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STATE FINALIST: 2013 ENGINEERING EXCELLENCE AWARDS

SOMERSET COMMUNITY CENTRE

PROJECT PROFILE

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Project Profile:

Somerset Community Centre

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ABSTRACT

The Somerset Community Center (aka Esk Community Hall) is a $3.4 million development located in Esk, Queensland, comprising a new 1,600m^2 multi-purpose community center.

Built Environment Collective (BE Collective) were commissioned by Somerset Regional Council to provide structural and civil design consultancy services. The center was officially opened on the 1st September 2012. On the 15th March 2013, the project was awarded the Australian Institute of Architects *Project-of-the-Year* for the Darling Downs region, and is shortlisted for the Bluescope Steel State Architecture Award. The project was also recognized as a state finalist in the 2013 Engineering Excellence Awards.

We perceive the role of engineer as one of not only service provision, but of stewardship. Working within this paradigm results in an iterative and collaborative options-based approach, which interrogates design alternatives with respect to key project drivers.

Whilst the majority of the structural design/detailing was repetitively paired back, refined, and finessed so as not to draw the eye, a wonderful 3-dimensional tessellated porte cochere at the front of the building is an intentionally striking component that cannot fail to draw attention. The complex nature of this building element meant that it was essential to model and analyse in 3D. A variety of materials were utilised in forming the elements comprising the building structure, including timber - to introduce warmth and human scale to what is essentially a brutal industrial structure.

This profile identifies that originality/ingenuity in engineering approach and application are evidenced through several aspects of the work undertaken by BE Collective on the project.

The BE Collective team worked through our 2011/2012 office Xmas closure in support of the construction program which was completed within the contracted period, and in time for the official opening on the 1st September 2012. The total adjusted contract value was $3,445,305.75 plus GST. This turn-out figure was greatly received by the Council, because after grant funding and insurance, their total payment contribution was just $189,836.33. In addition to this excellent financial result the project supported the Somerset economy through local employment, and local supply of equipment and materials.

A safe and healthy environment was facilitated via a wonderful interior space, one which is bathed in natural light, and with significant cross ventillation to temper peak summer heat. Due to its shape and apeture the Porte Cochere is akin to a sail. Large, combined pad-footings were required for the Porte Cochere columns (raked in 2 directions) to resist uplift, but also significant sliding forces.

Project Profile:

Somerset Community Centre

With destruction of the Lyceum Hall in 2010, the community lost not only a significant piece of heritage and extremely well utilised building. The Council, and then design team and contractor all worked at speed to restore this amenity within 2.5 years of the Lyceum Hall being lost. Dedicated community engagement informed the concept design, and resulted in the civic centre being twice the size of the original hall, and having multiple areas to truly respond to the mixed use brief.

Our Approach to engineering consultancy is intended to lead positive change and be referenced as a bench mark throughout Australia and abroad. In support of this paradigm a core value of BE Collective is to work towards a common goal based on a collaborative options-based approach. The benefits of a collaborative approach are clear through the positive outcomes derived on this project.

PROJECT INTRODUCTION

The Somerset Community Center (also known as the Esk Community Hall) is an $3.4 million development located on Esk-Hampton Road, in Esk, Queensland (about 100 kilometres northwest of Brisbane). The project comprised a new 1,600m^2 multi-purpose community centre on a 15,000m^2 development site.

Built Environment Collective (BE Collective) were commissioned by Somerset Regional Council to provide structural and civil design consultancy services following on from a winning a design completion entry led by principal consultant Thomson Adsett/Studio 39 architects.

The center was officially opened on the 1st September 2012. The inaugural event – the Esk Show Society Showgirl Dinner was held on the 8th September, and followed closely by the Esk Community Choir Concert and the Valley FM Gala Rave Awards.

On the 15th March 2013, the project was awarded the Australian Institute of Architects *Project-of-the-Year* for the Darling Downs region. It is shortlisted for the Bluescope Steel State Architecture Award as well, and is progressing towards the AIA national awards programme which is judged later this year.

On the 7th September 2013 the project was awarded as a state finalist in the Engineering Excellence Awards.

BE Collective are extremely proud to have contributed to such a successful and acclaimed project, especially given that delivery of a superior architectural solution was one of our adopted project objectives – and particularly that the super-structure is effectively an exposed industrial portal-frame. Whilst the industrialised steel connections and construction details were repetitively paired back, refined, and finessed so as not to draw the eye, a wonderful 3-dimensional tessellated porte cochere at the front of the building is an intentionally striking component that cannot fail to draw attention.

HISTORIC TIME-LINE

Somerset's historic Lyceum Hall was built in 1909, and in many ways was the heart of the Somerset community at Esk. On the evening of the 7th May 2010, the hall was decimated by a blaze which was so intense that the cause of fire remains un-established. It was a much loved building and well utilised for fitness and dance classes, community groups such as the community choir, and also for the Esk Show. Sadly the fire also consumed the choir's musical instruments and an irreplaceable collection of costumes and stage sets accumulated over many years by the community.

Figure 1 - Somerset's Lyceum Hall. Built 1909. Decimated by fire in 2010

Later in 2010 the Somerset Regional Council embarked on a reconstruction programme with disaster funding secured by the state and federal governments, as well as insurance monies. Our team contributed to a design completion entry led by principal consultant Thomson Adsett/Studio 39 architects, and were selected by the Council to proceed with the project.

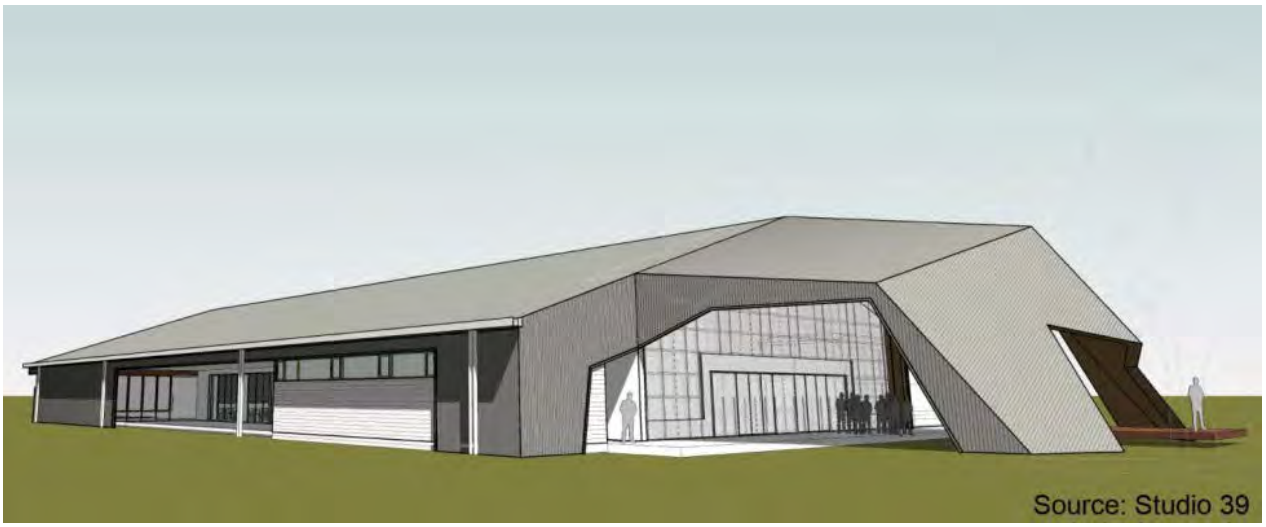


Figure 2 - Somerset Civic Centre, Artists Impression

The design process started with a three day community workshop in December 2010. This process was met with unbridled passion from local Councilors and key community representatives. An efficient and streamlined consultation process was created, where-by community feedback directly impacted concept designs with respect to aesthetic, space-planning, materials and structural design. This resulted in a mixed-use community asset, being twice the size of the original Lyceum Hall.

