cases (*Understanding the Seismic Performance of Timber Framed School Buildings Version 2, March 2015*).

The ULS wind event risks remain evident however it should be clarified that the desktop assessment considered a simplified 2D model of the portal frames only. The in-situ testing should give a clearer indication of how the building performs in its entirety, and it is assumed that the overall building performance will be better than the simplified model used for the purposes of this report.

The desktop assessment did not assess the longitudinal bracing direction.

CEBUS Mk 4 Buildings (Blocks A, B, C and D)

The structural characteristics of Blocks A, B, C and D within the school property appear to be in line with the design documentation of CEBUS Mk 4 buildings.

A detailed assessment of this building typology was undertaken by Opus in 2013. The purpose of analysing this building typology for Tauhara College therefore is to provide a site-specific evaluation only.

As mentioned above, the CEBUS system utilises timber connectors forming a moment couple and resulting in a 'box' portal frame structure with presumed moment rigidity on all sides.

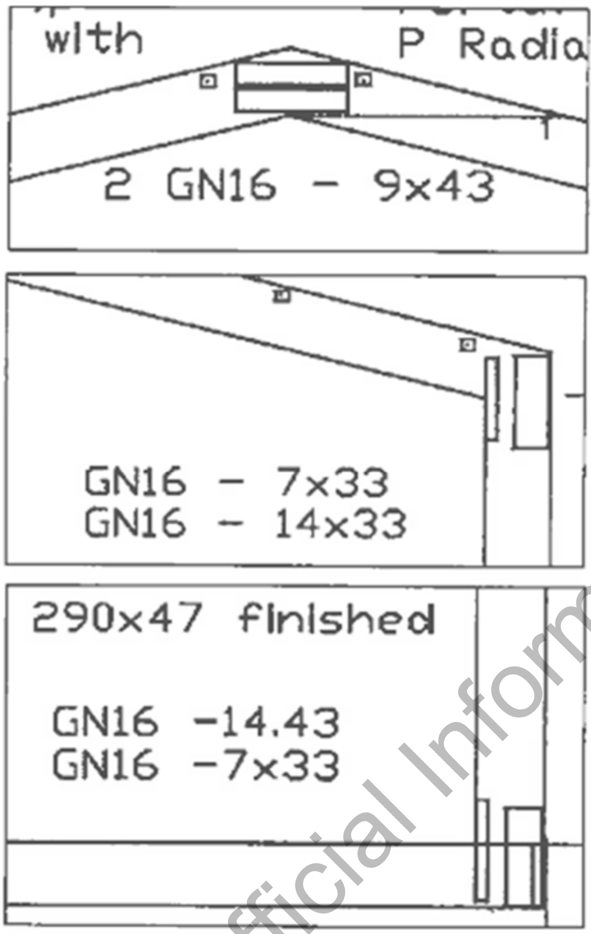


Figure 10: Typical CEBUS Mk 4 detailing

Gangnail plates

As observed with the R Block, some external timber portal legs and gangnail plate timber connectors at Blocks A, B, C and D were observed on site to be in poor condition. For this analysis, we have assumed a remediation process will be undertaken and that the nail teeth are fully embedded into the timber, and that durability is not an issue.

Ultimate Limit State flexural strength assessment of documented design

The same parameters as the R Block (above) were used to assess the CEBUS portal structures using a Spacegass 2D analysis model and the equivalent static method (NZS1170.5). The foundations were also not assessed.

(See calculations in appendix)

The results of the ULS checks are noted below by way of %NBS:

Table 3: CEBUS Mk 4 - ULS RESULTS

Load case	Members	Connections
1.2G + 0.4Q + Wu – *worst case wind event*	134% NBS	120% NBS
G + 0.4Q + Eu – *worst case seismic event*	196% NBS	167% NBS

Deflection analysis of documented design

Under serviceability loading, the following deflections were noted:

Table 4: CEBUS Mk 4 - SLS RESULTS

Load case	**Calculated deflection**	**AS/NZS1170.0 deflection limit**
2G + 0.4Q – long term *permanent load + imposed loading*	18mm (ridge span / 161)	Span / 300 = 10mm
G + 0.4Q + Ws – permanent, imposed + serviceability wind loading	12mm (bay width / 242)	Bay width / 200 = 15mm

The SLS deflections of the CEBUS Mk 4 buildings at Tauhara College are therefore more closely aligned to the recommendations of AS/NZS1170.0, when compared against the R Block.

Findings of technical desktop assessment on Blocks A, B, C and D

Based on the findings above from the information available and reviewed, it is the professional opinion of Sullivan Hall that the design meets requirements of the current New Zealand Building Code.

It should be clarified that the desktop assessment considered the documented design parameters and a simplified 2D model of the portal frames only. The in-situ testing should give a clearer indication of how the building performs in its entirety, and it is assumed that the overall building performance will be better than the simplified model used for the purposes of this report.

The desktop assessment did not assess the longitudinal bracing direction.

Recommendations

Based on the desktop analyses, and without the in-situ test results available at the time of writing this report, it is the professional opinion of Sullivan Hall that due to the inferred maintenance issues, the buildings forming Blocks A, B, C, D and R are not suitable to continue normal use without undergoing a process of remediation.

Our opinion is that unsound timber and corroded steel connectors should be individually assessed and remediated or replaced as necessary. This remediation may involve specific engineered design work and would need to be undertaken by a suitable Chartered Professional Engineer.

Our opinion is that once this work has taken place, the buildings would then become suitable for normal use.

Limitations

- This assessment contains the professional opinion of Sullivan Hall Limited as to the matters set out herein, in light of the information available to it during the preparation, using its professional judgement and acting in accordance with the standard of care and skill normally exercised by professional engineers providing similar services in similar circumstances. No other express or implied warranty is made as to the professional advice contained in this report.
- We have prepared this report in accordance with the brief as provided and our terms of engagement. The information contained in this report has been prepared by Sullivan Hall Limited at the request of Ministry of Education – Bay of Plenty and is exclusively for the clients use and reliance. It is not possible to make a proper assessment of this assessment without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to and the assumptions made by Sullivan Hall Limited. The assessment will not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. No responsibility or liability to any third party is accepted for any loss or damage whatsoever arising out of the use of or reliance on this assessment by any third party.
- The assessment is also based on information that has been provided to Sullivan Hall Limited from other sources or by other parties. The assessment has been prepared strictly on the basis that the information that has been provided is accurate, completed, and adequate. To the extent that any information is inaccurate, incomplete or inadequate, Sullivan Hall Limited takes no responsibility and disclaims all liability whatsoever for any loss or damage that results from any conclusions based on information that has been provided to Sullivan Hall Limited.

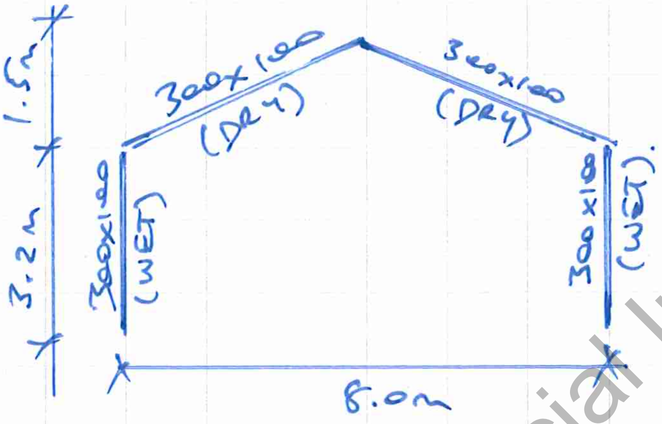
Appendix

Assessment of;

- **Block R**
- **Blocks A, B, C and D**

Portal frame assessment – R Block.

→ Structural drawings for R-Block were located on the property file. The assessment is based on those drawings.



3.0m bay centres.

→ loadings on portals

*** RAFTERS:**

$W^*_G = 0.37\text{kPa} \times 3.0\text{m c/c} = 1.1\text{kN/m}$

$W^*_Q = 0.25\text{kPa} \times 3.0 = 0.75\text{kN/m}$

$W^*_{\text{wind, crosswind}} = -0.89\text{kPa} \times 3 = -2.67\text{kN/m}$

$W^*_{\text{wind, upwind}} = [-0.53, -0.06] \times 3 = [-1.59\text{kN/m}, -0.18\text{kN/m}]$

$W^*_{\text{wind, downwind}} = [-0.51, -0.41] \times 3 = [-1.53\text{kN/m}, -1.23\text{kN/m}]$.

