



Special Education Needs (SEN) School as an example of conversion of CAD based design data into BIM Common Data Environment with the use of BIM designing programme



I. Introduction



JSA Architects, an Architectural Practice from Dublin started designing work for the Special Education Needs School (SEN) building in 2013. The task has been assigned Project Number of 3312 in the Company's Project Register.

The Client is St Michael's House (SMH), a charity organisation that helps people with intellectual and physical disability. They provide education and care facilities adapted to the needs of their service users. The service users present with varying degrees of ability from mild to moderate up to severe and profound. Most service users present with multiple issues.

The Preliminary stage of the project began from careful site investigation. SMH owned a vacant site in Ballinteer, Dublin. The Project is based on this site, although the school is temporarily located in Sandyford.



II. Site Conditions



The Site measures 5,688 sq.m area. It is located in Ballinteer, Dublin 16, north of the existing petrol station on Ballinteer Avenue with the site access to the east of it.

There is Our Lady's Girls and Boys National School located to eastern boundary of the subject site and residential houses (Broadford Rise) to the north of the site.

Both, the existing school and residential area have been defined as the areas being potentially affected by the Project.

There are the remains of a former residential building located near the southern boundary of the site. These will be removed from the site.

The site is not level in terms of its topography. The levels range from +87.77 in northwest corner to +92.40 at site south entrance.

There are mature trees located along the eastern boundary of the site. There are also trees located along the western boundary of the site abutting the open space which serves the existing adjacent residential development. The trees will be retained.

There were no existing services on site which are in use.



III. Proposed Site Plan



The proposed Site Plan took into consideration the proximity of the residential development to the north of the site, leaving an 11.0 meters set back free from the site boundary. The proposed L-shape form of the School with internal angle of 135 degrees between its wings enabled us to locate the staff car park with school bus bays in front of building entrance. The location of playground area with a sensory garden has been proposed on northwest of the building. The proposed site entrance with the series of adjacent pedestrian ramps has been located at the existing site entrance. The distance from eastern end of proposed school to existing girls' school is 34.1m and from south end of school to petrol station is 11.1m. There is a distance of 19.4m from the existing residential development to the end of the northern wing of the proposed building. In order to ensure privacy to school users, the existing palisade fencing has been proposed to be replaced with closed fencing from the petrol station side.

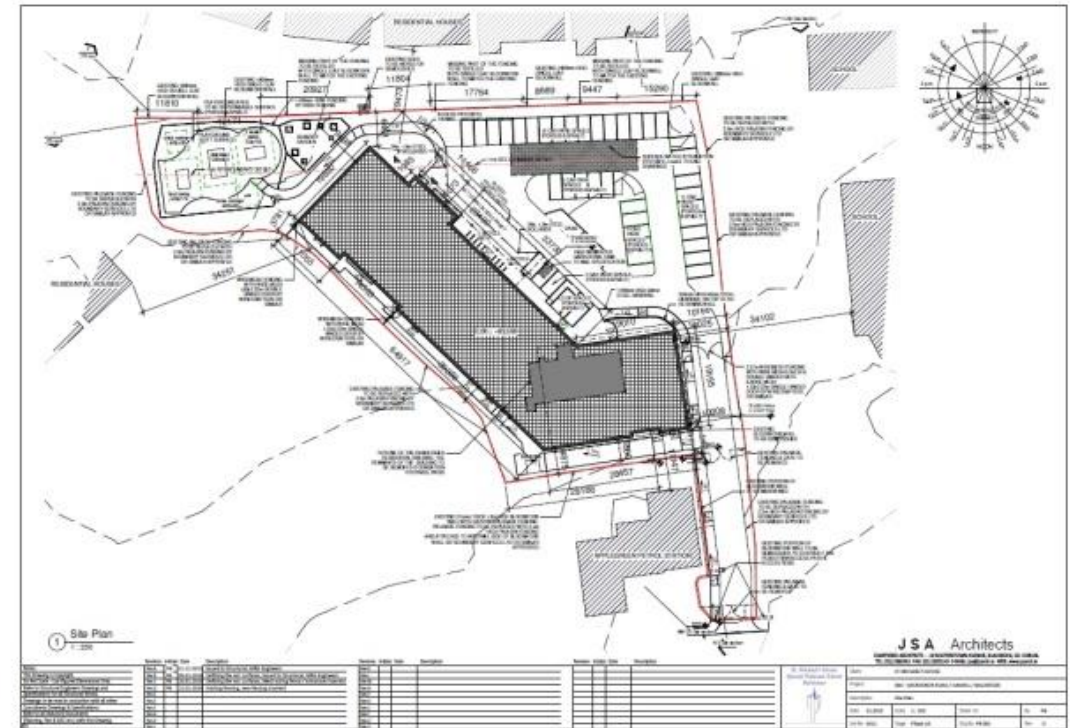


Fig. 1: Site Plan



IV. Form and Architecture



The proposed building is L-shaped. It has the highest 3-storey part located closest to the site entrance. This part contains classrooms on ground and first floor level, offices and sensory rooms on second with the exit to play area over 1st floor level and plant room above.