Construction tender for the development was let in December 2011, with DGW Group appointed as contractor. Construction started in January 2012, with practical completion achieved in support of the official opening on the 1st September 2012.

Figure 3 - Construction

PROJECT DESCRIPTION

The Somerset Community Center (also known as the Esk Community Hall) comprises a 1,600m^2 multi-purpose community center on a 15 ,000m^2 development site. Key elements of the community center include:

- Auditorium with room for 350 patrons in a dining seating configuration (20m wide clear span);
- A stage of adequate size for visiting choirs and orchestras, with access wings from both sides;
- Dressing rooms;
- Rehearsal rooms;
- Store for grand piano;
- Kitchen & bar, accessible both internally and externally;
- Vehicular access for loading and unloading to the backstage area;
- Tuition rooms;
- Separate space for art gallery;
- Storage area for stage sets and props;
- Storage area for chairs/tables;

- Wooden dance floor;
- Toilet and shower facilities;
- Ticket box area;
- Carpark and circulation roadway

Structural & civil elements of the development comprised:

- A structural steel portal frame:
  - 3-dimensionally framed end units incorporating the porte cochere and plant/loading dock areas;
  - Exposed/expressed members and connections;
  - Suspended lighting frame;
- Steel-framed elevated stage area;
- Architecturally expressed timber auditorium/foyer wall incorporating large pivot doors
- Jointed reinforced concrete industrial slabs (recessed as required to enable integration of raised timber dance floor) atop raised engineered fill building pad;
- Deep pad foundations for structural steel framing;
- Piped and overland stormwater flows to onsite swale;
- External pavements.

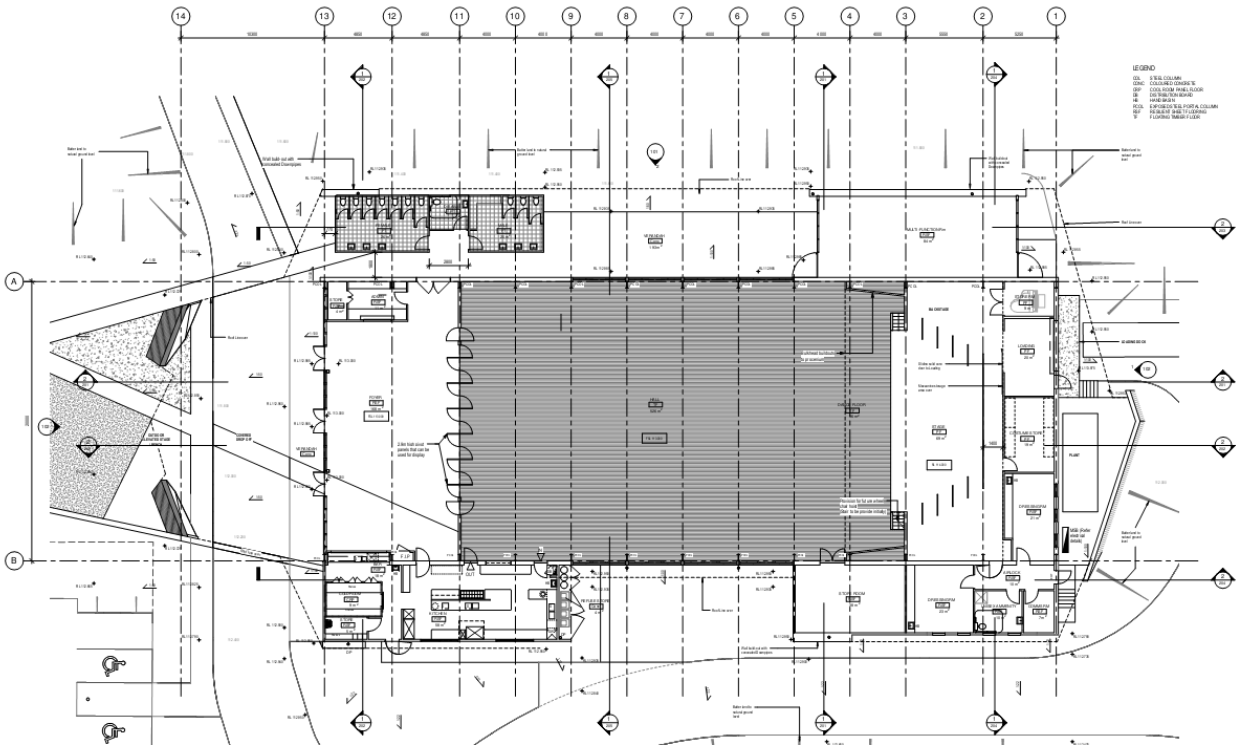


Figure 4 - Civic Center Floor Plan (courtesy Thomson Adsett)

ENGINEERING PRACTICE & PRINCIPLES

OPTIONS-BASED DESIGN

We perceive the role of engineer as one of not only service provision, but of stewardship – one which facilitates an optimal outcome for both client and community. Working within this paradigm results in an i terative and collaborative options-based approach, which interrogates design alternatives with respect to key project drivers.

This options-based approach was evidenced in the critical analysis and choice of each structural element of the project. An example is the choice of superstructure framing. The key drivers considered in interrogating the selection for this element was the provision of:

- A column free floor plan;
- Architectural detailing of exposed framing;
- Low-cost deliverable.

Several variants of portal-ised framing were analysed for the 20m span and proposed to the design team in order to identify the optimal outcome, including:

1. Sustainable hard-wood frames at 2m centres
2. Laminated timber frames at 4m centres
3. Hot-rolled steel frames at 4m centres
4. Hot-rolled steel frames at 8m centres

Review of cost estimates resulted in the elimination of options 1 & 2 above. Architectural and space efficiency considerations resulted in option 3 being adopted. An example is the outcome of our efforts to support the architect's desire to disguise the low-cost industrial structure, so as to create a refined interior design. Details and connections were repetitively paired back, refined, and finessed so as not to draw the eye.

Similarly, several options were tabled and considered in relation to the flooring system including suspended light-weight steel framing, stiffened raft foundation (to AS 2870) in controlled and compacted fill, and jointed reinforced concrete industrial flooring.

Flooring System Option:	**Suspended Steel Framing**	**Stiffened Raft (to AS 2870)**	**Industrial Pavement**
Engineered fill required to achieve design level	No	Yes	Yes
Joints in slabs	N/A	Yes	Multiple
Separate foundations for superstructure	Yes	Yes	Yes
Relocation of existing bore/spear-pump within building footprint	No	Yes	Yes

Significant ground works/foundations details	No	Yes	No

Figure 5 - Floor System Options Summary

A jointed reinforced concrete industrial pavement system was identified as providing optimal economy.