Sullivan Hall
CHARTERED ENGINEERS
p: (09) 8397044 www.sullivanhall.co.nz f: (09) 8354791

Tauhara College Assessment
Tauhara College, Invergarry Road
Taupo 3330

5495	Dec-20	JP

ROOF

	kPa		
Cladding			
Iron	0.06	x	0.06
Metal Tiles	0.08		0
AC Shingles	0.22		0
Timber Shingles	0.22		0
9mm Plywood	0.05		0
12.5mm Plywood	0.07		0
20.0mm Plywood	0.20		0
Concrete Tiles	0.47		0
Clay Tiles	0.67		0
Butynol (1.5mm)	0.02		0
Misc.			0
Framing			
Standard (600crs.)	0.09	x	0.09
Heavy (400crs.)	0.14		0
Ceiling Battens	0.05	x	0.05
Ceiling			
Insulation	0.02	x	0.02
9.5mm Gib Board	0.09	x	0.09
12.5mm Gib Board	0.12		0
14.5mm Gib Board	0.13		0
7mm Fib. Plaster	0.08		0
12.5mm Fib. Plaster	0.14		0
6mm Hardiflex	0.09		0
4.5mm Hardiflex	0.07		0
6mm Bisonboard	0.05		0
6mm Hardboard	0.06		0
12mm Pinex	0.04	x	0.04
7.5mm Plywood	0.05		0
25mm Sarking	0.09		0
32mm Sarking	0.15		0

	DL (kPa)	LL (kPa)
ROOF WEIGHT	0.35	
ROOF ANGLE	18	
Cosec x ROOF WEIGHT	0.37	0.25

FLOOR

		Level 1		Level 2	
Flooring					
100 Rib w 75mm top	2.6		0		0
125 Rib w 75mm top	2.7		0		0
200 Rib w 75mm top	3		0		0
225 Rib w 75mm top	3.1		0		0
additional 25mm topping	0.625		0		0
additional 75 mm toppin	1.875		0		0
Framing					
150 x 50 Joists	0.13		0		0
200 x 50 Joists	0.15	x	0.15		0
250 x 50 Joists	0.2		0		0
300 x 50 Joists	0.25		0		0

	kPa	Level 1		Level 2	
Decking					
40mm Pine	0.21		0		0
32mm Pine	0.17		0		0
25mm Pine	0.13		0		0
20mm particle board	0.15	x	0.15		0
17.5mm Plywood	0.1		0		0
Butynol (1.5mm)	0.02		0		0
Ceiling	0.09		0		0
Battens	0.05		0		0
Insulation	0.02		0		0
Superimposed DL	0.5		0		0
1st FLOOR WEIGHT		0.3			
2nd FLOOR WEIGHT					
DECK WEIGHT					

INTERNAL WALLS

Framing & Linings Std.	0.35	x	0.35

EXTERNAL WALLS

Framing			
Standard	0.1	x	0.1
Heavy	0.15		0
Internal Linings	0.2	x	0.2
Insulation	0.02	x	0.02
Cladding			
Hardiplanks	0.12		0
6mm Hardiflex	0.09		0
Pinex Weatherboards	0.08		0
Hardies boards	0.12	x	0.12
Pine Weather Boards	0.16		0
Cedar Weather Boards	0.11		0
Insulclad	0.07		0
Plaster on Harditex	0.26		0
20mm Hardplaster	0.48		0
Hardplaster & Plywood	0.53		0
150mm thick walls	3.75		0
Plaster on Hardibacker	0.53		0
Concrete Masonry			
All Cells Filled			
100 Series	2.2		0
150 Series	3.1		0
200 Series	4.2		0
Partially Filled			
100 Series	1.75		0
150 Series	1.85		0
200 Series	3.5		0
Reinforced Conc.			
100mm	2.4		0
150mm	3.6		0
200mm	4.8		0
Joinery & Glazing	0.3		0

INTERNAL WALL WEIGHT	0.35
EXTERNAL WALL WEIGHT	0.44

CHECKWIND v5.2.2 AS/NZS 1170 SITE REPORT

STRUCTURE: BUILDING
ORIENTATION: 90°
WIDTH: 8.00 m
LENGTH: 15.00 m
HEIGHT (h): 5.00 m
BASE RL: 0.00 m

LATITUDE: -38.696886
LONGITUDE: 176.103949
ELEVATION: 441.00 m

WIND REGION: A7
ULTIMATE ARI: 500 YEARS
ULTIMATE VR: 45 m/s

CRITICAL DIRECTION: North West
Md: 1.00
TC: 2.10
Mz,cat: 0.9020
Ms: 1.0
Mh: 1.0
Mlee: 1.0
Mel: 1.0
Mt: 1.0
Vdes,θ: 40.59 m/s
qdes,θ: 0.99 kPa

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TITLE: Wind Report
PROJECT: Tauhara College
CODE: SHL5495

Sullivan Hall
Thursday, 10 December 2020 14:37:27

*LATERAL LOADINGS:

- use NZS3604 bracing demands.
- Wind zone = "High" (S.E.D wind speed = 40m/s)
- EQ zone = 2.
- Soil class = D or E (assumed).

→ wind:-

H = 5m, h = 2m (Tb 5.6)

PORTAL DEMAND = 50 BU/m × 3.0m = 150BU = 7.5kN.

→ seismic:-

(refer spreadsheet).

Sullivan Hall
CHARTERED ENGINEERS

EQUIVALENT STATIC SEISMIC FORCE DISTRIBUTION - SINGLE PORTAL FRAME (R BLOCK)

SHL project number: 5495

Tauhara College Assessment

JP

Date: 11-Jun-21

Gravity Loads Wt = 12

Adjust weight to model results 0%

Seismic Coefficient

μ = 1.25 X direction

μ = 2.5 Y direction

Period Calculation

x direction	0.0045	seconds
y direction	0.0046	seconds

	X direction uls	X direction sls	Y Direction uls	Y Direction sls
Soil Class	D		D	
Period	0.4		0.4	
Ch(T), Spectral Shape Factor	3	3	3	3
Z, Hazard Factor	0.28	0.28	0.28	0.28
R, Return Period	1	0.25	1	0.25
N, Near Fault Factor	1		1	
Understanding the Seismic Performance of Timber Framed School Buildings' Table 1-> **Sp, Structural Performance Factor**	0.5	0.5	0.5	0.5
C(T) uls	0.840		0.840	
C(T) sls	0.210		0.210	
kμ =	1.143	1.143	1.857	1.143
Cd(T), Horizontal Design Action Coefficient	0.368	0.092	0.226	0.092