A 6deg roof made of *Kingspan Standing Seam Panels* on purlins sloping north, covers this part of building.

That part also contains ambulant accessible staircase with the lift and boiler room at the lower ground floor level.

The middle part is 3 storey high and contains:

- the classrooms on ground,
- kitchen, dining rooms on 1st floor with the play area of porous soft rubber floor on the top and the access to an escape stair leading to ground floor.

Fig. 2: 3D South East View





V. CAD Documentation



Based on DoES Guidelines, JSA responded with a series of CAD drawings (Site Plan, Layouts, Section and Elevations) and a report meeting the requirements of DoES's Stage 1.

Stage 2 required multidisciplinary design coordination accompanied by a Bill of Quantities and a predicted Construction Cost. In order to carry out a detailed 3d appraisal and to look at possible cost savings, Design Team Members decided to use Autodesk Revit LT 2016 software.

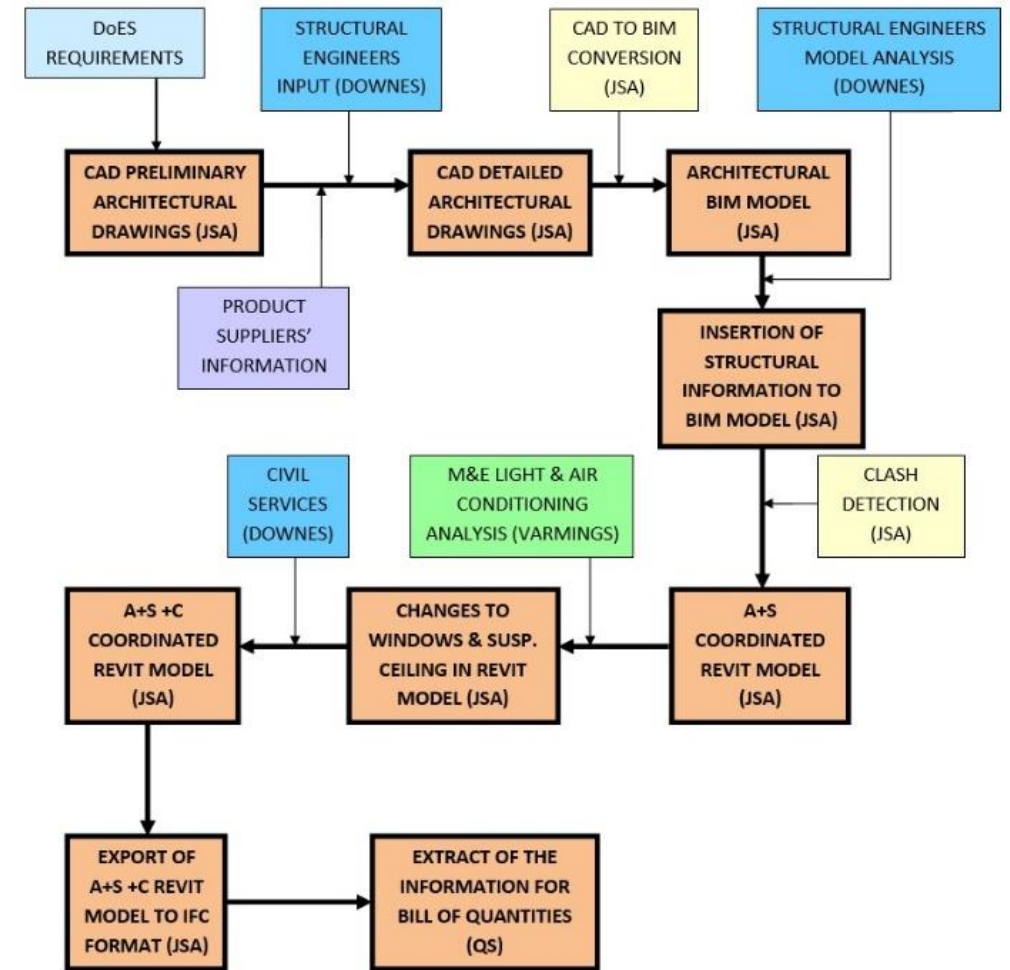


Fig. 3: Overall Process Diagram

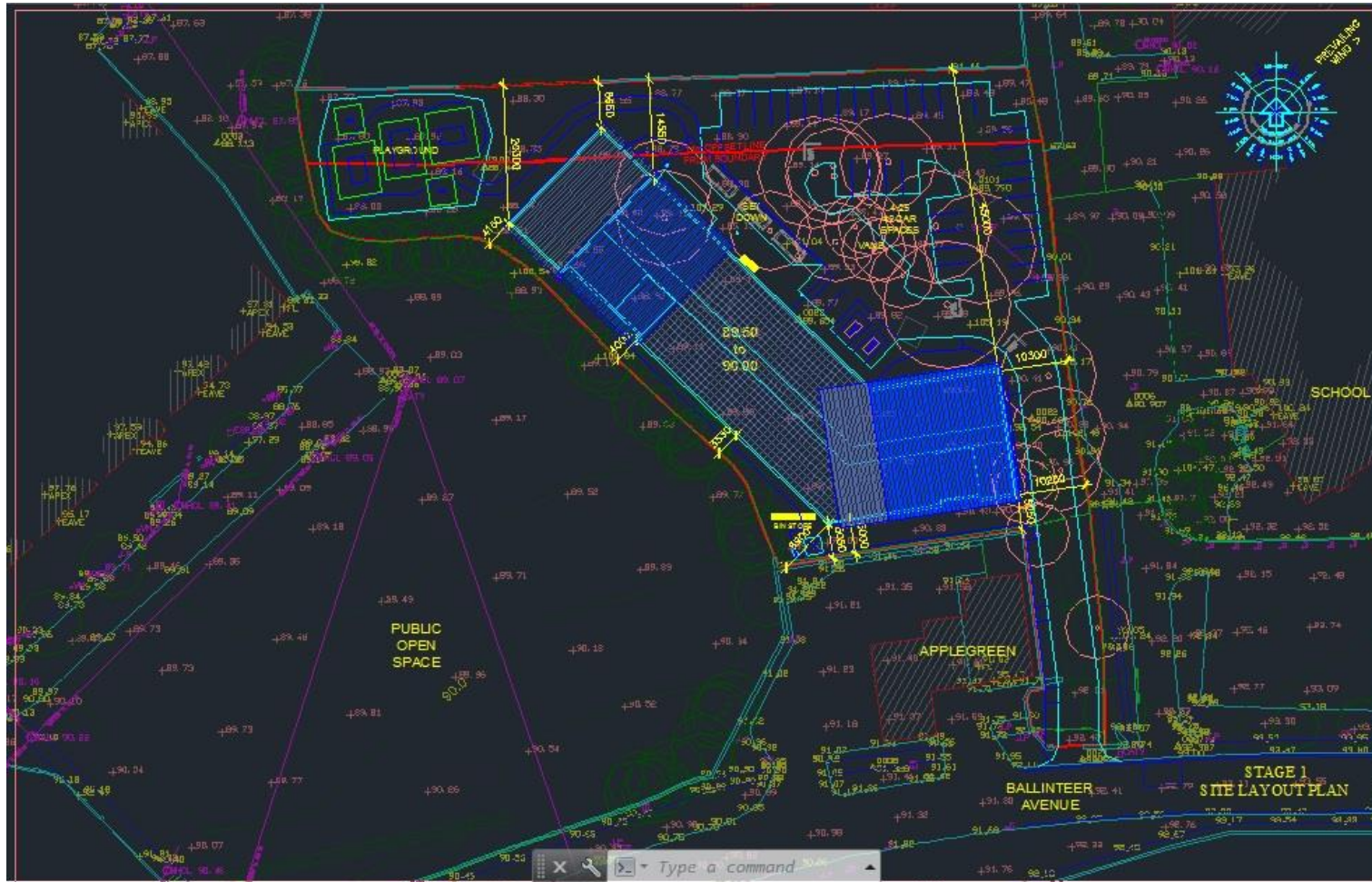


Fig. 4: Site Plan in AutoCAD

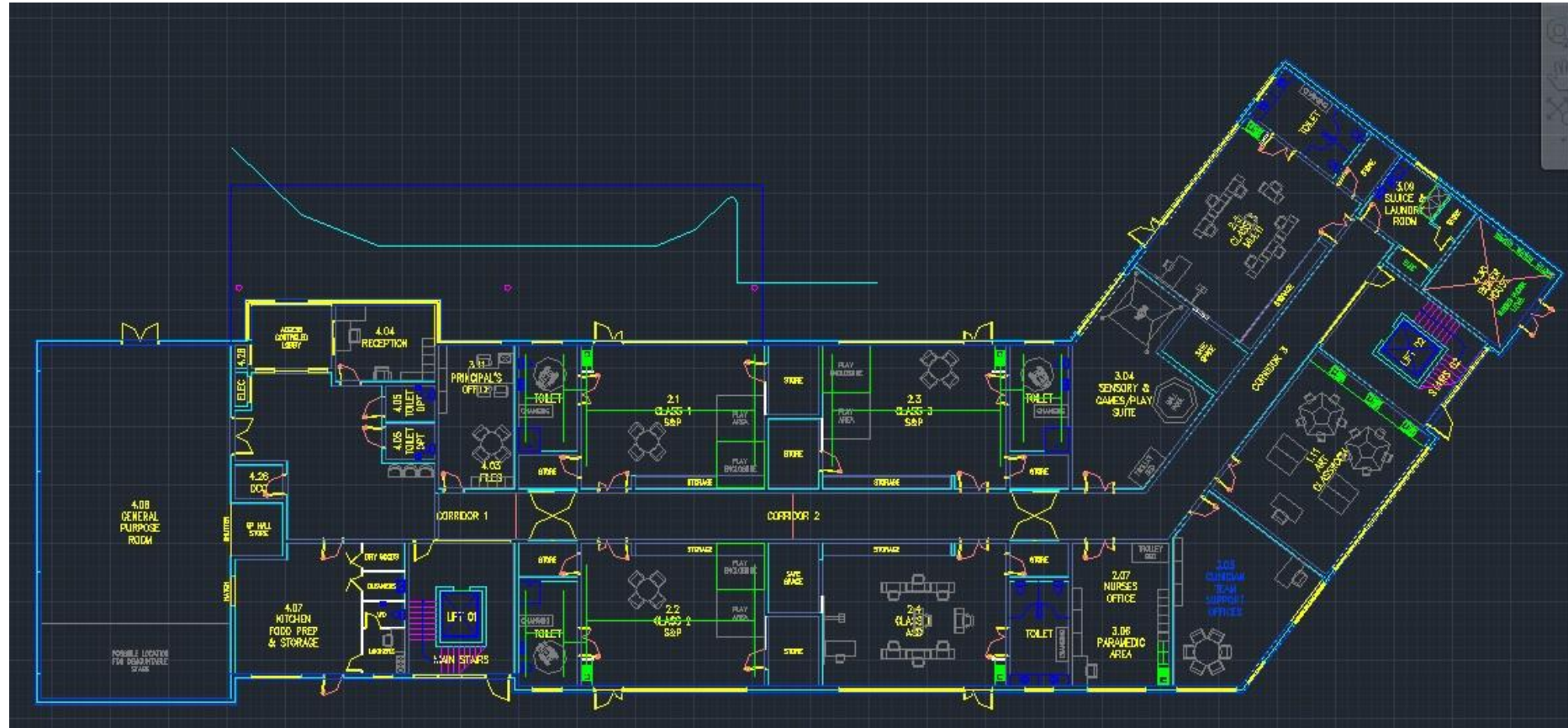


Fig. 5: Ground Floor Plan in AutoCAD

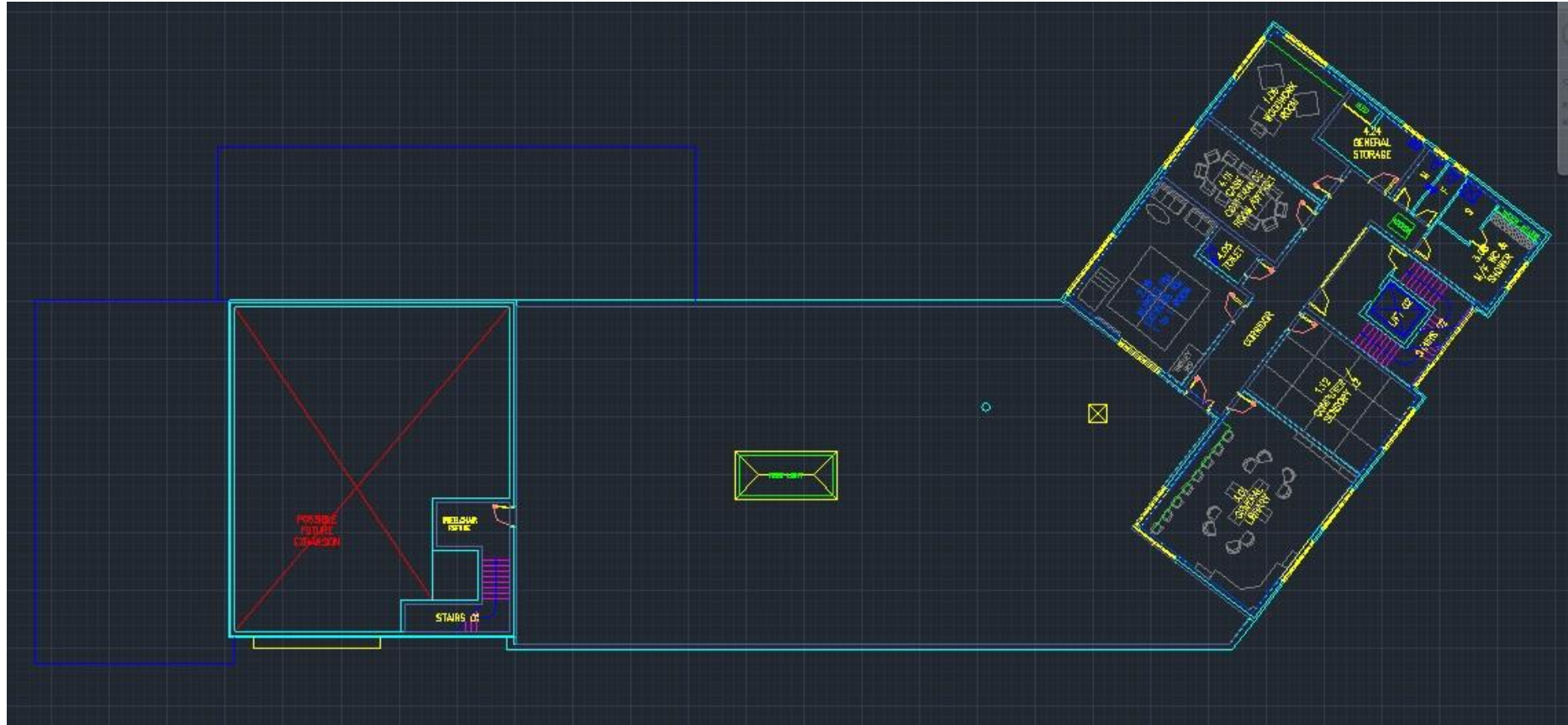


Fig. 6: Second Floor Plan in AutoCAD



VI. Revit Conversion



The AutoCAD drawings have been imported to Autodesk Revit software using 'Import CAD' tool from 'Insert' tab.

Then, using the 'Import CAD' dialogue window, the specific CAD file name has been selected (.dwg). Colours, Layers, Units, Positioning and Placement (of CAD Import) fields have been set.

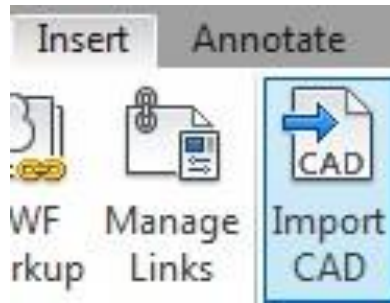


Fig. 7: Import CAD Tool on Insert Tab Process Diagram



Fig. 8: Import CAD Formats dialogue window



The CAD file has been imported to Revit and placed on a specific *Project Level*. The CAD file contained all the levels needed to start creating the model using the wall / slab / floor / roof properties as that was in the CAD drawings.

The CAD file was drawn precisely in order to avoid misalignments after the file had been imported.