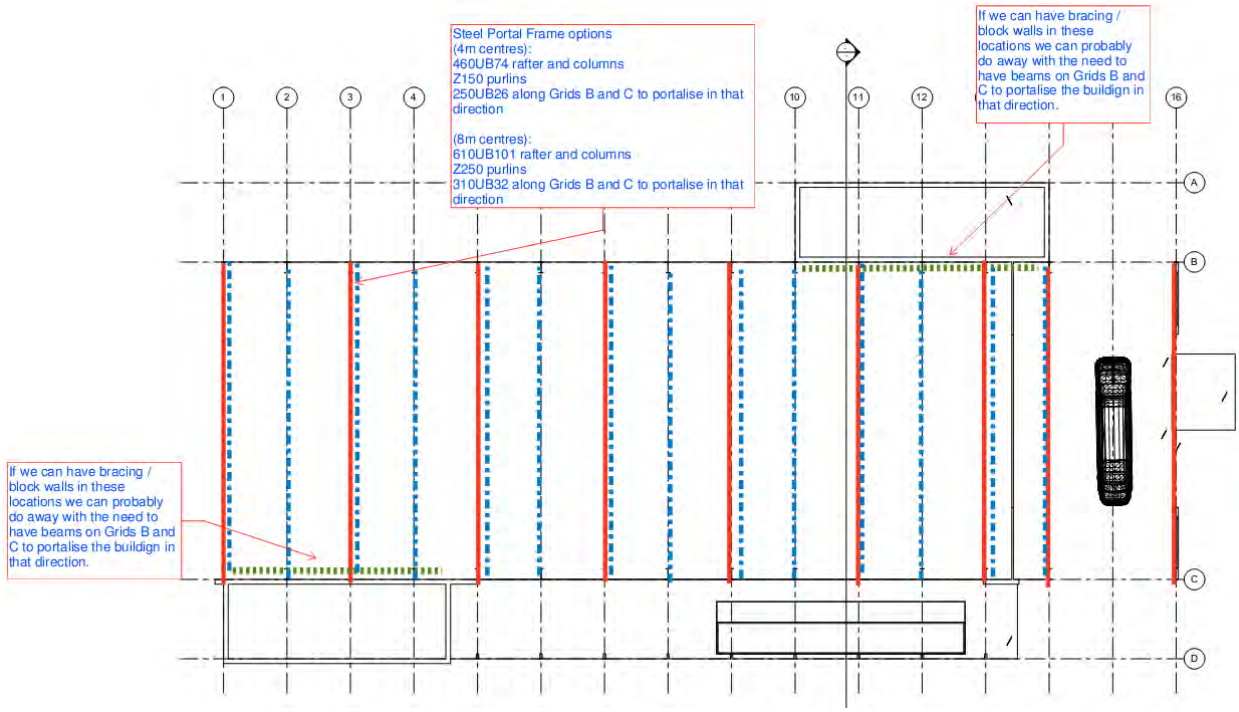


Figure 6 - Part summary of framing options

STRUCTURAL DESIGN OF PORTE COCHERE

Whilst the majority of the structural design/detailing was repetitively paired back, refined, and finessed so as not to draw the eye, a wonderful 3-dimensional tessellated porte cochere at the front of the building is an intentionally striking component that cannot fail to draw attention.

The complex nature of this building element meant that it was essential to model and analyse in 3D. Two key pieces of software were utilised for the super structure, being S-Frame and Tedds (internationally prevalent software by CSC).

Calculations for the porte cochere are included as Appendix A as an example of structural analysis and design undertaken for the project.

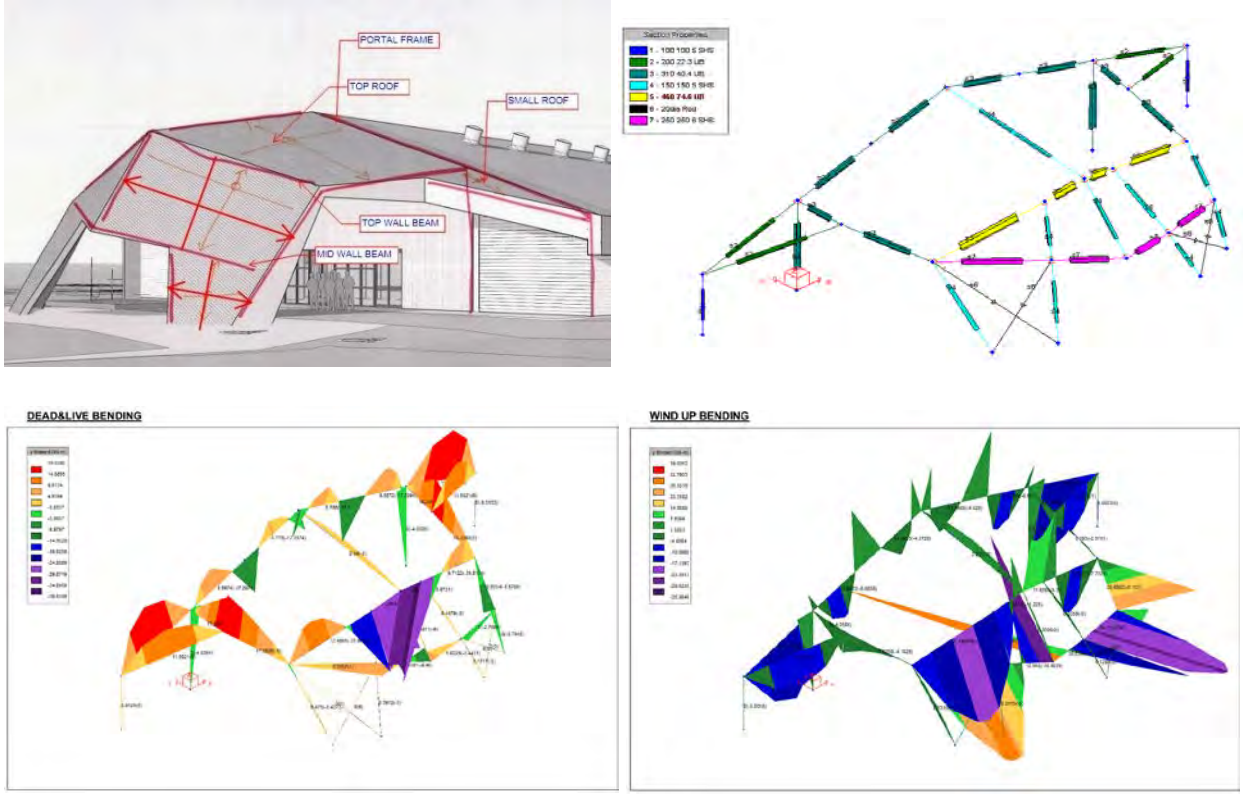


Figure 7 - Modelling the Porte Cochere element

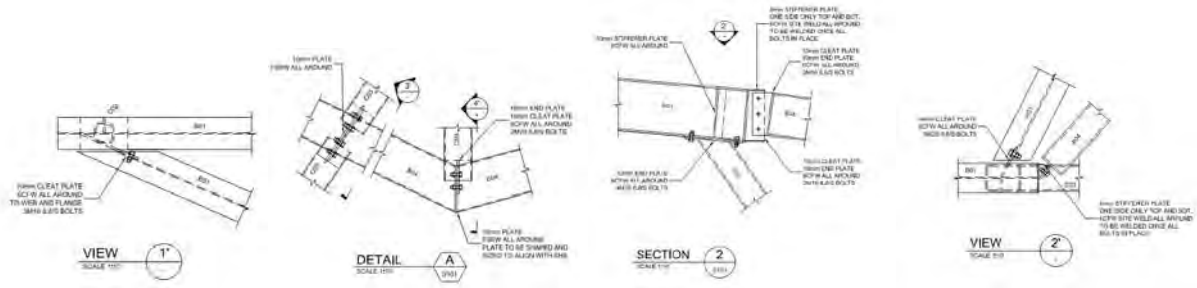


Figure 8 - Porte Cochere: Complex connections

ENGINEERING STANDARDS & CERTIFICATION

A variety of materials were utilised in forming the elements comprising the building structure. Structural design was undertaken in compliance with the following references:

- BCA-2010
- AS 1720.1 - 1997: Timber structures design methods
- AS 4100 -1998: Steel Structures
- AS 3600-2009: Concrete Structures
- AS/NZS 1170.0, 0.1 & 0.2 -2007: Loading
- AS 3700-2001: Masonry

- AS 2870-2006: Residential Slabs & Footings
- Guide to Industrial Floors and P avements, Cement Concrete & Aggregates Australia, 1999

Figure 9 - 3-D tessellated Porte Cochere

ORIGINALITY & INGENUITY:

Originality/ingenuity in engineering approach and applications are evidenced through several aspects of the work undertaken by BE Collective on the project. One example is our approach to the role of engineer being one of stewardship – facilitating an optimal outcome for both client and community. This paradigm supports in an iterative and collaborative options-based approach, eg our interrogation of framing options extended to the consideration of closely spaced portal frames constructed of sustainable traditionally sized timber elements.