C (x dir)= 0.368
C (y dir)= 0.226

ESTIMATED V (x dir) C x Wt= 4
ESTIMATED V (y dir) C x Wt= 3

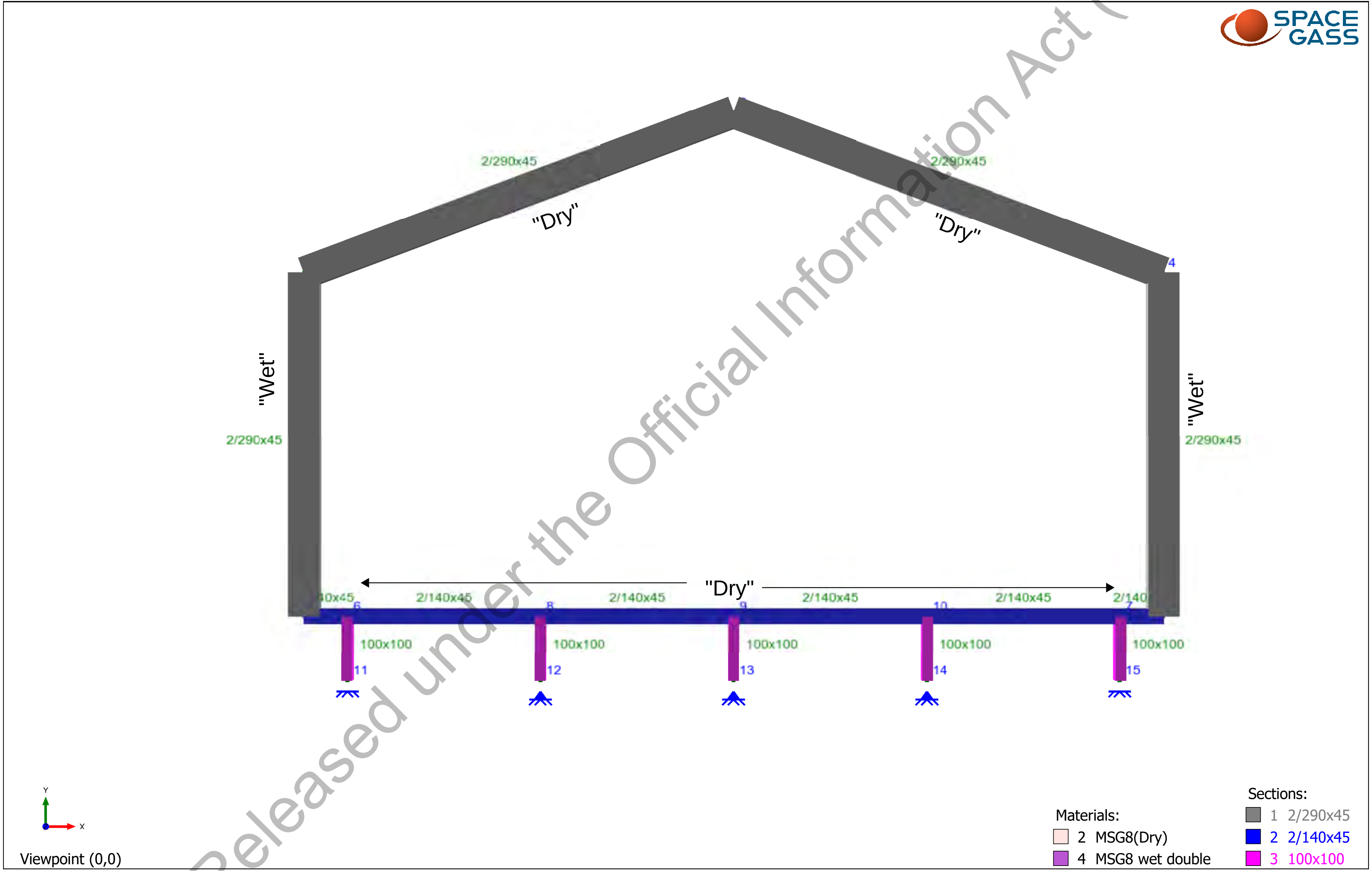
Number of Levels in proposed design 1

			ROOF DL	ROOF LL	Floor 1 DL	-	Floor 1 LL	Floor 2 LL	Walls - external	Walls - internal	-	-	Joinery & Glazing	TOTAL DL (kN)	TOTAL LL (kN)	TOTAL (kN)	Hx	Hx*Wx	Fx (kN)	Shear X (cum. F)	Fy(kN)	Shear Y
		Unfactored Loads	0.36 kPa	0.25 kPa	0.3 kPa	0.00 kPa	3.0 kPa	2.0 kPa	0.4 kPa	0.4 kPa	0.0 kPa	0.0 kPa	0.4 kPa									
		ψ_e =		0.00			0.30	0.30														
		Factored Loads		0.0 kPa			0.9 kPa	0.6 kPa														
ref		Interfloor Height	AREA (m²)																	kN		
5	Roof	0												0	0	0	2.6	0	0.0	0.0	0.0	0.0
4	Level 4	0												0	0	0	2.6	0	0.0	0.0	0.0	0.0
3	Level 3	0												0	0	0	2.6	0	0.0	0.0	0.0	0.0
2	Level 2	0												0	0	0	2.6	0	0.0	0.0	0.0	0.0
1	Level 1	2.6	24	24					8					12	0	12	2.6	31	4.4	4.4	2.7	2.7
0	ground													0	0	0	0.0	0	0.0	4.4	0.0	2.7
		Totals												12	0	12		31	4.4	4.4	2.7	2.7

1219.4292 kg

```
SPACE GASS 12.85 - SULLIVAN HALL
Path: T:\Projects\2020 Projects ...\1. Portal frame assessment\Timber portal
Designer:  Date: Wednesday, December 16, 2020 2:31 PM, Page: 1
```

R BLOCK

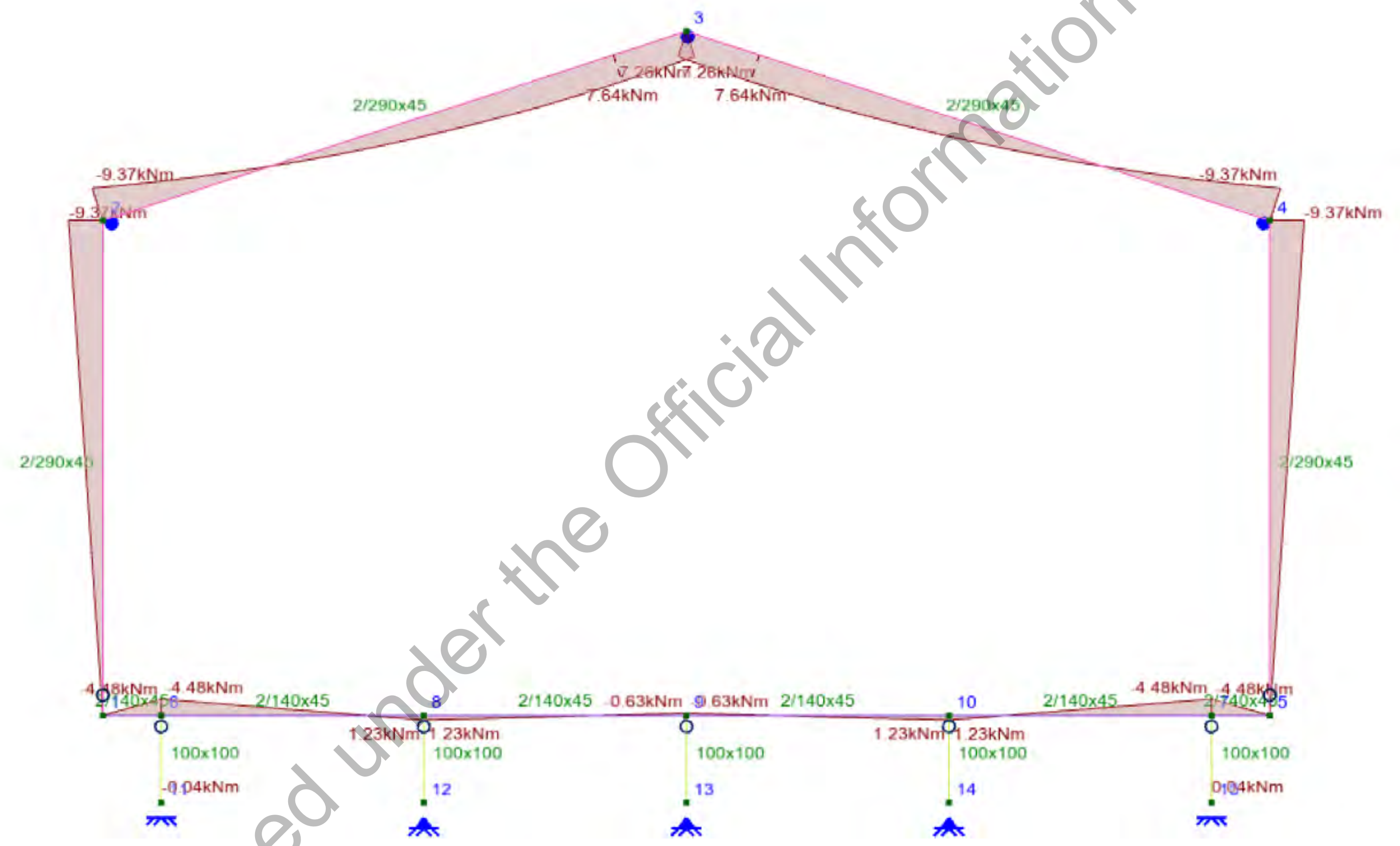


SPACE GASS 12.85 - SULLIVAN HALL
Path: T:\Projects\2020 Projects ...\1. Portal frame assessment\Timber portal
Designer: Date: Wednesday, December 16, 2020 2:33 PM, Page: 1