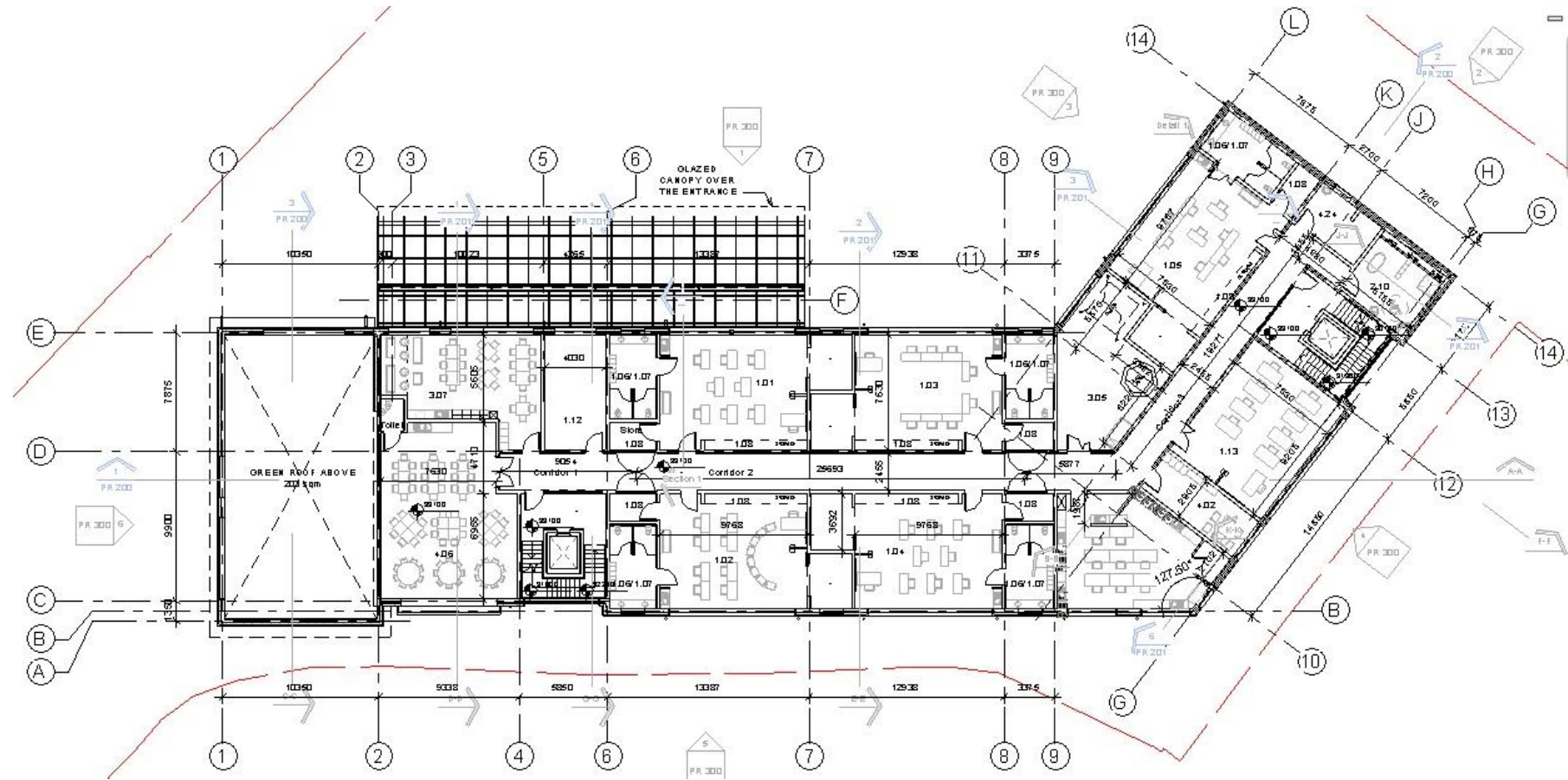


Fig. 9: First Floor Level View modelled in Revit



After 1st floor had been modelled, the second floor has been modelled and subsequently, the roof using standard Revit tools. Architectural grids have been added during modelling (in the centres of the walls).

