Suite 2, Level 1
33 Herbert Street
ST LEONARDS NSW 2065

PO Box 292
ST LEONARDS NSW 1590

T 02 9438 5098
F 02 9438 5398

www.acor.com.au

ENGINEERS

MANAGERS

INFRASTRUCTURE PLANNERS

DEVELOPMENT CONSULTANTS

SSD – 10371

Trinity Grammar School, Summer Hill Campus - The Renewal Project

Structural Services

ACOR Project No.: SY180898

Revision No.: 02

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REVISIONS

Revision	Date	Purpose	Prepared By	Approved By
00	15/11/2019	Draft issue for Peer Review	Bradley Martin Dale Lenden	Chris Rowse
01	05/12/2019	Final Issue	Bradley Martin Dale Lenden	Chris Rowse
02	04/02/2020	Issue for SSDA	Brad Martin	Chris Rowse

Review Panel	
Division/Office	**Name**

Unless otherwise advised, the parties who have undertaken the Review and Endorsement confirm that the information contained in this document adequately describes the conditions of the site located at corner of Seaview St, Prospect Rd and Victoria St, Summer Hill, NSW.

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1 Project Overview

1.1 Aims and Objectives

The following objectives have been identified as forming the basis of the proposed development of the existing educational establishment:

- Create an education precinct to create a high-quality teaching and learning environment for staff and students;
- Establish additional floor space to increase availability and efficiency of teaching functions for Trinity Grammar School Summer Hill Campus;
- Improve site access, car parking and surrounding traffic functions in the precinct;
- Strengthen pedestrian linkages throughout the campus;
- Enhance the overall campus aesthetic, upgrade the public domain to create visually interesting transitions through the campus, and promote the heritage elements of the campus;
- Ensure minimal environmental impact;
- Maintain the significant green fields assets and provide opportunities for new outdoor environments;
- Ensure development is compatible with surrounding development and the local context; and
- Create a safe environment to support and nurture the boys growth.

The site and proposed design are considered to meet the objectives of the project as it allows for development on land that has been previously used for educational purposes.

1.2 Description of the Proposal

The proposed development seeks detailed built form approval of new teaching and educational facilities, as detailed below:

- New five (5) storey building at the heart of the Campus to accommodate contemporary, flexible teaching and learning spaces;
- Improve movement and flow for students, with better east-west and north-south links across the school grounds and between levels, including more accessible connections between the Junior School, ovals and car park, and providing strong visual and physical connections;
- Renewal and Refurbishment of existing teaching and learning facilities;
- Reconfiguration and connection of underground car park improve traffic flow for the school drop-off and pick-up zone and improve the safety of boys and visitors who enter the school grounds as pedestrians from Victoria Street;
- New multipurpose pavilion between Ovals 1 and 3 containing a championship size basketball court with practice overlay, spectator seating and amenities;
- Demolition of school-owned residences at 46, 48, 50 and 52 Seaview Street, improving the existing service, maintenance and delivery facilities;
- Improvement and extension to Junior School outdoor teaching, assembly and recreational area.

2 Site Data

Note: Reports prepared by third parties are taken at face value and are included into the design documentation as such. ACOR will not be responsible for incorrect recommendations and advice by third parties.

ACOR's design will be undertaken under the assumption that any third-party data supplied has been prepared by competent qualified professionals vetted by the Client.

2.1 Geotechnical Report and Site Description

An initial geotechnical site investigation report has been prepared by *Douglas Partners* for the Trinity Grammar site referenced *86861.00* dated September 2019.

The anticipated soil conditions are likely to consist of a fill, overlaying residual clays, which are in turn underlaid by weathered Ashfield Shale which varies from very low to medium strength as the depth increases.

While ground water was encountered at depths of approx. 2.9m in some monitoring wells, the Geotechnical assessment considers this to be perched seepage rather than regional groundwater table.

2.1.1 Retaining Walls, Shoring and Temporary Batters

The geotechnical report indicates that temporary batters of 1(H):1(V) may be implemented for cut depths up to 3m in the fill, residual clay and weathered rock materials. Beyond this depth, intermediate benches may need to be implemented to reduce the overall slope angle.