R BLOCK

Load case 20

▇ 20 (SW) ULS 1.2G+1.5Q



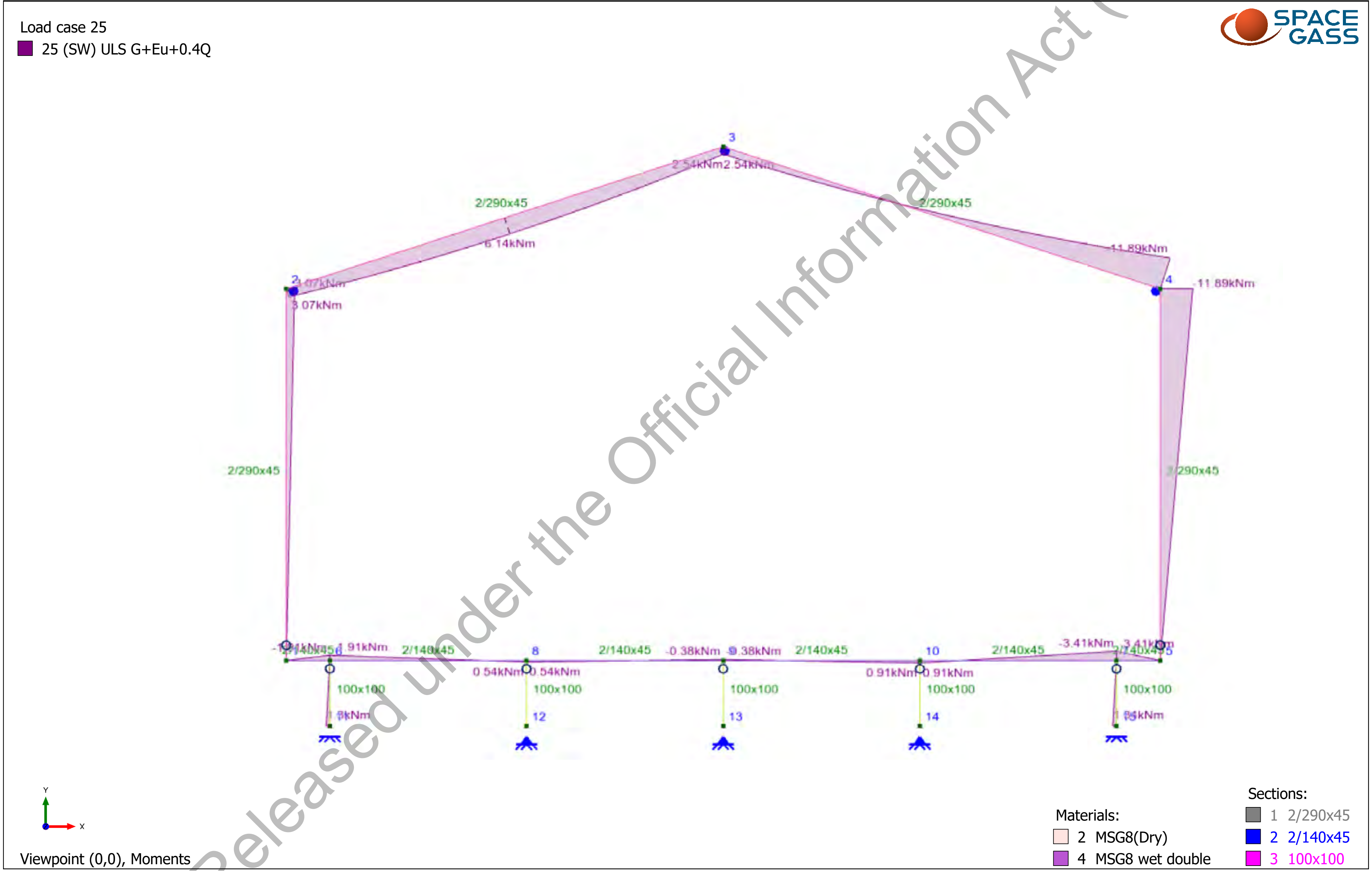
Viewpoint (0,0), Moments

Materials:
☐ 2 MSG8(Dry)
■ 4 MSG8 wet double

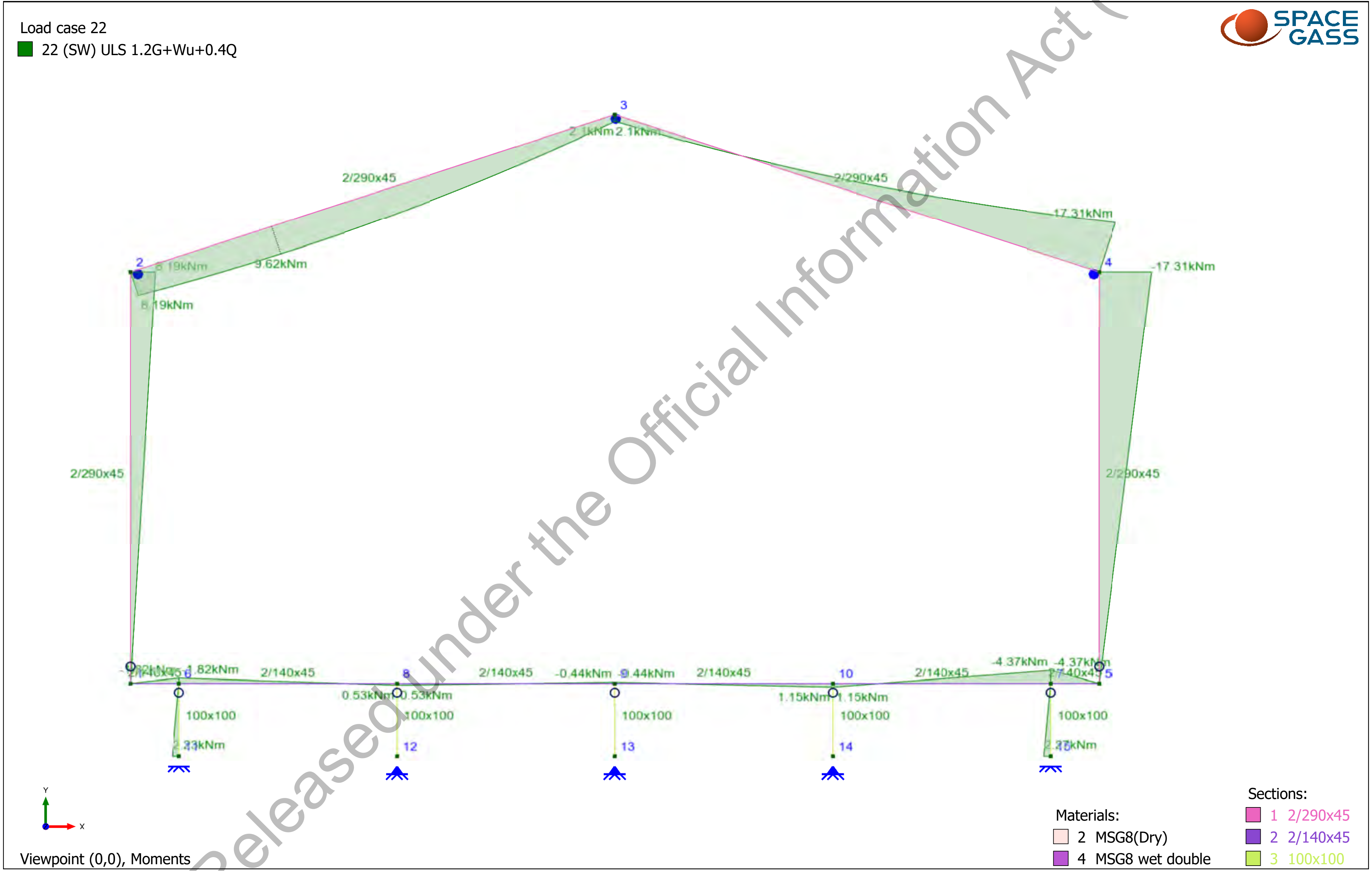
Sections:
■ 1 2/290x45
■ 2 2/140x45
■ 3 100x100

SPACE GASS 12.85 - SULLIVAN HALL
Path: T:\Projects\2020 Projects ...\1. Portal frame assessment\Timber portal
Designer: Date: Wednesday, December 16, 2020 2:35 PM, Page: 1

R BLOCK



```
SPACE GASS 14.00 - SULLIVAN HALL
Path: T:\Project...\1. Portal frame assessment\Timber portal - R Block REV A
Designer:  Date: Tuesday, June 15, 2021 8:39 AM, Page: 1
```

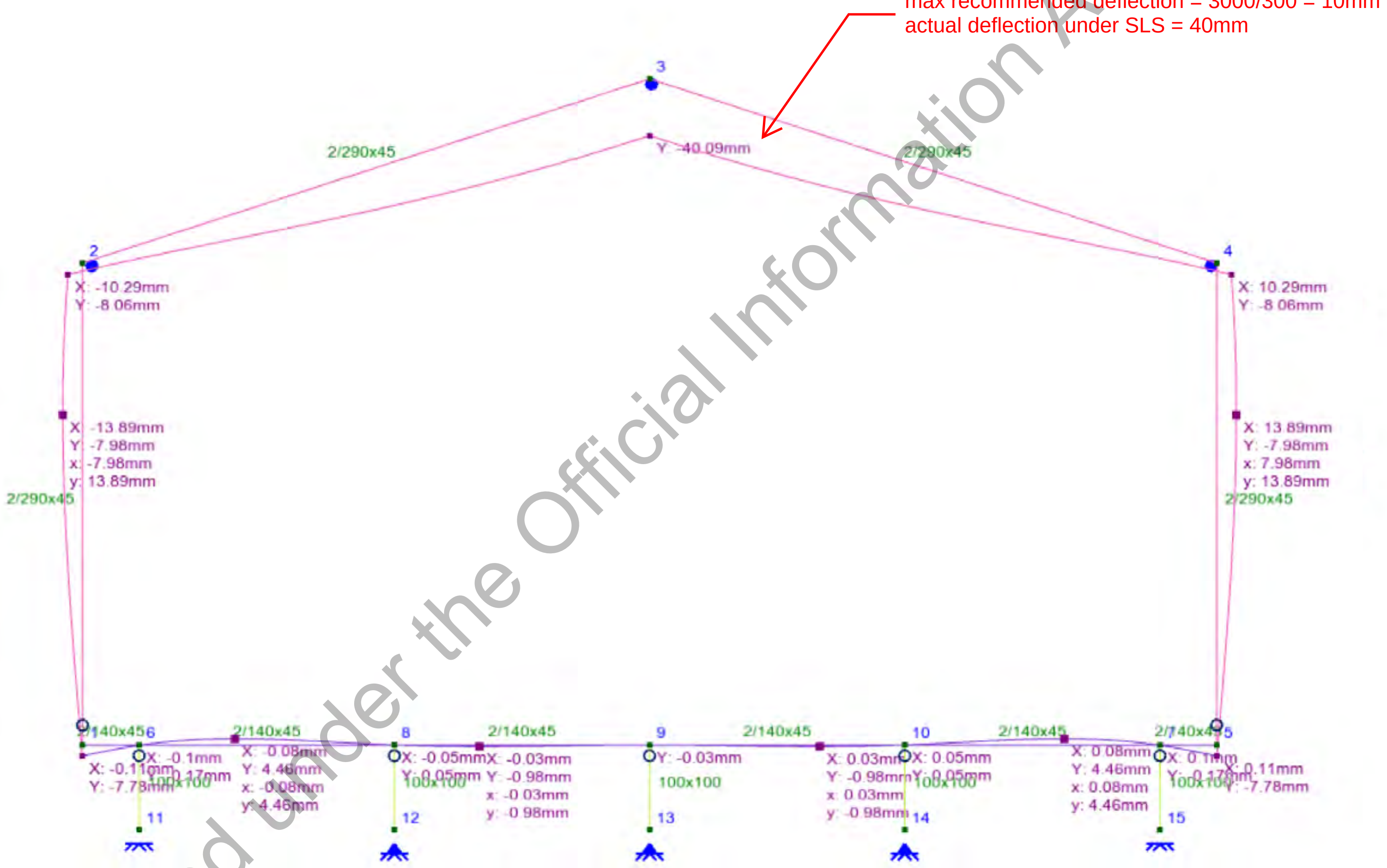


SPACE GASS 12.85 - SULLIVAN HALL
Path: T:\Projects\2020 Projects ...\1. Portal frame assessment\Timber portal
Designer: Date: Wednesday, December 16, 2020 2:36 PM, Page: 1