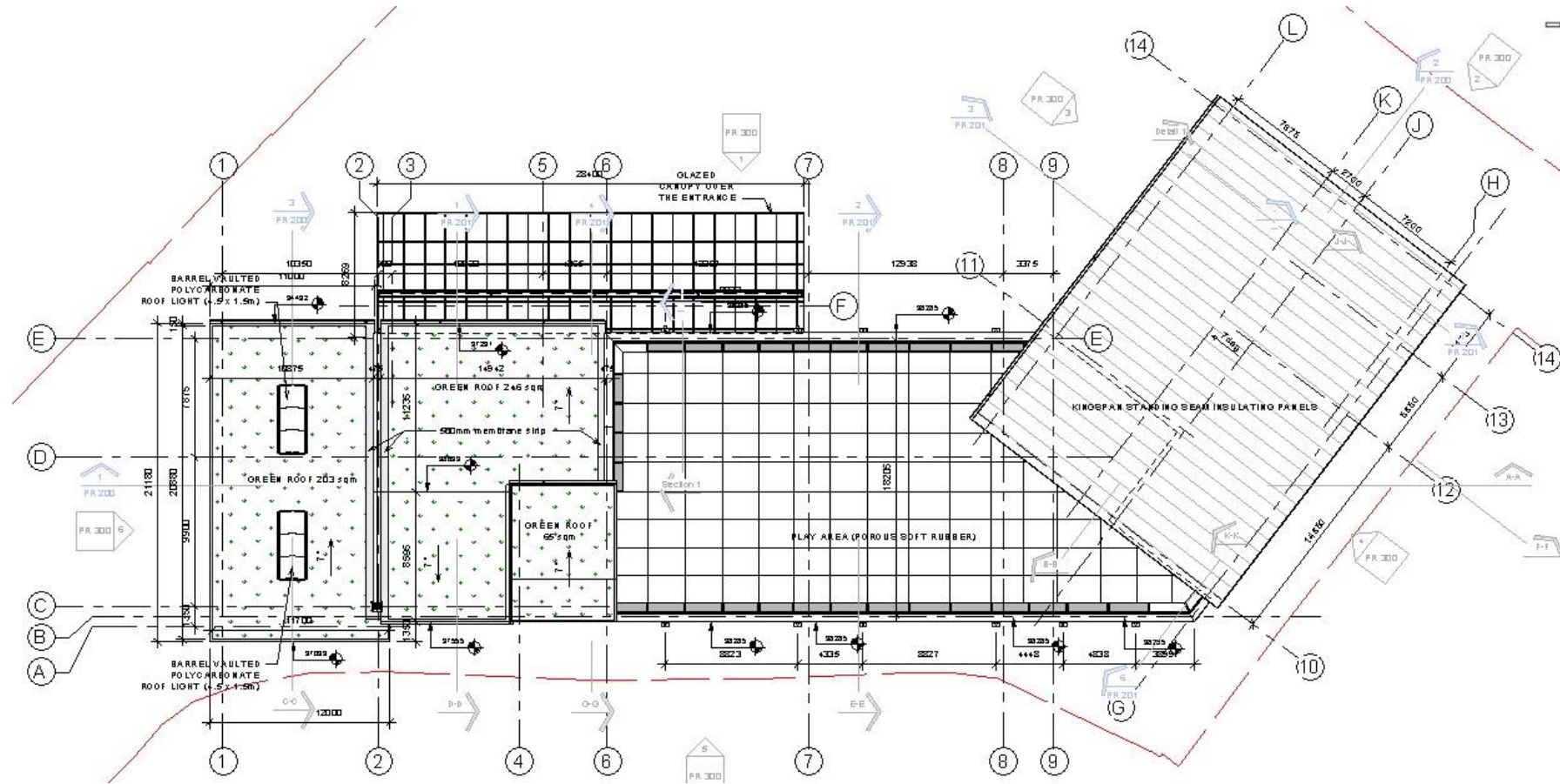


Fig. 10: Roof Level View modelled in Revit



After the building was modelled, the site model was created using the *Toposurface* Tool (under *Site* Tab) by placing points where they were located in the imported CAD file.