Table 5 of the report provides material and strength parameters for the design of excavation support structures, refer extract from Geotechnical report below;

Table 5: Material and Strength Parameters for Excavation Support Structures

Material	Bulk Density (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Ultimate Passive Earth Pressure (kPa)
Fill	20	0.4	0.6	-
Firm to Stiff Clay	20	0.35	0.5	75
Very Stiff to Hard Clay	20	0.3	0.45	150[1]
Class V/IV Shale	22	0.2	0.3	500[1]
Class III Shale	23	0.1	0.15	2000[1]
Class II Shale	24	10 kPa	10 kPa	6000[1]

Notes: [1]Only below bulk/detailed excavation level

The Report does not recommend the use of cantilevered walls to support adjacent structures.

2.1.2 Foundations

The Geotechnical Report recommends that all building foundations are founded in materials below the fill and topsoils. This material will be shale bedrock.

Based on the depth to quality rock, and the foundations used on other buildings across the site, it is likely that piled footings will be utilized under the large column loads anticipated. An extract of the materials and strength as nominated in the Geotechnical report, is presented below;

Table 7: Design Parameters for Bored Piles

Material	Allowable End-Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)*	Ultimate End-Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa)*	Young's Modulus (MPa)
Class V Shale	700	50	1,500	100	75
Class IV Shale	1,000	100	3,000	150	150
Class III Shale	3,500	350	10,000	700	500
Class II Shale	6,000	600	30,000	1,000	1,500

Notes: *Pile socket should be clean and roughened to achieve these shaft adhesion values

2.1.3 Site Classification

Due to the presence of uncontrolled fill, the site is classified as Class "P" in accordance with AS2870-2011 Residential Slabs and Footings.

The site classification can be improved to "M" when slabs on ground and footings are founded in the residual clay layers.

2.1.4 Seismicity

A Hazard Factor (Z) of 0.08 would be appropriate for the development site in accordance with Australian Standard AS 1170.4 – 2007 Structural design actions – Part 4: Earthquake actions in Australia. The site sub-soil class would be Class Ce.

3 Australian Standards and Specifications

The structural design of the development shall be carried out in accordance with the provisions of the relevant Australian Standards, Council Standards and the Building Code of Australia, and in accordance with the accepted practice and principles of structural engineering.

Where there is no relevant Australian Standard or Code, use may be made of appropriate overseas standards or recognised method of analysis, design or testing.

The following Australian Standards have been identified as relevant:

- AS1170.0: 2002 – Structural Design Actions : General principles
- AS1170.1: 2002 – Structural Design Actions : Permanent , imposed and other actions
- AS1170.2: 2011 – Structural Design Actions : Wind actions
- AS1170.3: 2003 – Structural Design Actions : Snow and ice actions
- AS1170.4: 2007 – Structural Design Actions : Earthquake Actions
- AS2159: 2009 – Piling: Design and Installation
- AS3600: 2018 – Concrete Structures
- AS3700: 2018 – Masonry Structures
- AS4100: 1998 – Steel Structures
- AS4600: 2005 – Cold Formed Steel Structures

4 Regulatory

4.1 Building Code of Australia

The structure is to be designed in accordance with the relevant parts of the Building Code of Australia (BCA). Refer to the BCA reports prepared by Design Confidence.

Based on our understanding, the following items are deemed to be appropriate for the structural design;

Description	Specification
Classification;	Class 9b
Rise in Storeys;	7
Importance Level	3
Annual Probability of Exceedance for Wind (Area A2; non cyclonic)	1:1000
Annual Probability of Exceedance for Snow	N/A
Annual Probability of Exceedance for Seismic	1:1000
Type of Construction	A
Main Building (Fire Rating)	
External columns	120/-/-
Common walls	120/120/120
Lift/Stair walls	120/120/120
Internal Columns	120/-/-
Floors	120/120/120
Roofs	120/60/30

We understand that a Fire Engineer Report is also being completed for the project which may change the required FRL for some of the elements noted above, however we expect the above criteria to be a minimum.