Another example was the outcome of our efforts to support the architect's desire to disguise the low-cost industrial structure, so as to create a refined interior design. Details and connections were repetitively paired back, refined, and finessed so as not to draw the eye.

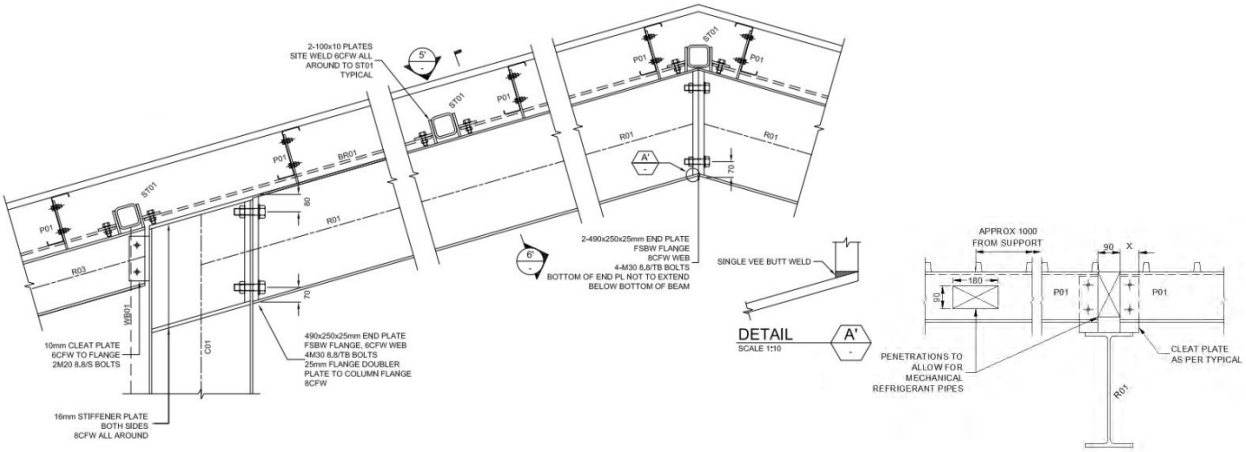


Figure 10 - Ingenuity evidenced by refined engineering detailing & connections

Documentation extracts included as Figure 10 show how the exposed member end-plates were designed within the depth of portal-frame members, so as not to protrude into the interior space. Instead of traditional industrial fly-bracing, web-plates were employed to provided lateral restraint. Roof cross-bracing and strut elements were incorporated above the beams (and above the ceiling line) via a slight increase in cleat-plate length. All mechanical services were also coordinated within this zone via discontinuous purlins, purlin 'block-outs', and original cleat plate design.

Figure 11 shows the clean lines and magnificent high quality finish achieved via our original and ingenious efforts.

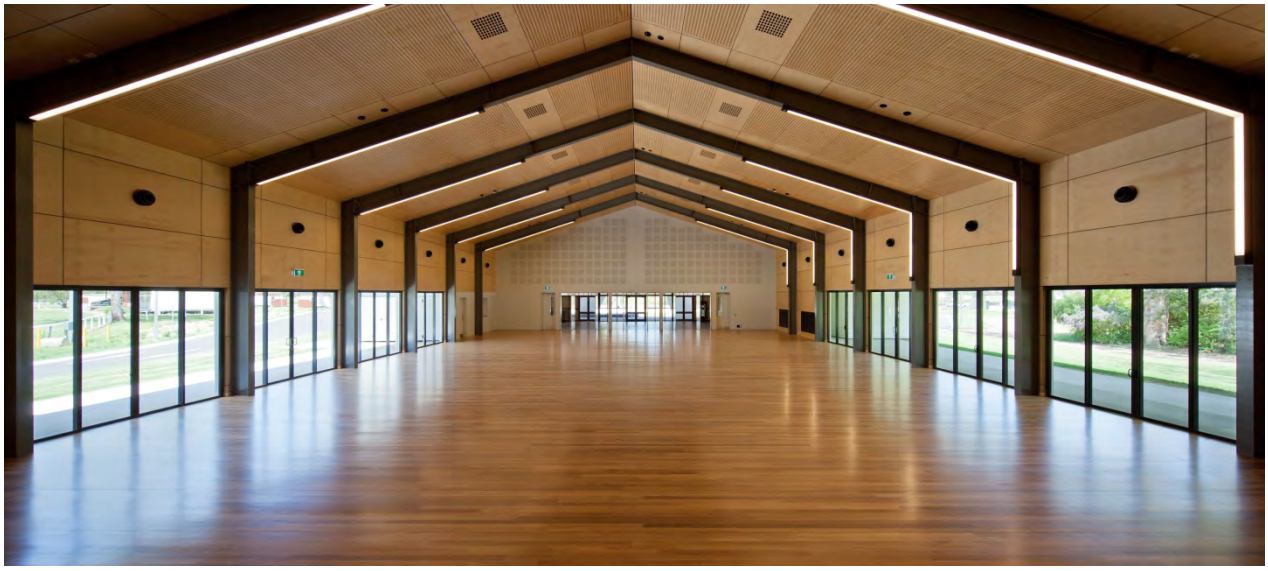


Figure 11 - Paired back, refined & finessed details & connections

The introduction of timber framing is also an original approach to industrial framing, which helps to soften and humanise the otherwise brutal low-cost structural form. Figure 12 shows the timber-framed polycarbonate end wall of the foyer.

Figure 12 - Timber-framed polycarbonate foyer end wall

BUDGET & PROGRAM

Thomson Adsett was officially appointed as architect and principal consultant on the 25th October 2010. The community consultation workshop occurred in December 2010, and concept design started in earnest in January 2011. Our first formal documents were issued in April 2011.

DGW was appointed as contractor in December 2011. The BE Collective team worked through our 2011/2012 office Xmas closure in support of the construction program, and undertook first foundation inspections mid-January 2012. Construction was completed within the contracted period, and in time for the official opening on the 1st September 2012, and the inaugural events of:

- Esk Show Society Showgirl Dinner (8th September 2012);
- Esk Community Choir Concert;
- FM Gala Rave Awards.

Figure 13 - Esk Ball, September 2012

The project budget was identified as $5 million, comprising:

- $2 million government restoration grant;
- $1.6 million insurance claim (due to the destruction of the Lyceum Hall);
- Proposed $1.4 million Somerset Regional Council contribution.

Advice received from the contractor, DGW, is that the total adjusted contract value was $3,445,305.75 plus GST. This turn-out figure was greatly received by the Council, resulting in their total payment contribution of $189,836.33.

A SAFE & HEALTHY ENVIRONMENT

Figures 11 & 12 evidence how our options-based engineering approach facilitated a wonderful interior space, one which is bathed in natural light, and with significant cross ventillation to create a healthy environment and to temper peak summer heat. Wall cross-bracing to the northern elevation has been restricted to outside of the hall perimeter.

Particular and rigourous analysis has been undertaken with respect to the Porte Cochere element, which due to its shape and apeture is akin to a sail and subject to significant wind-uplift forces (refer Appendix A). Large, combined pad-footings were required for the Porte Cochere columns (raked in 2 direction to resist uplift, but also significant sliding forces.