JSA was able to model the site using CAD file with Z-coordinates. Also, JSA could have used *Points File* (.txt) but this file did not exist at that time. *Toposurface* has been modelled by *Point by Point* method using the imported CAD file in the underlay.

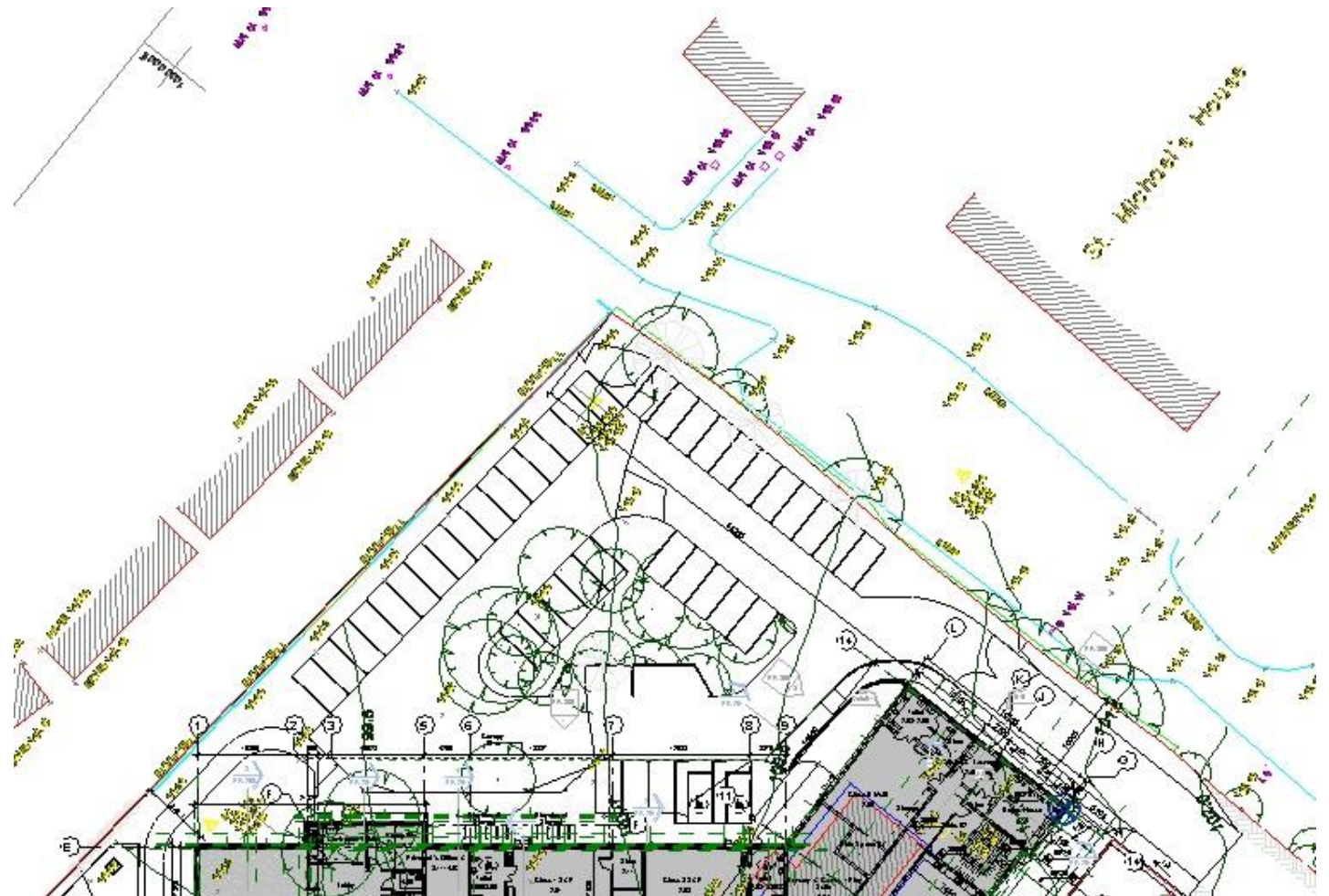


Fig. 11: Imported CAD file into Site Plan view



Dun Laoghaire-Rathdown County Council raised the issue that a specific percentage of the site area had to be designed to be soft landscape . Also it needed to be covered with porous asphalt (playground and car parking spaces) to deal with surface water run off.

Fig. 12: Modelled Site with given site surface and roof surface areas





JSA incorporated green roofs (31% of roof area) into the design (above school hall and above 1st floor level where the roof exit is located) using *Bauder XF301 Sedum Blanket* Green Roof products. Soft surface (porous asphalt) was proposed in the play area on the roof in middle part of the building (37% of roof area).