R BLOCK

Load case 15

▇ 15 (SW) SLS 2G+0.4Q(dry)



max recommended deflection = 3000/300 = 10mm
actual deflection under SLS = 40mm

Viewpoint (0,0), Displacements

Materials:
☐ 2 MSG8(Dry)
▇ 4 MSG8 wet double

Sections:
▇ 1 2/290x45
▇ 2 2/140x45
▇ 3 100x100

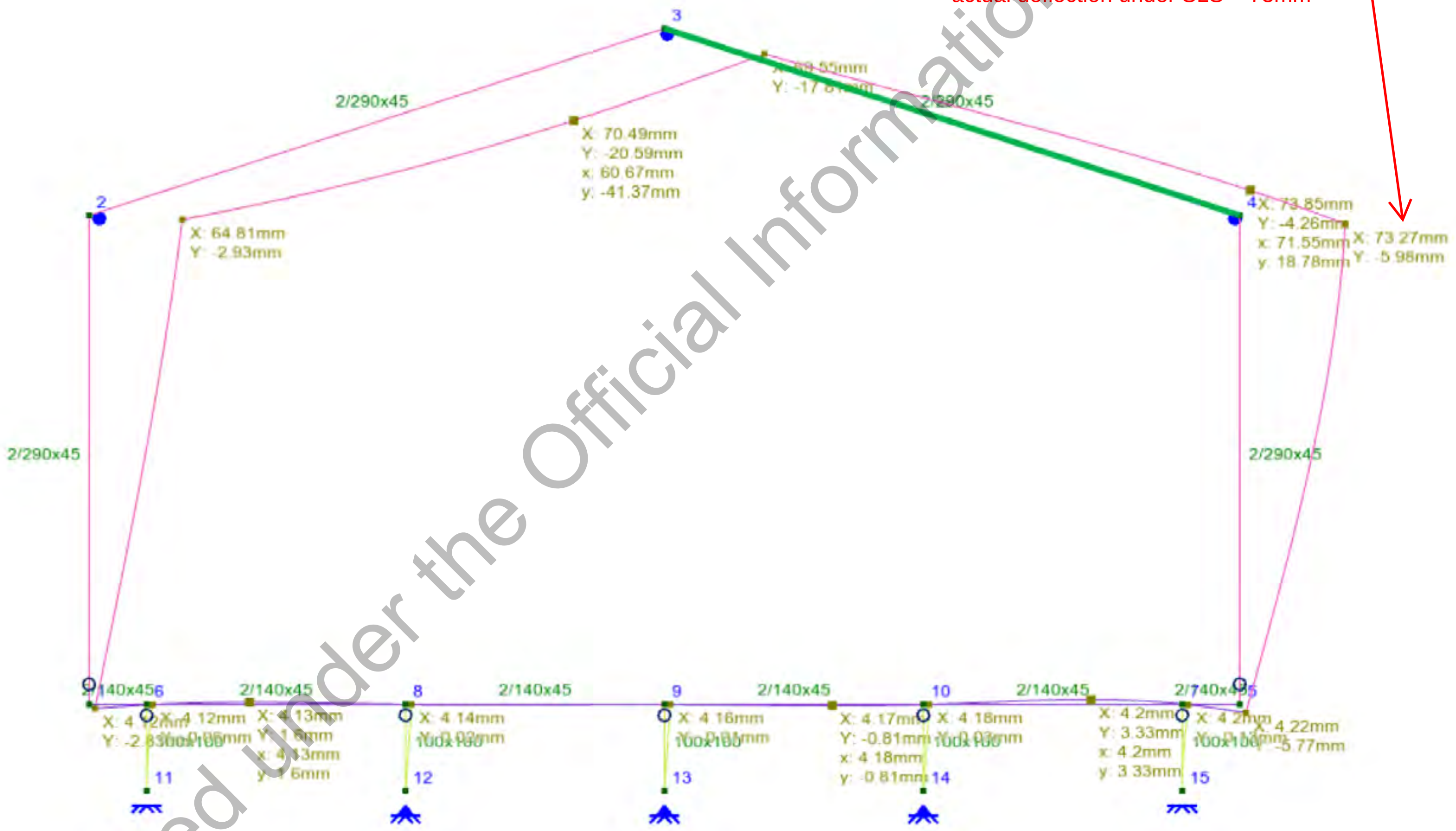
SPACE GASS 12.85 - SULLIVAN HALL
Path: T:\Projects\2020 Projects ...\1. Portal frame assessment\Timber portal
Designer: Date: Wednesday, December 16, 2020 2:37 PM, Page: 1

R BLOCK

Load case 11

🟫 11 (SW) SLS G+0.4Q+Ws

max recommended deflection = 3000/200 = 15mm
actual deflection under SLS = 73mm



Viewpoint (0,0), Displacements

Materials:

- ▢ 2 MSG8(Dry)
- 🟪 4 MSG8 wet double

Sections:

- ■ 1 2/290x45
- 🟦 2 2/140x45
- 🟪 3 100x100

Sullivan Hall
CHARTERED ENGINEERS

EQUIVALENT STATIC SEISMIC FORCE DISTRIBUTION - SINGLE PORTAL FRAME (CEBUS MK4)

SHL project number: 5495

Tauhara College Assessment

JP

Date: 16-Jun-21

Gravity Loads Wt = 11

Adjust weight to model results **0%**

Seismic Coefficient

μ = **1.25** X direction

μ = **2.5** Y direction

Period Calculation

x direction 0.0042 seconds

y direction 0.0044 seconds

Understanding the Seismic Performance of Timber Framed School Buildings' Table 1->

	X direction uls	X direction sls	Y Direction uls	Y Direction sls
Soil Class	D		D	
Period	0.4		0.4	
Ch(T), Spectral Shape Factor	3	3	3	3
Z, Hazard Factor	0.28	0.28	0.28	0.28
R, Return Period	1	0.25	1	0.25
N, Near Fault Factor	1		1	
Sp, Structural Performance Factor	0.5	0.5	0.5	0.5
C(T) uls	0.840		0.840	
C(T) sls	0.210		0.210	
kμ =	1.143	1.143	1.857	1.143
Cd(T), Horizontal Design Action Coefficient	0.368	0.092	0.226	0.092