ECONOMIC CONTRIBUTION

Somerset is a local government area centred about the town of Esk, about 100 kilometres northwest of Brisbane, Queensland. With a residential population in the order of 20,000, and an area of 5,381.5 km², it is not difficult to appreciate the difficulties in maintaining an annual Council budget in the order of $50 million.

The completed development has certainly been of positive economic benefit to the area. Our options-based approach to engineering options contributed significantly to the turn-out figure of $3,445,305.75 (plus GST), which resulted in a total turn-out cost to Somerset Regional Council of just $189,836.33 (0.38% of annual budget).

DGW's site foreman, Gerry de Roo, is a Somerset local and was employed full time on the project for the construction duration. Wet-hire excavators, trucks and cranes were all sourced locally within the community, as were materials including concrete supply, fixings, timber (except plywood and flooring) and miscellaneous hardware items.

Figure 14 - Site inundation, 2011

Whilst the impetus for the project was the fire which decimated the Lyceum Hall, the project was also adversely influenced by severe flooding in South East Queensland at the beginning of 2011. The design team responded to the site inundation by increasing in finished floor level, and thus increasing the asset's resilience (and reducing potential reconstruction costs) with respect to future flood events.

QUALITY OF LIFE

With destruction of the Lyceum Hall in 2010, the community lost not only a significant piece of heritage, but also a much loved building which was extremely well utilised for fitness and dance classes, community groups such as the community choir, and also for the Esk Show. Sadly the fire also consumed the choir's musical instruments, and an irreplaceable collection of costumes and stage sets accumulated over many years by the community. The Council, and then design team and contractor all worked at speed to restore this amenity within 2.5 years of the Lyceum Hall being lost.

A significant contribution to the success of the outcome was the community workshop. Lead by the architect and held over 3-days in December 2010, the design team were able to facilitate, interact, appreciate and identify the needs of the community. This resulted in the civic centre being twice the size of the original Lyceum Hall, and having multiple areas to truly respond to the mixed use brief. The Centre is such that auditorium can accommodated 800 patrons (350 in dinner seating configuration), and even the foyer can accommodated 120 people seated.

Figure 15 - Esk Show Society Showgirl Dinner, September 2012

WORLD BEST PRACTICE, INNOVATION & LEADERSHIP

Our Approach to engineering consultancy is intended to lead positive change and be referenced as a bench mark throughout Australia and abroad. We perceive the role of engineer as one of not only service provision, but of innovation and stewardship – one which facilitates an optimal outcome for both client and community. In support of this paradigm a core value of BE Collective

is to work towards a common goal based on a collaborative options-based approach (refer corporate video). The benefits of this options-based approach are documented throughout this submission. It facilitates lateral thinking and the questioning of traditional rational.

The benefits of a collaborative approach are also clear through the positive outcomes derived from the 3-day community workshop in 2010. Our request to participate in this exercise was embraced by the lead consultant, and helped derive a common goal and superior benefit.

The Australian construction industry is geographically insulated from innovation, and is slow to adopt change. The Tedds engineering software employed for the design calculations was first used by BE Collective Director, John Tuxworth, in Ireland in 2000 – however has yet to be adopted by several of the large engineering consultancies in Australia. The software uses Microsoft Word as a platform to automate calculations (refer Appendix A). The tool is an integral part of our internal Quality Assurance and has facilitated analysis, design, documentation and checking of the structural engineering for the Somerset Civic Centre.

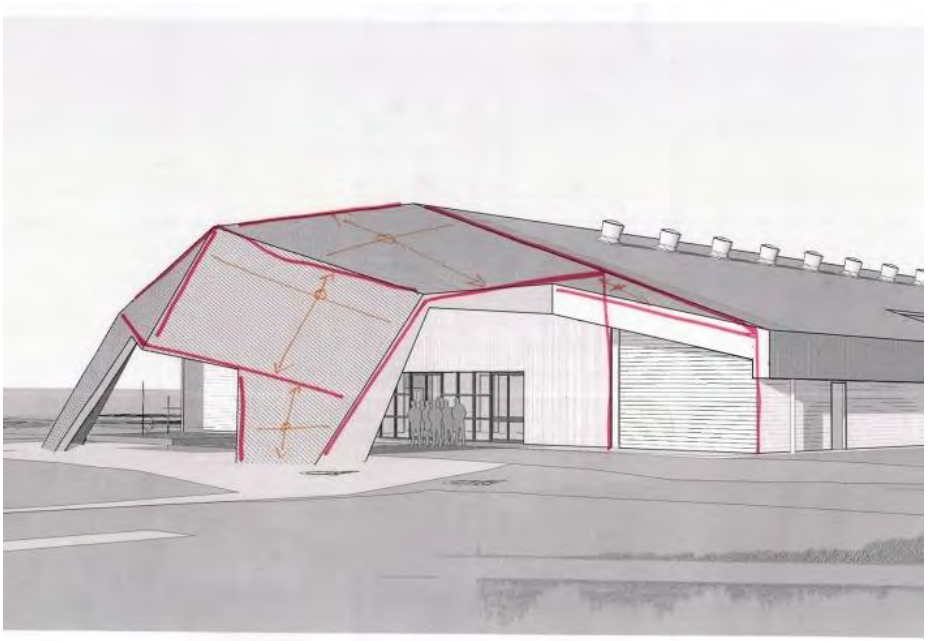
APPENDIX A – SAMPLE DESIGN CALCULATIONS: PORTE COCHERE

1. Project information

This is a mixed use development. It will comprise of a new Community centre type building. The building is located in Esk (Lot 195 CP 899620 – Reserve 36, Esk-Hampton Rd) within the Somerset Regional Council

The Project will consist of steel portal frames spanning around 20m at 4m centres. Bracing for the long direction will be taken as steel cross bracing within the walls provided by the Architect. The roof is to be braced using rods with turnbuckles.

The main entrance consists of a architecturally designed roof overhang. This is to be framed as a lean-to structure using moment connections and welded members where required to provide restraint.



Roof loads

Dead	SWT = 0.35kPa
Superimposed dead	SDL = 0.5kPa
Dead maximum	Gmax = SWT + SDL = **0.850** kPa
Dead minimum	Gmin = SWT = **0.350** kPa
Live (maintenance loads only on roof)	Q = 0.25kPa

Wind loads

Importance class 3 due to having many people in it, and being suggested as a place for refugee in the aftermath of a disaster (as opposed to a shelter for use during a disaster)

1:1000 year wind speeds, zone B — V_R = 60m/s

1:25 year wind speed, Zone B — V_{sls} = 39m/s

M_d = 1.0

Terrain category 2

M_{zcat} = 1 — average height 8m, use 10m conservativly (slightly)

M_s = 1.0

M_t = 1.0

$V_{sit} = V_{des} = V_R * M_d * M_{zcat} * M_s * M_t$ = **60.000** m/s

$V_{SLS} = V_{sls} * M_d * M_{zcat} * M_s * M_t$ = **39.000** m/s

C_{fig} = 1.0

C_{dyn} = 1.0

ρ_{air}=1.2kg/m^3

$p_{ULS} = (0.5 * \rho_{air}) * V_{des}^2 * C_{fig} * C_{dyn}$ = **2.160** kPa

$p_{SLS} = (0.5 * \rho_{air}) * V_{SLS}^2 * C_{fig} * C_{dyn}$ = **0.913** kPa

Service RatioR = p_{SLS}/p_{ULS} = **0.4225**

Aerodynamic shape factor for entrance

Design as attached canopy as per AS1170.2-2011 Appendix Cl: D4

h_c = 9m W_c = 20m h_c/h = 1

k_a = 1

k_l = 1 for structure k_{lp}= 2 k_{lpf} = 3 for free roofs up to 0.5a (a is around 3.6m) (first 3 purlins from edge and ridge)

for free slope assume close to 15 degrees (16.5), non-conservative.