5 Loadings

Generally, all loadings and load combinations will be in accordance with the latest version of AS1170.0: 2002. Loading diagrams reflecting the loads indicated below are to be developed as part of the drawing documentation

5.1 Dead Loads

Dead loads shall be calculated as provided for in the latest version of AS1170.1:2002 Dead and Live Loads. The major dead loads to be used in design include the following:

Material Density

▪ Reinforced concrete generally	25kN/m3.
▪ Lightweight concrete	18kN/ m3
▪ Water (in Storage Tanks)	9.8kN/ m3
▪ Masonry	To be determined but not less than: (kN/m2 vertical) 140mm hollow block 1.8 190mm hollow block 2.1 Single skin brick 2.55 Double skin brick 5.10
▪ Soil (in planters)	18kN/m3-
▪ Glazed panels (windows, doors)	25kN/m3.
▪ Structural Steel	78kN/m3.
▪ Timber	
– Softwood	6kN/m^3 minimum
– Hardwoods, nominally KDH	10kN/m^3 minimum
▪ Tiling and grout	To be determined but not less than 20kN/m^3
▪ Ceilings and miscellaneous dead load	0.25kPa. minimum
▪ Services Ducts, Lighting etc.	0.25kPa. minimum
▪ Lightweight Partitions	0.5 KPa (vertical)

5.2 Floor Live Loads

Live loads shall be calculated as provided for by the latest version of AS1170.1:2002 – Permanent, Imposed and other Actions.

The live loads shown below should be applied with flexibility of future use in mind. For example, a lesser loading than generally required over a large adjacent area should not be used for one room just because that room has a lower code loading requirement. Generally, a minimum Live Load UDL of 3kPa will be applied to all floor areas to allow for future flexibility of use.

The major live loads to be used in design include the following (distributed loads shown - point loads as per code or lift/plant manufacturer):

Classrooms	3.0kPa
Public Assembly Areas (with fixed seating)	4.0kPa
Public Assembly Areas (without fixed seating)	5.0kPa
Compactus areas	10 kPa minimum (localized as indicated on architectural drawings)
Storage	5.0kPa, based on 2.1m of maximum storage height
Corridors and Lift lobbies	4.0 - 5.0kPa
Balconies and Terraces	Equal to area providing access but net less than 4.0kPa
Plant Rooms and BOH areas	5.0kPa min (actual plant loading will be used if greater than 5.0 kPa as per architectural drawings and suppliers loading requirements)
Public and Fire Stairs	4.0kPa
Commercial/Institutional Kitchens	5.0kPa
Cool Rooms	15.0kPa
Pergolas, Awnings, Canopies	1.5kPa
Roof Non-trafficable	0.25kPa minimum.
Substation	7.5kPa
Ovals used for Fair Activities	Not less than 5kPa. T.B.C.
For other areas not defined	refer to AS1170.1

5.3 Superimposed Floor Dead Loads

Generally, a superimposed dead load allowance of 1.0 to1.5kPa will be applied throughout the structure to account for partitions, ceilings, services, fixtures and other items fixed to the slabs.

Partition walls	0.5kPa minimum
Ceilings/services	0.5kPa minimum (Concentrated actions to be applied where operable walls are required)
Masonry walls	Calculated for each case.
Applied toppings (including roof membrane	1.5kPa minimum. Actual loads are to be calculated and

and topping)	include allowances for falls, membranes, toppings, etc.
▪ Ovals over suspended slabs	12.5kPa (600mm soil zone + toppings for falls)
▪ Landscaped areas	T.B.C. following review of Architectural and Landscape architectural plans.

5.4 Earth Pressures

At rest K_0 value will be adopted for equivalent soil pressures against rigid walls and supports.

Stability of non-rigid cantilever retaining walls will be designed for an active K_a value.

Refer Section 2.1 for coefficient values.

5.5 Surcharge Loads

During construction it has been assumed surcharge loads will not exceed 10kPa adjacent to the excavation and retaining walls. Additional surcharge load requirements will be incorporated into the design as required.

Surcharge loading of adjacent structures will be calculated on a case by case basis.

5.6 Hydrostatic Pressures

The permanent shoring walls and retaining walls will be typically provided with a vertical drainage system consisting of vertical strip drains and granular drainage material with a rear horizontal drainage pipe respectively. Therefore, no hydrostatic pressures will be included in the design.

The basement slab will be provided with subfloor drainage consisting of a drainage base layer and a number of drainage pipes connected to pump out sumps to minimise the potential for any hydrostatic uplift pressures. Regular clean out points should be allowed for.