C (x dir)= 0.368

C (y dir)= 0.226

ESTIMATED V (x dir) C x Wt= 4

ESTIMATED V (y dir) C x Wt= 2

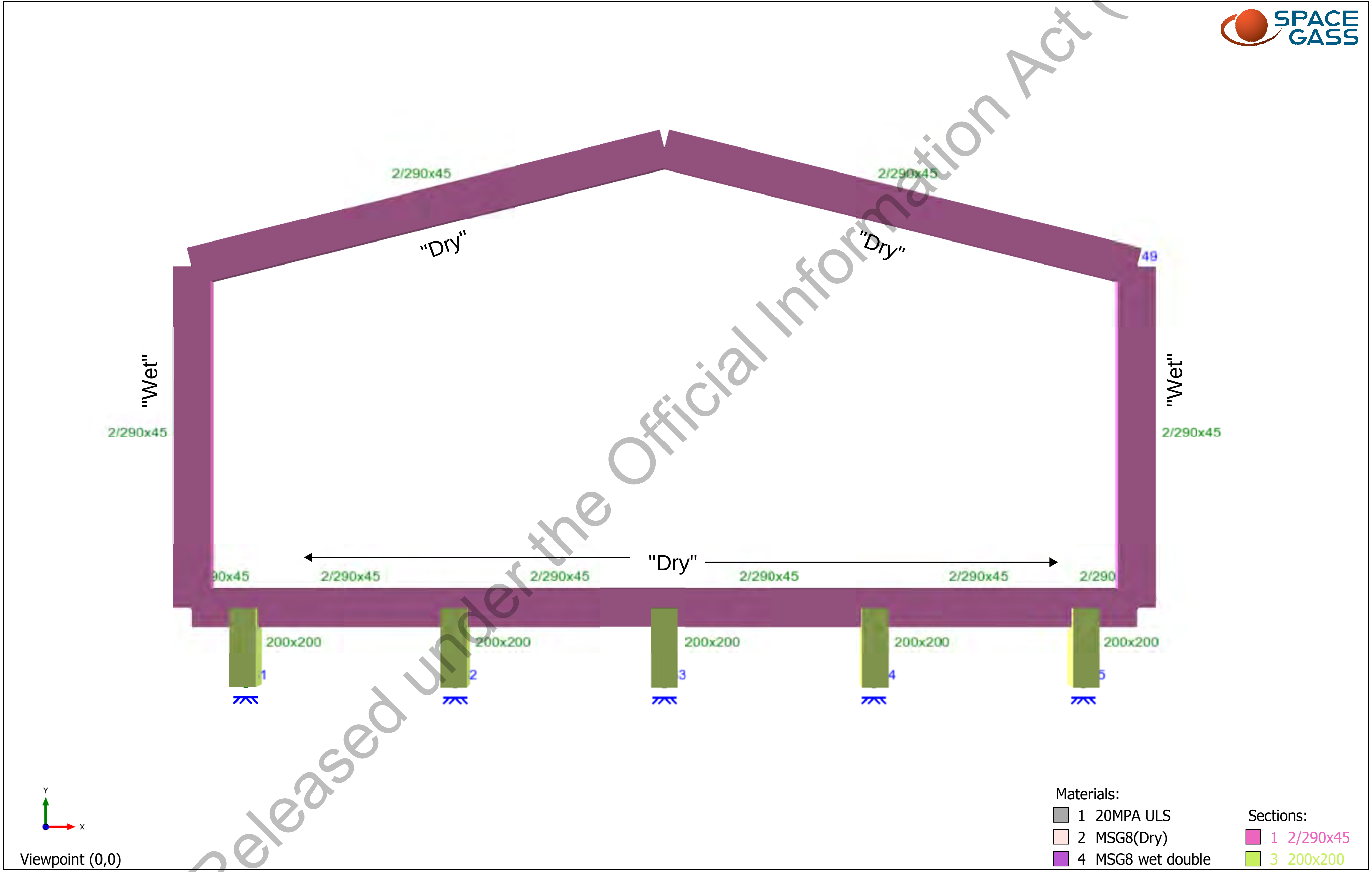
Number of Levels in proposed design 1

			ROOF DL	ROOF LL	Floor 1 DL	-	Floor 1 LL	Floor 2 LL	Walls - external	Walls - internal	-	-	Joinery & Glazing	TOTAL DL (kN)	TOTAL LL (kN)	TOTAL (kN)	Hx	Hx*Wx	Fx (kN)	Shear X (cum. F)	Fy(kN)	Shear Y
		Unfactored Loads	0.36 kPa	0.25 kPa	0.3 kPa	0.00 kPa	3.0 kPa	2.0 kPa	0.4 kPa	0.4 kPa	0.0 kPa	0.0 kPa	0.4 kPa									
		ψ_e =		0.00			0.30	0.30														
		Factored Loads		0.0 kPa			0.9 kPa	0.6 kPa														
ref		**Interfloor Height**	AREA (m²)																	kN		
5	Roof	0												0	0	0	2.6	0	0.0	0.0	0.0	0.0
4	Level 4	0												0	0	0	2.6	0	0.0	0.0	0.0	0.0
3	Level 3	0												0	0	0	2.6	0	0.0	0.0	0.0	0.0
2	Level 2	0												0	0	0	2.6	0	0.0	0.0	0.0	0.0
1	Level 1	2.6	21	21					8					11	0	11	2.6	28	4.0	4.0	2.5	2.5
0	ground													0	0	0	0.0	0	0.0	4.0	0.0	2.5
		Totals												11	0	11		28	4.0	4.0	2.5	2.5

1104.9337 kg

```
SPACE GASS 14.00 - SULLIVAN HALL
Path: T:\Projects\202...\2. Mk 4 CEBUS assessment\Timber portal - Mk 4 CEBUS
Designer:  Date: Monday, June 14, 2021 4:28 PM, Page: 1
```

CEBUS MK4



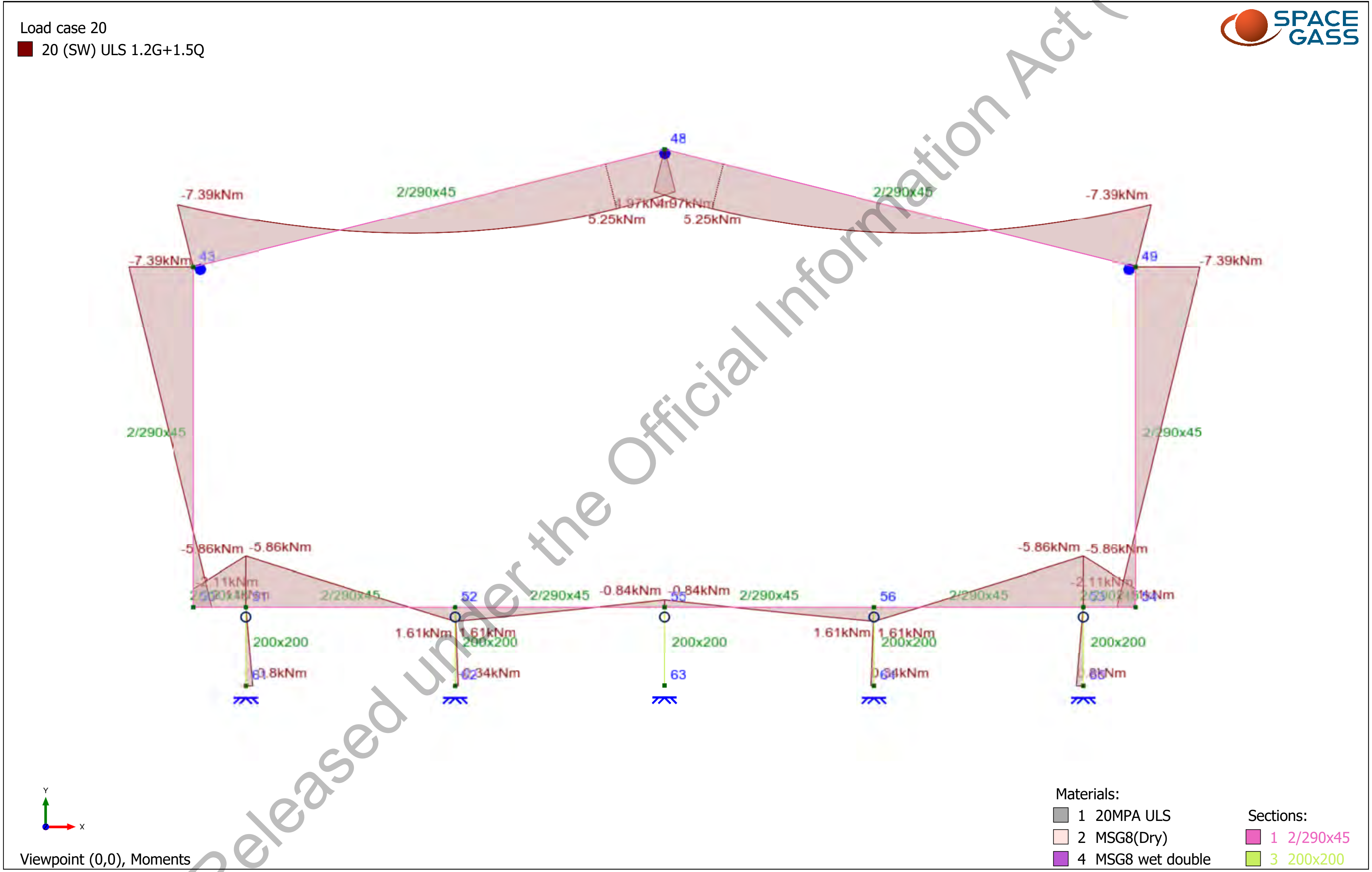
Materials:
- ▨ 1 20MPA ULS
- ☐ 2 MSG8(Dry)
- ▨ 4 MSG8 wet double

Sections:
- ▨ 1 2/290x45
- 🟩 3 200x200

```
SPACE GASS 14.00 - SULLIVAN HALL
Path: T:\Projects\202...\2. Mk 4 CEBUS assessment\Timber portal - Mk 4 CEBUS
Designer:  Date: Monday, June 14, 2021 4:31 PM, Page: 1
```

Load case 20

🟥 20 (SW) ULS 1.2G+1.5Q



Viewpoint (0,0), Moments

Materials:

- ▨ 1 20MPA ULS
- ▨ 2 MSG8(Dry)
- ▨ 4 MSG8 wet double

Sections:

- ▨ 1 2/290x45
- ▨ 3 200x200

```
SPACE GASS 14.00 - SULLIVAN HALL
Path: T:\Projects\202...\2. Mk 4 CEBUS assessment\Timber portal - Mk 4 CEBUS
Designer:  Date: Monday, June 14, 2021 4:32 PM, Page: 1
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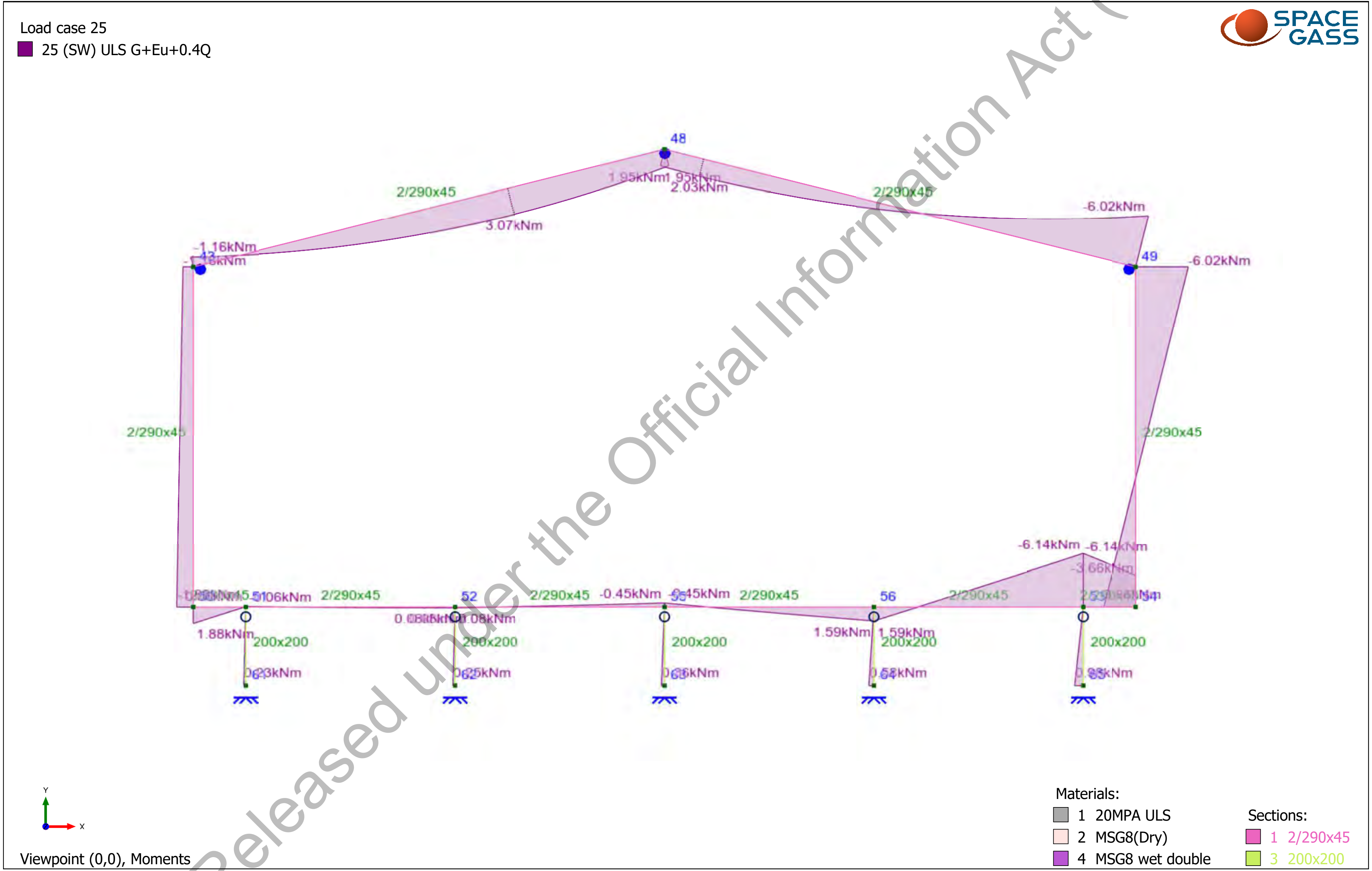
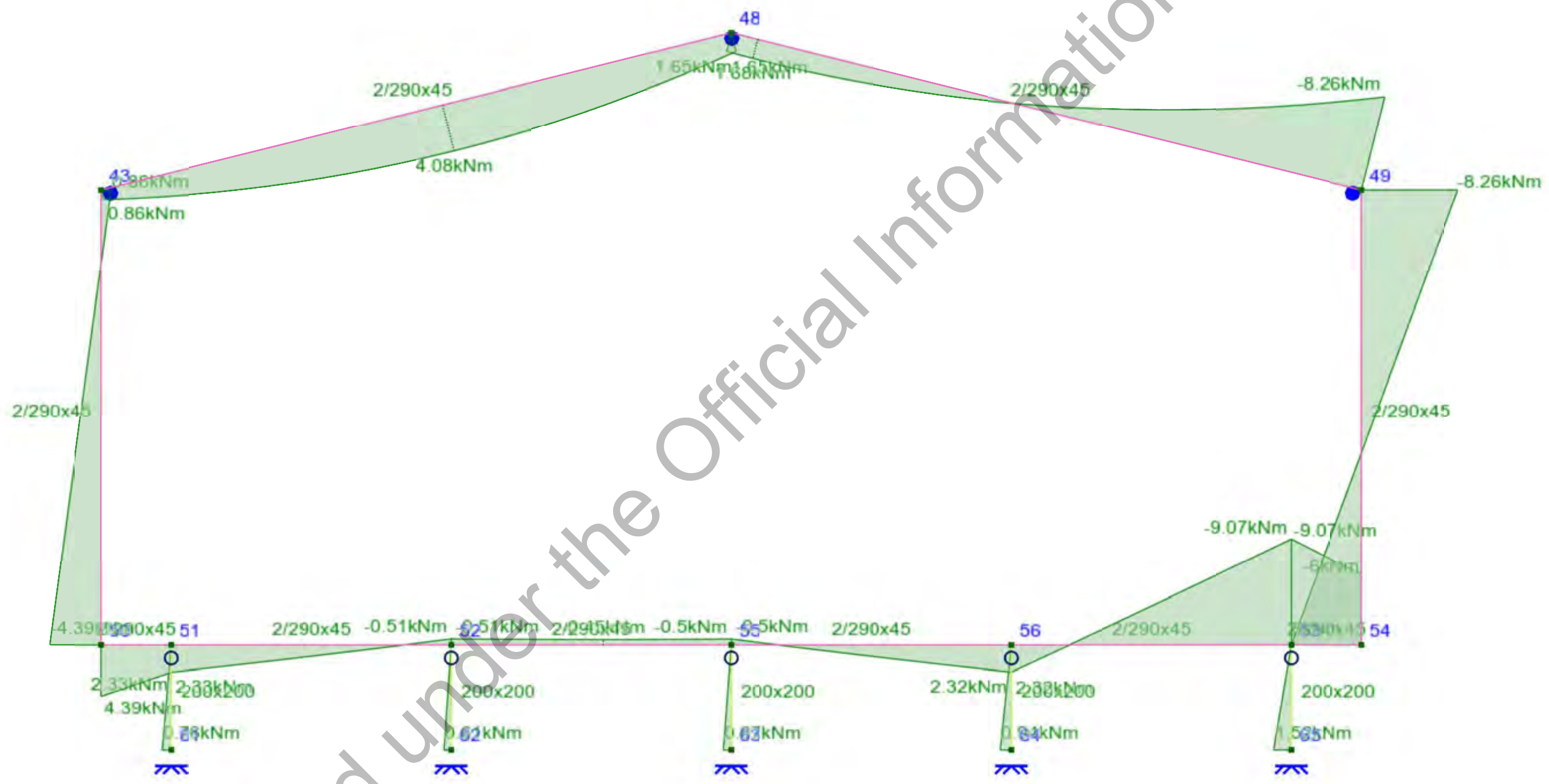


SPACE GASS 14.00 - SULLIVAN HALL
Path: T:\Projects\202...\2. Mk 4 CEBUS assessment\Timber portal - Mk 4 CEBUS
Designer: Date: Monday, June 14, 2021 4:33 PM, Page: 1

Load case 22
🟩 22 (SW) ULS 1.2G+Wu+0.4Q



Viewpoint (0,0), Moments

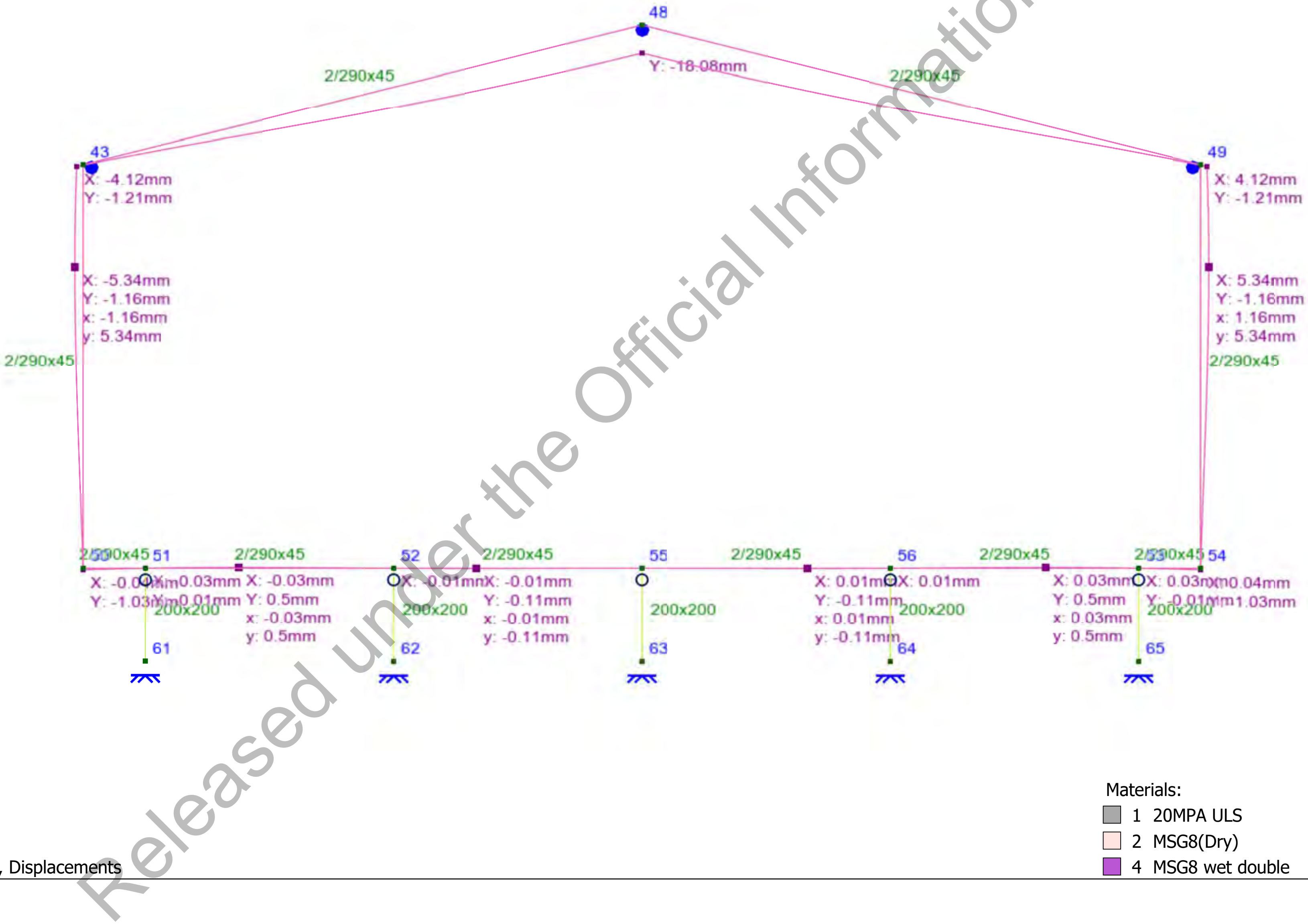
Materials:	
▨ 1	20MPA ULS
▨ 2	MSG8(Dry)
▨ 4	MSG8 wet double

Sections:	
▨ 1	2/290x45
▨ 3	200x200