Long Wind

$C_{pnu} = -0.3-0.6*(h_c/W_c)$ =**-0.57** — C_{pnd} = 0.2

Cross Wind

C_{pwu} = -0.3 — C_{pwd} = 0.4

C_{plu} = -0.4 — C_{pld} = 0

Walls

Pressure	C_{pp} = 0.7
Suction	C_{ps} = -0.65

Longwind upward wind coefficient is worst case, apply same pressure over entire roof.

Cross wind will require checking for downward due to varying coefficients on upward and downward slope

Wind pressure upward, Long $W_{pu} = p_{ULS} * C_{pnu} =$ **-1.23** kPa
Wind pressure upward, Long $W_{puc} = p_{ULS} * C_{plu} =$ **-0.86** kPa

Wind pressure downward, windward slope $W_{dw} = p_{ULS} * C_{pwd} =$ **0.86** kPa
Wind pressure downward, leeward slope $W_{dl} = p_{ULS} * C_{pld} =$ **0.00** kPa
Windward Pressure downward long wind $W_{dlw} = p_{ULS} * C_{pnd} =$ **0.43** kPa

Wind pressure wall $W_{wp} = p_{ULS} * C_{pp} =$ **1.51** kPa
Wind Suction wall $W_{ws} = p_{ULS} * C_{ps} =$ **-1.40** kPa

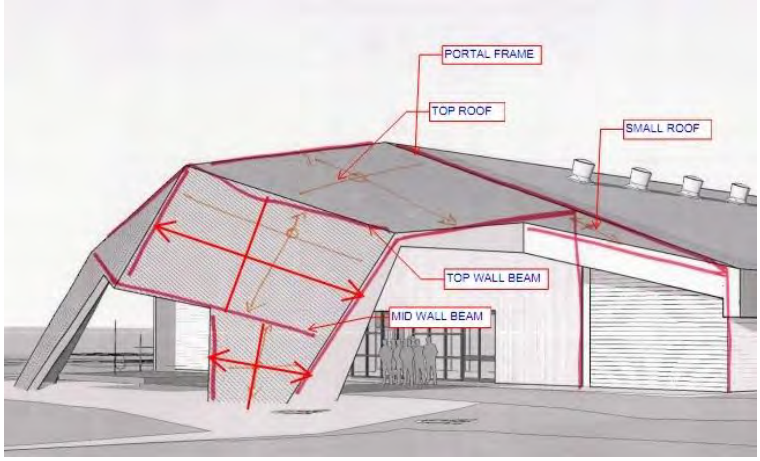
Wind uplift for Purlins $W_{pp} = W_{pu}*2 =$ **-2.46** kPa k_l is 2
Spacing of purlins S_p = 900mm
Ultimate wind load $W_l = (0.9* SDL - W_{pp})*S_p =$ **2.62** kN/m
Try 250.24 with outward capacity of 2.49kN/m with 3 bridges @ 8.7m (conservative design)

<u>Load widths</u>
Top roofs L_{wr} = 4m
Top small roof L_{ws} = 1.5m max distance (VDL)
Top beam Side Wall L_{ww} = 2m
Mid beam side wall L_{wm} = 3.5m

<u>UD Loads</u>
Dead Load Roof $F_{dr} = SDL*L_{wr} =$ **2.00** kN/m
Dead Load small roof $F_{ds} = SDL*L_{ws} =$ **0.75** kN/m
Live Load Roof $F_{lr} = Q*L_{wr} =$ **1.00** kN/m
Live Load small roof $F_{ls} = Q*L_{ws} =$ **0.38** kN/m

Cross Wind
Wind Downward on roof $W_{dr} = W_{dw} *L_{wr} =$ **3.46** kN/m
Wind down on small roof, Start of VDL $W_{ds} = W_{dw} *L_{ws} =$ **1.30** kN/m
Wind Suction on top beam $W_{pw} = W_{wp} * L_{ww} =$ **3.02** kN/m
Wind Suction on mid beam $W_{pm} = W_{wp} * L_{wm} =$ **5.29** kN/m

Long Wind
Wind up on roof $W_{ur} = W_{pu} * L_{wr} =$ **-4.92** kN/m
Wind up on small roof, Start of VDL $W_{us} = W_{pu} *L_{ws} =$ **-1.85** kN/m
Wind Pressure on top beam $W_{pw} = W_{ws} * L_{ww} =$ **-2.81** kN/m
Wind Pressure on mid beam $W_{pm} = W_{ws} * L_{wm} =$ **-4.91** kN/m
Portal Frame to have 1.5 times the load to include extra 2m of load width from normal roof loads



S-FRAME ENTERPRISE VERSION 8.00

(c) Softek Services Ltd.