It is not anticipated that the site will be subjected to any groundwater issues as noted in the geotechnical report, refer to section 2.1.

5.7 Ultimate Limit State Wind Loads

The wind pressures will be calculated using the following parameters:

Regional Wind Speed Parameters		
Code	AS1170.2:2011	
Location	Region A2	
V_R	48m/s	1:1000 Annual Probability of Exceedance
M_s	1.0	
M_t	1.0 to 1.05	
M_d	1.0	Any direction
Terrain Category	3 (Typical)	Typical throughout.

$M_{(Z,cat)}$	0.89 (TC 3)	Varies with height
General Pressure coefficients		
$C_{p,eW}$	+0.8	Varies with height (Refer AS1170.2:2011)
$C_{p,eL}$	-0.5	Refer AS1170.2:2011
$C_{p,eS}$	-0.65	Refer AS1170.2:2011
K_a	1.0 max	Refer AS1170.2:2011
K_c	1.0 max	Refer AS1170.2:2011
K_l	1.0 to 3.0	Refer AS1170.2:2011
K_p	1.0	Refer AS1170.2:2011
$C_{p,i}$	-0.3 or 0.0	Refer AS1170.2:2011

5.8 Earthquake Loads

Code	AS1170.4:2007	
Structure Classification	Importance Level	III
	Annual Probability of Exceedance	1:1000
	Location	Sydney
	Probability Factor	Kp =1.3
	Hazard Factor	Z=0.08
	Founded	Class Ce
	Structure height	H>12m, H<50m
Earthquake Design Category		EDC II

5.9 Snow Loads

In accordance with AS1170.3:2003, Snow loadings are not applicable for the location of this project.

5.10 Lateral Loading System

Generally, in order to provide future flexibility to buildings, stability will be provided by walls contained within lift cores, stair cores, riser walls, etc and column to beam connection stiffness. The use of shear walls remote from cores will be avoided to optimise future flexibility of structure.

5.11 Load Contingencies

Not Applicable.

5.12 Load Combinations

All elements of the structure shall be checked for load combinations set out in AS1170.0:2002 Section 2.

5.13 Live Load Reduction

Live load reduction will be applied to vertical elements in accordance with AS1170.1:2002.

Live load reduction will not be applied to slab/ beam elements in accordance with AS1170.1:2002.

6 Structural Design Criteria

The principal design criteria are:

- **Post Disaster Function**. The building will not be designed for post disaster function, adopting a Building Importance Level of 3.
- Annual probability of exceedance for seismic activity (1 in 1000 year earthquake)
- Annual probability of exceedance for wind (1 in 1000 year wind)

The design has made no allowance for blast/explosion, vehicular or aircraft impact, etc on the building structures.

- **Strength** and ductility of the building and all its components shall be adequate to resist the load combinations in accordance with AS1170.0:2002 and the relevant current code limit state provisions.
- **Stability** of the building and in particular the stability of the individual primary lateral load resisting structural elements when subjected to wind and/or seismic loading, using the code load combinations, shall be maintained in accordance with AS1170.0:2002 Dead and Live Loads and Load Combinations
- **Deflection** of the building as a whole and inter-storey height deflections when subjected to serviceability limit state wind loads and/or seismic loading shall comply with the following:

Total lateral deflection shall not exceed height/500 for wind loads

Inter-storey drift shall not exceed 1.5% of the storey height under Ultimate Limit State earthquake.

- **Floor Deflections** calculated to AS3600/AS2327.1 or AS4100 as appropriate and limited to span/250 total long-term deflection or maximum 25mm and span/500 incremental for lightweight partitions and well-articulated masonry walls.
- **Durability** to be to AS3600:2018/AS4100:1998 provisions

The School is to confirm their requirements, however, in general the design life has been specified for the following structural elements:

– Precast concrete façade element	50 years
– Sealants	25 years
– Concrete	50 years
– Structural steel fabrication	50 years
– Exposed steel work painting	15 years

- **Fire rating** to AS3600:2018/AS3700:2018/AS4100:1998 as appropriate and the Building Code of Australia. Fire ratings for structural elements as per section 4.1.
- **Natural Frequency of floor elements.** Floor vibration design response to occupant activity to generally comply with recommendations of AS2670.
- **Adaptability, Flexibility and Expandability.** The School is to confirm the requirements of future proofing, however the following will be adhered to:
  - The building structural system and grid will optimise functionality and future adaptability and expansion avoiding internal shear walls and transfer beams where possible.