```
SPACE GASS 14.00 - SULLIVAN HALL
Path: T:\Projects\202...\2. Mk 4 CEBUS assessment\Timber portal - Mk 4 CEBUS
Designer:  Date: Monday, June 14, 2021 4:34 PM, Page: 1
```

Load case 15

■ 15 (SW) SLS 2G+0.4Q(dry)



Viewpoint (0,0), Displacements

Materials:

- ▨ 1 20MPA ULS
- ☐ 2 MSG8(Dry)
- ■ 4 MSG8 wet double

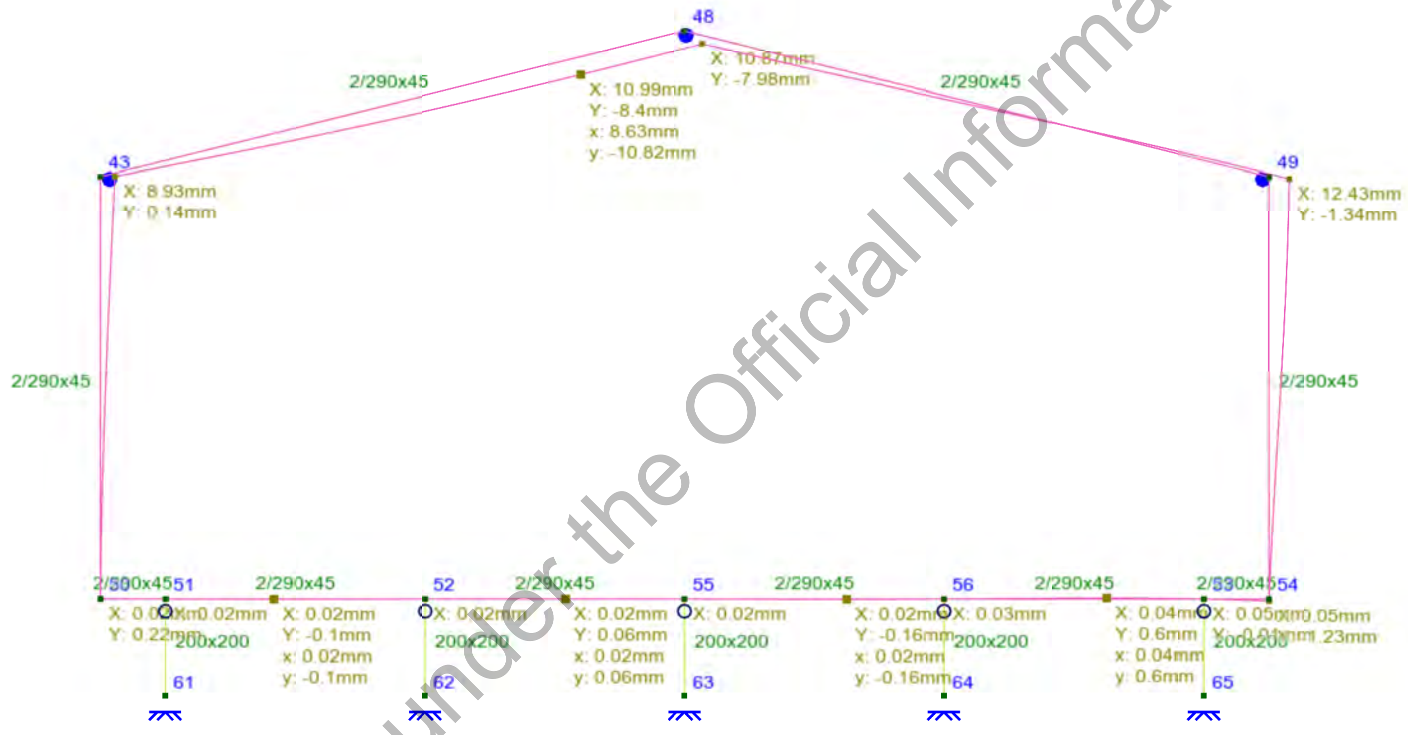
Sections:

- ■ 1 2/290x45
- ■ 3 200x200

```
SPACE GASS 14.00 - SULLIVAN HALL
Path: T:\Projects\202...\2. Mk 4 CEBUS assessment\Timber portal - Mk 4 CEBUS
Designer:  Date: Tuesday, June 15, 2021 8:46 AM, Page: 1
```

Load case 11

🟫 11 (SW) SLS G+0.4Q+Ws



Viewpoint (0,0), Displacements

Materials:

- ▨ 1 20MPA ULS
- ☐ 2 MSG8(Dry)
- ■ 4 MSG8 wet double

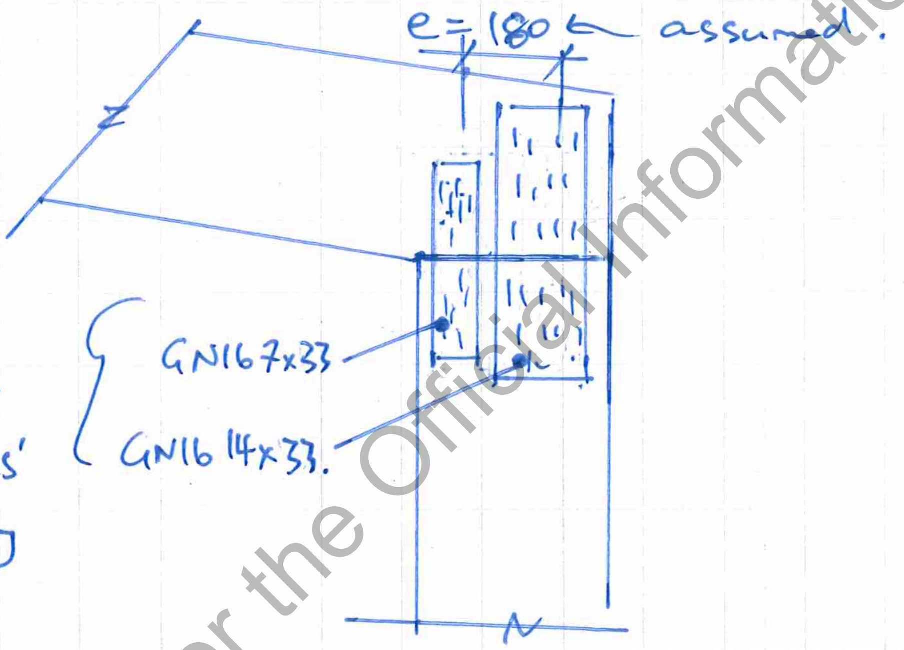
Sections:

- 🟪 1 2/290x45
- 🟩 3 200x200

Consider moment connections at knees.

→ R-Block only has moment connection at top of portal leg.

→ CEBUS has connections at top + bottom of portal leg.



from 'TYPICAL CEBUS DETAILS' summary page.

- Mitek do not publish characteristic strengths for the 'GN16' product.
- Assess as lumberlok tylok 10T10 pairs. capacity (tension) of strap

$\phi N_t = \phi_k . 10 \times 10 \times 0.505 \text{kN}.$

$= 0.7 \times \underset{\text{green}}{0.8} \times 10 \times 10 \times 0.505 \times \underset{\text{(pair)}}{2} = 56 \text{kN}.$

$\phi M_n = \phi N_t . e = 56 \times 0.18 = \underline{10.0 \text{kNm}}.$

→ Based on this moment capacity, the following % NBS scores can be attributed to the R-Block + CEBUS buildings. (assume negligible shear force is taken by nail plate on compression side).

* R-Block (%NBS)

	Members	Connections.
$1.2G + 0.4Q + W_u$	63%	$10/17.3 = 58\%$
$G + 0.4Q + E_u$	97%	$10/11.9 = 84\%$

* CEBUS. (%NBS)

	Members	Connections.
$1.2G + 0.4Q + W_u$	134%	$10/8.3 = 120\%$.
$G + 0.4Q + E_u$	196%	$10/6.0 = 167\%$.