PROJECT INFORMATION

Project Name: Somerset Civic Centre

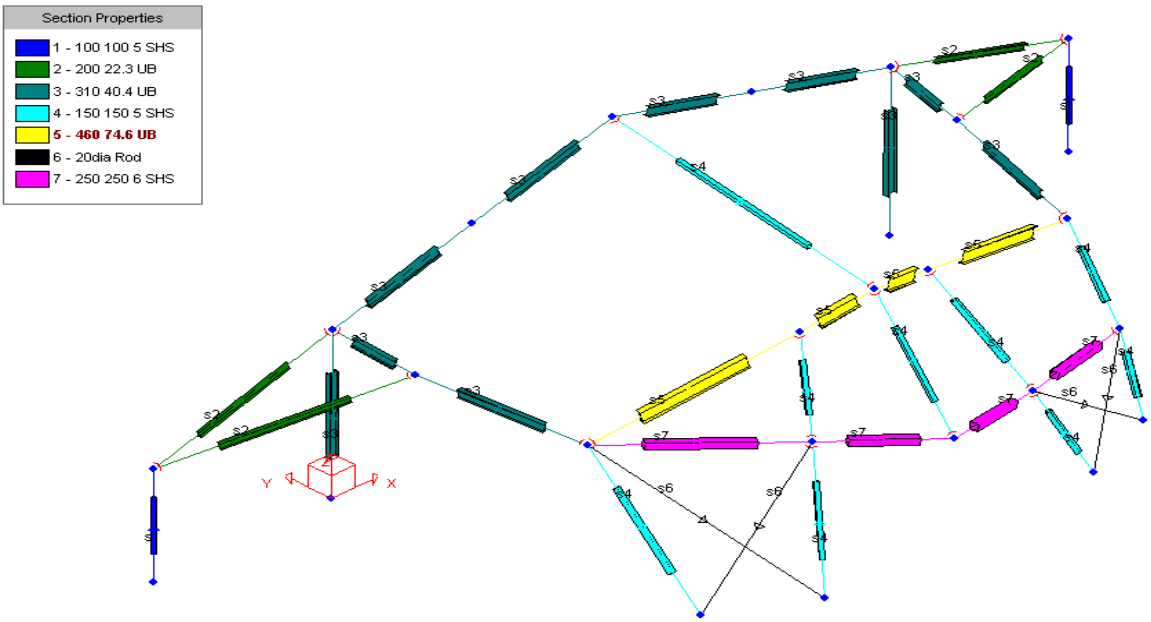
Structure Description: Entrance Roof

Engineer: Rhys Kilpatrick

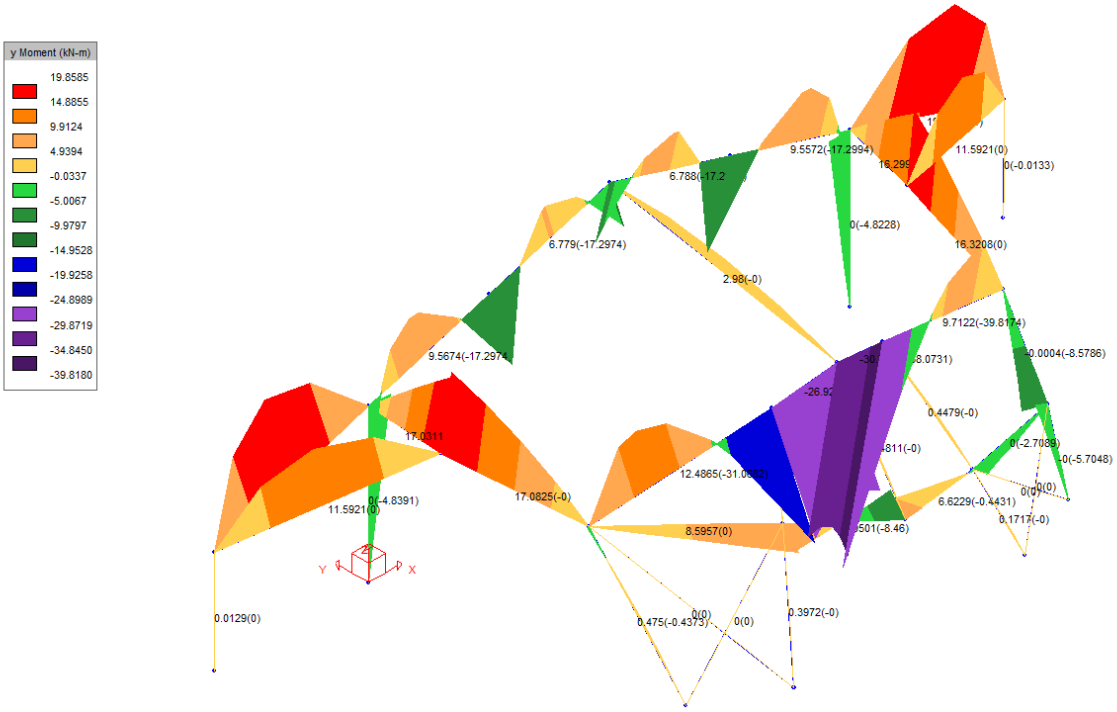
File Name: P:\03 - Projects\6028 - Somerset Civic Centre\Calculations GLE\Structural & Civil\110419 - Front Entrance Awning\Front Entrance.TEL

BE Collective 9 Hynes St Fortitude Valley, Q 4006 T: +61 7 3252 1001	Project Somerset Civic Centre				Job Ref. 6028	
	Section Porte-Cochere Structural Calculations				Sheet no./rev. 5	
	Calc. by RK	Date 16/04/2011	Chk'd by ASM	Date 21/09/2011	App'd by	Date

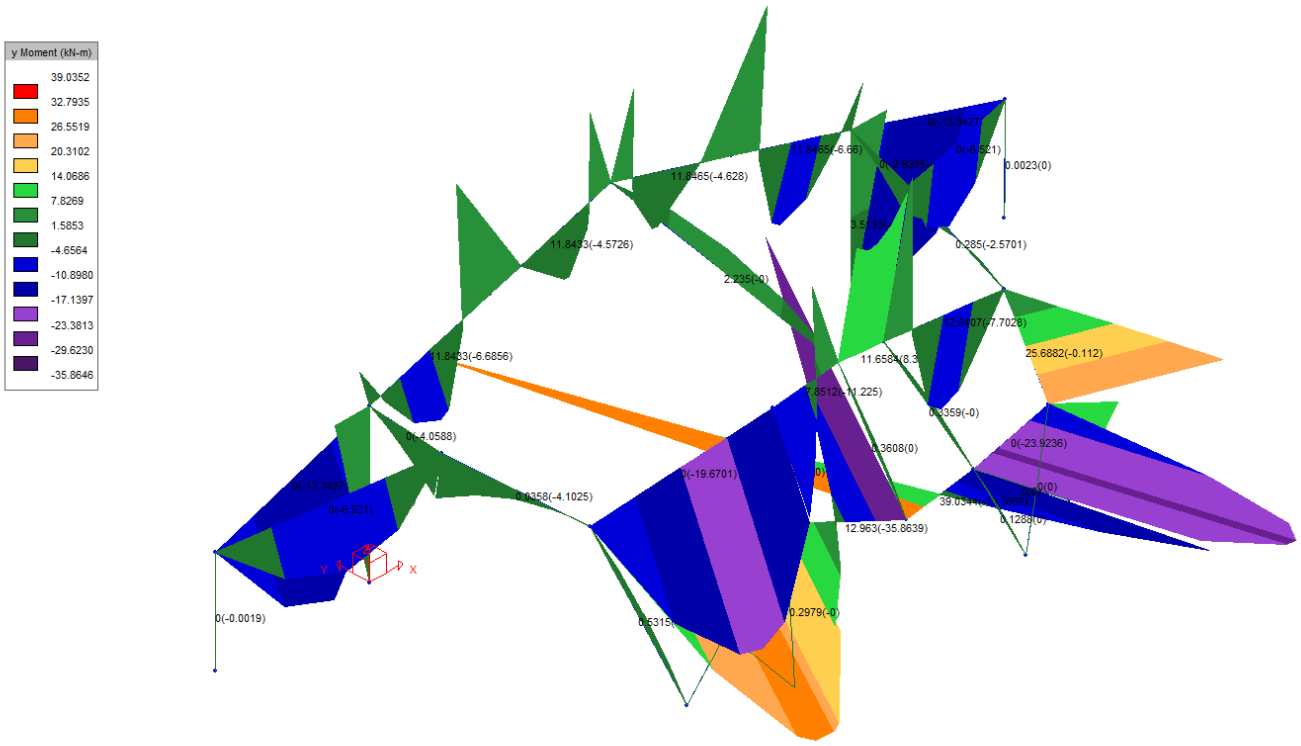
MEMBER SIZES



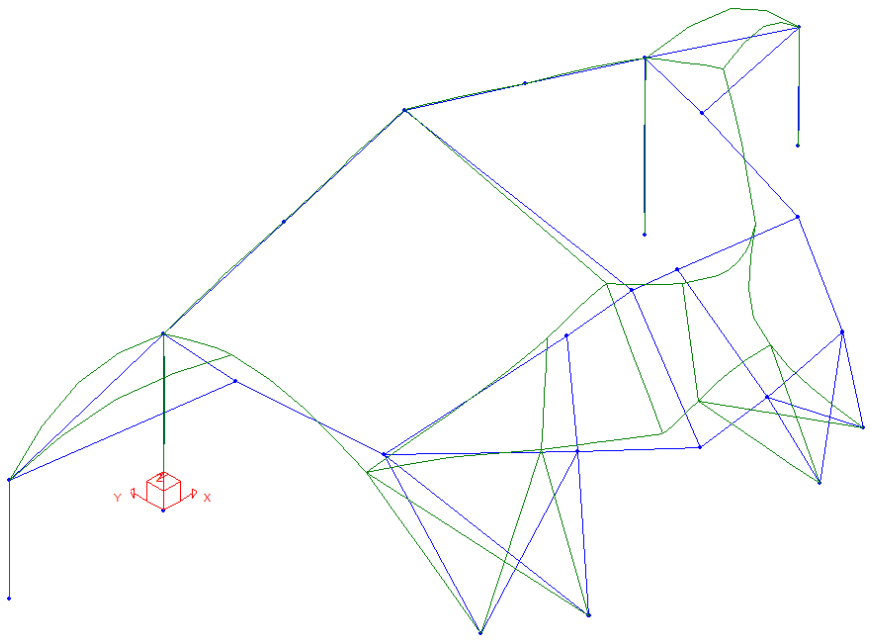
DEAD&LIVE BENDING



WIND UP BENDING



DEFLECTED SHAPE



S-FRAME ENTERPRISE VERSION 10.0

(c) Softek Services Ltd.