- The use of post-tensioned concrete will not limit future flexibility in regard to placement of penetrations, etc relative to any other structural system.

- **Set Downs.** Areas requiring set-downs are to be identified by the architect and the floor designed appropriately.

7 Materials

7.1 Concrete

Reinforced and prestressed concrete, including elements reinforced with permanent steel formwork and plain concrete, shall comply with the provisions of AS3600:2018 and the standards referenced therein, in terms of analysis, design, and specification of constituent materials including reinforcement.

7.2 Structural Steel

Structural steel, including steel used in composite construction and connections, shall comply with the provision of AS4100 and standards referenced therein, in terms of analysis, design and the specification of constituent materials.

Structural steel with strength grades higher than provided for by AS4100:1998 may be used subject to compliance with suitable overseas standards, research results or accepted practice.

7.3 Masonry

Masonry structures shall comply with the provisions of AS3700:2018 and the standards referenced therein, in terms of analysis, design and the specification of constituent materials.

7.4 Timber

Timber elements, where permitted by the NCC, shall comply with the provisions of AS1720.1:2010 and the standards referenced therein, in terms of analysis, design and the specification of constituent materials.

7.5 Aluminium and Glass

Aluminium and glass (eg. in facade elements designed by the façade consultant) shall comply with the provisions of AS1664:1997, for aluminium, and AS1288:2006, for glass, and the other standards referenced therein, in terms of analysis, design and the specification of constituent materials.

8 Building Construction

8.1 Structural Form

The general building form has been determined by functional and architectural planning requirements.

A description of the likely structural solutions for each of the key building areas is noted below;

8.1.1 Arrow Building

The Arrow Building is to function as the link between the key teaching and learning spaces and will sit on the western side of these spaces.

The structure will consist of exposed steel structure in the form of double UC columns (or similar) and UB beams supporting the multi floor structure with expressed stairs and a lift providing the link between levels. The floor slabs are likely to be constructed from a permanent formwork, metal deck steel profile, with a suspended ceiling concealing Hydraulic and Electrical services.

The structural solutions will be developed closely with the architect and fire engineer to ensure the performance criteria of the NCC is meet, especially with the steel framing elements.

8.1.2 Teaching and Learning Building

The main teaching and learning building will be over 5 levels (plus basement) based on a uniform column grid with minimal or no transfers between floors. The building is to link with the Arrow building and adjacent existing structures.

High level concept designs have been carried out on this structure with a post tensioned banded slab or 2-way flat slab considered the most appropriate to minimise the structural zone and provide adequate clearance for building services.

8.1.3 Multipurpose Hall

The Multipurpose hall is proposed for the southern end of the site and will provide space for 2 practice or 1 championship basketball courts. It is anticipated that this hall will provide an essential function to the school as a flexible multipurpose space.

It is anticipated that the building will be a steel framed superstructure with deep steel trusses spanning 28m. Consideration of the truss depth will need to ensure adequate clearance of the basketball courts.

The floors of the hall and courts are to span over the delivery and loading area. Key design considerations will be ensuring sufficient head room for the delivery / rubbish trucks, whilst also providing a rigid level surface, suitable to a championship basketball court.

8.1.4 Southern Car Park and Oval

The renewal project also includes the construction of a new basement carpark what will extend from under the Multipurpose hall to under the South Western most oval of the school grounds. The client has expressed a preference for this oval to be constructed with a 600mm soil zone over the top of the concrete structure to allow for natural grass.

This oval is also often used for community gatherings and fair like activities which is to be factored into the structural design.

A post tensioned band beam and slab construction supported by blade columns is considered to be most appropriate structural form for the structural slab over the carpark.

8.1.5 Modifications to Existing Buildings

Part of the Renewal project scope includes the modification to existing buildings in various locations across the school. These modifications range from internal fit outs and refurbishment, all the way through to wholesale structural modifications and changes.

In each case, the proposed modifications will be reviewed in depth against the available documentation records of each structure, with the final design requirements to be confirmed as part of the detailed design and documentation phases of the project.

8.2 Foundations

The foundations will be designed in accordance with the recommendations provided in the Geotechnical Report prepared by Douglas Partners, refer to section 2.1. It is likely that piled foundations to shale bedrock will be provided to support the concentrated large column loads. This is consistent with the footing design employed throughout the school on various developments and will be utilised to avoid any differential settlement between structures.

8.3 Lateral Stability

The building will be required to resist lateral loads due to wind and earthquake actions. From the form and shape of the building, earthquake and wind loading will be determined to ensure the most severe lateral load imposed on the building is analysed and resolved in the design.

In order to resist these lateral loads, all methods of stability will be considered including moment resisting frames and braced frame systems.

Consideration and adequate detailing will be given to movement joint locations and the interaction of adjacent buildings under the lateral forces.

Where deemed necessary, seismic upgrades may be undertaken on existing buildings and structures where there is a change of use.

8.4 Basement Floors

Basement floor slabs will typically be a slab on ground provided with a drainage base course layer draining to a nominal network of drainage pipes and pump out sumps. Subfloor drainage systems will permit a “dry” internal environment and ensure floor slabs are not subjected to any hydrostatic uplift forces.

Floor slabs will be cast in longitudinal panels with saw cuts and dowel joints provided at regular intervals to allow for movement and minimise the risk of potential cracking. Treatment of floor finishes over these joints requires careful consideration and detailing as long-term maintenance issues may arise if they are not treated appropriately.

8.5 Temporary Shoring and Staging

Temporary shoring and staging will be considered in all locations where temporary excavation batters and space does not permit alternative solutions. These shoring walls will be required to be designed in accordance with the geotechnical report requirements.

8.6 Retaining Walls

Where open batter excavation is proposed, reinforced core filled blockwork retaining walls are typically proposed. These are to be founded on strip footings on suitable bearing strata identified within the Geotechnical Engineers report.

If the design requires, it may be necessary to back prop the retaining walls prior to backfilling behind the walls. Where walls are to be propped in the permanent case with a concrete slab over, they shall not be back filled until the slab has been poured and cured.

The fill immediately behind the wall will be a granular fill or sand drainage layer to facilitate drainage behind the wall. Any ground water will be drained from behind the walls using a horizontal drainage pipe behind the wall which will drain into the subfloor drainage system in the basement.

8.7 Basement Drainage

Generally (and subject to architectural requirements), it is the intention that the basement retention/retaining wall systems shall not be “tanked” or impervious to ground water. Accordingly, should ground water permeate through the walls it is proposed such water is collected within an open drain along the perimeter of the basement floor slab and drained to the subfloor drainage system in the basement, then pumped out to the stormwater system designed by Civil and Hydraulic Engineers for the project.

8.8 Transfer Elements

There will be a number of localised transfer elements to accommodate the architectural and functional layout. These column transfers will be supported by concrete beams and thickenings. Transfers are to be limited (subject to architectural layouts and planning) wherever possible to avoid the need for deep structural elements fouling with the required ceiling heights and services zones.

8.9 Partitions and Walls

For the structural design it has been assumed that generally partitions will be non-load bearing, lightweight dry wall construction.

Some limited areas, such as plant rooms, utility areas, operating suites, etc have been designed for solid/blockwork non-load bearing walls to achieve the required FRLs.

8.10 Lift and Stair Walls

It is proposed that these walls will be designed as reinforced concrete walls to provide vertical support to the adjacent slab areas as well as the stairs.

These walls will also be used to provide lateral stability to the building frame to optimise the building system and maximise the flexibility of the structure and its ability to accommodate changes in the future through the avoidance of internal shear walls within the building and functional space.

8.11 External Façade

At the time of preparing this report the façade design had not yet been finalised.

8.12 Work by Others

8.12.1 Waterproofing

We understand that unless noted elsewhere all roofs, balconies, concourse areas and wet areas of amenities, will be waterproofed as specified by the Architect or other specialist consultant.

9 Miscellaneous Considerations

9.1 Constructability

The structural design is to proceed in consultation with the client, project manager, architect and early contractor involvement (ECI) to ensure that comments on staging, constructability, sequencing, craneage, access requirements, and general buildability etc are adequately considered and reflected in the structural details.