PROJECT INFORMATION

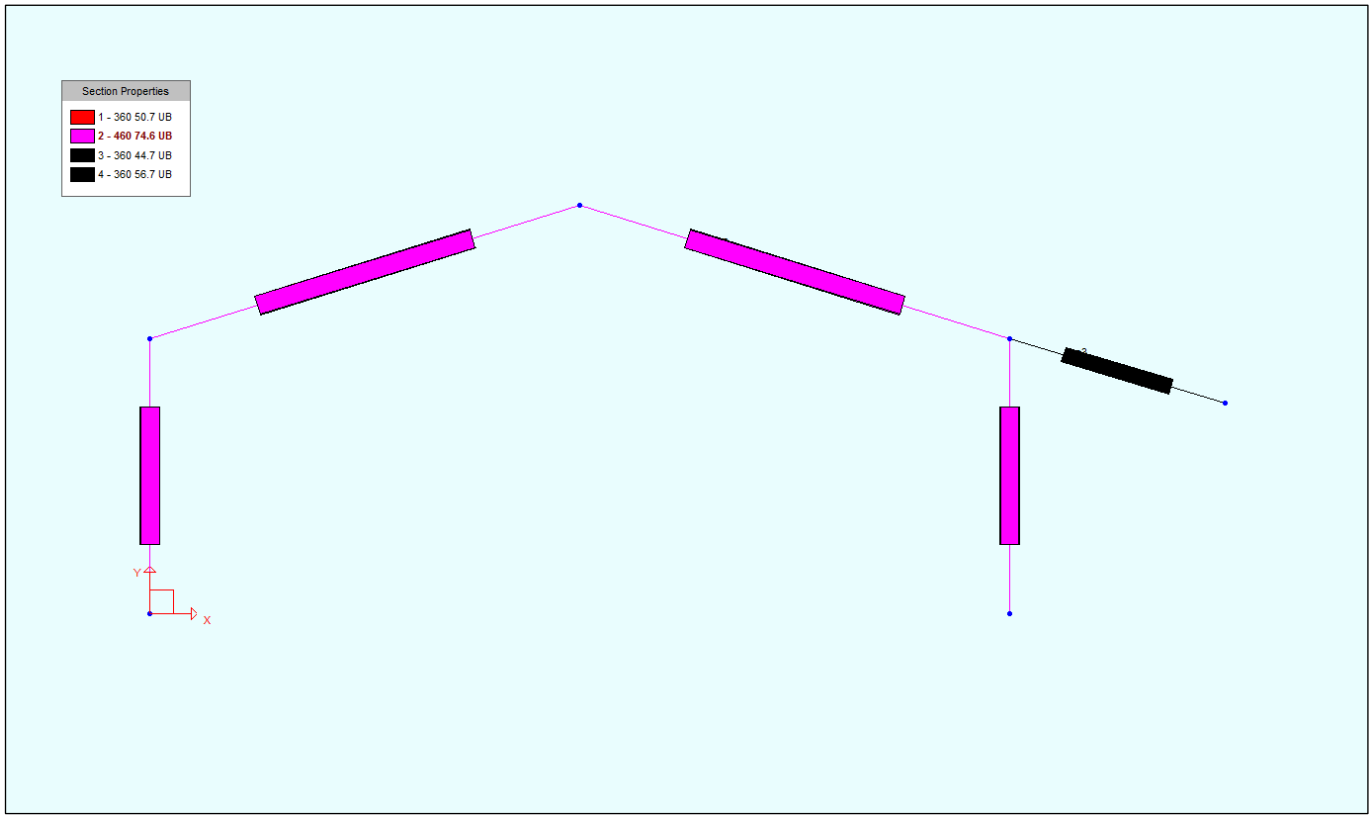
Project Name: Somerset Civic Centre

Structure Description: Portal Frame

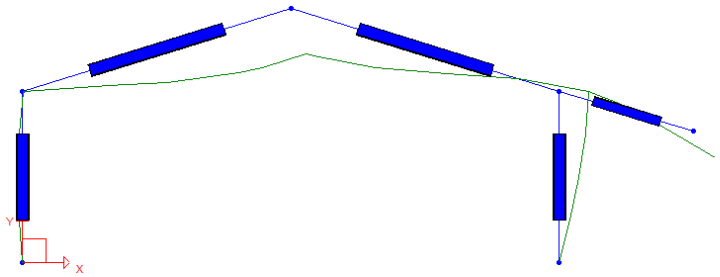
Engineer: Rhys Kilpatrick

File Name: P:\03 - Projects\6028 - Somerset Civic Centre\Calculations GLE\Structural & Civil\01 - Working Directory\110419 - Portal Frame\Portal Frame.TEL

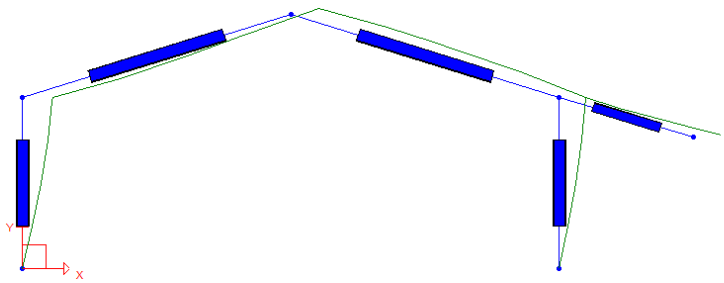
MEMBER SIZES



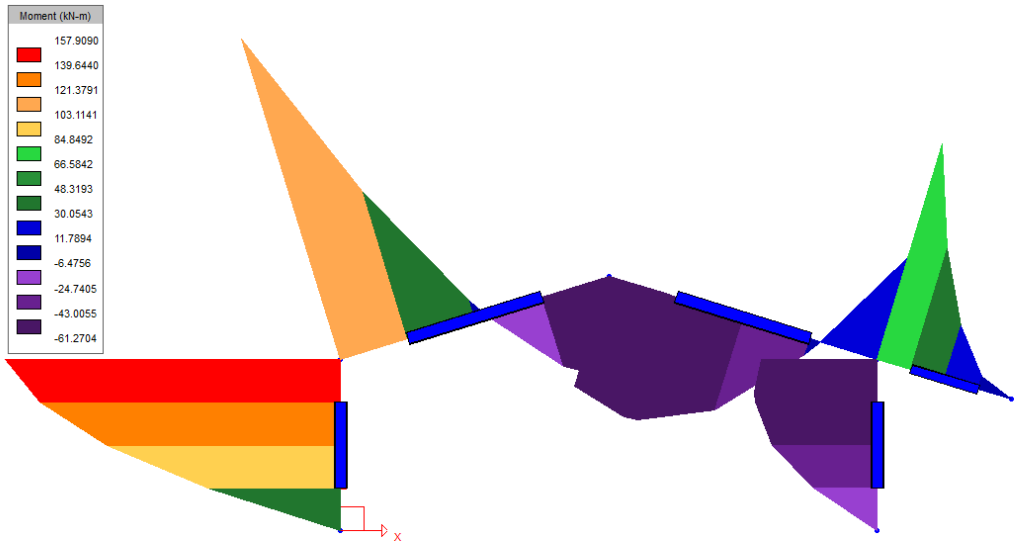
DEFLECTION



DEFLECTION WIND



WIND BENDING



DEAD&LIVE BENDING