Fig. 13: : 3D View of modelled building from east





VII. Model Details



The modelled building contained a lot of architectural details to enhance its appearance. The service users needs' required additional items to be included in the project. One example was the glazed canopy at the entrance to protect service users while embarking + disembarking from mini-bus transport. This has both a functional and aesthetic purpose.

Fig. 14: Glazed Canopy over the main school entrance



The curved polycarbonated roof lights (width =1,6m with f=5) have been modelled over the school hall (using *Sloped Glazing Roof System Family*) to provide additional daylight to meet the requirements of the Building Regulations.

JSA also incorporated protective fencing around the outdoor play area located to the northwest of the building as well as the sensory garden in the form of planters.

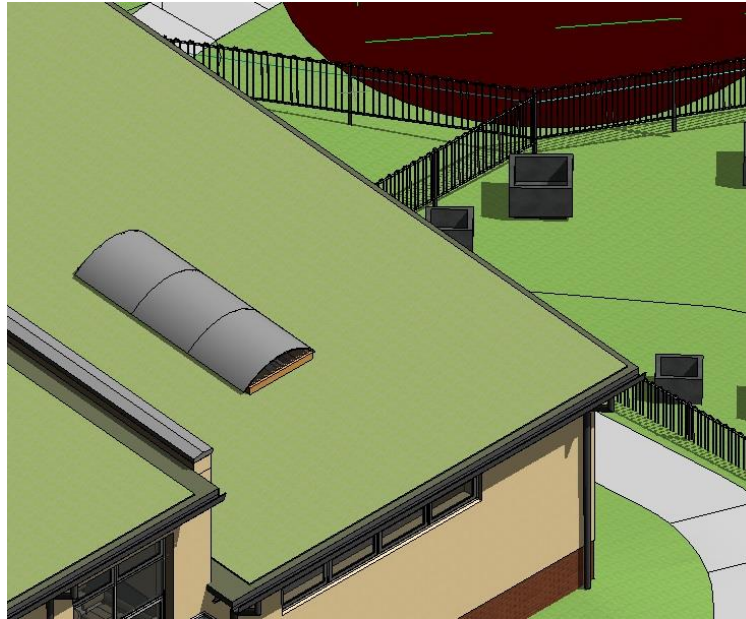


Fig. 15: Curved rooflights, protective fencing and planters

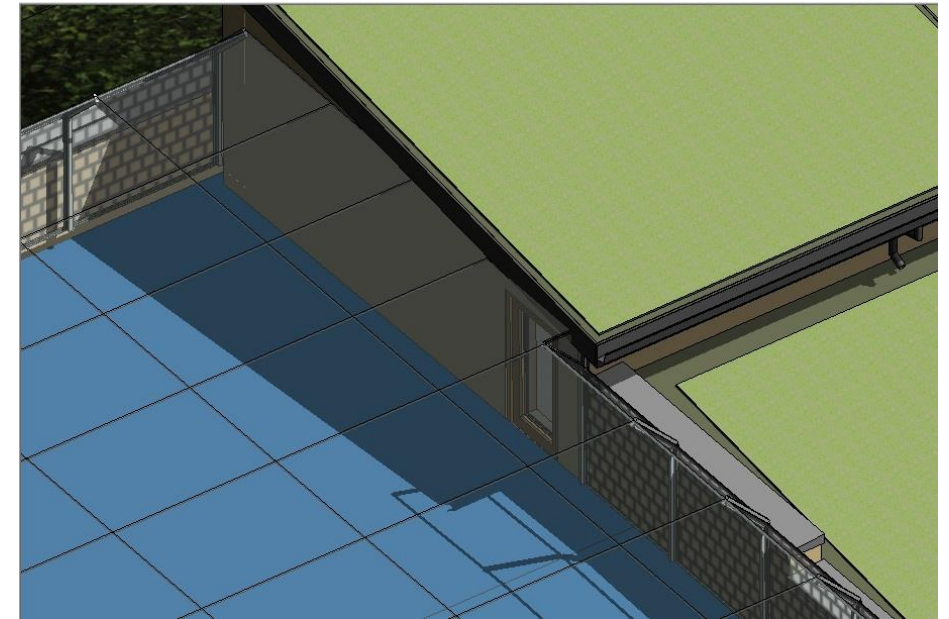


Fig. 16: Mesh over 2nd floor play area with escape stair

JSA proposed protective mesh over roof play area to form a barrier against the danger of falling from height. The green roof with *Bauder Blanket* over the escape stair has been finished with a fascia, gutter and rainwater pipe. Due to differences of the levels of the roof surface, walls with coping have been introduced. There is a roof security access ladder proposed over the school hall in the model.



Fig. 17: Roof ladder over the school hall roof



Fig. 18: 3D View from northeast to Main Entrance



VIII. Structural Input



Downes & Associates were appointed as Civil and Structural Design Consultants being responsible for site services and structural elements for the proposed school building.

This included foundations, floor slabs, roof structure, stairs and all structural design. Downes based on JSA's architectural model, proposed wall thicknesses and created their own structural model of the building which contained the structural elements.

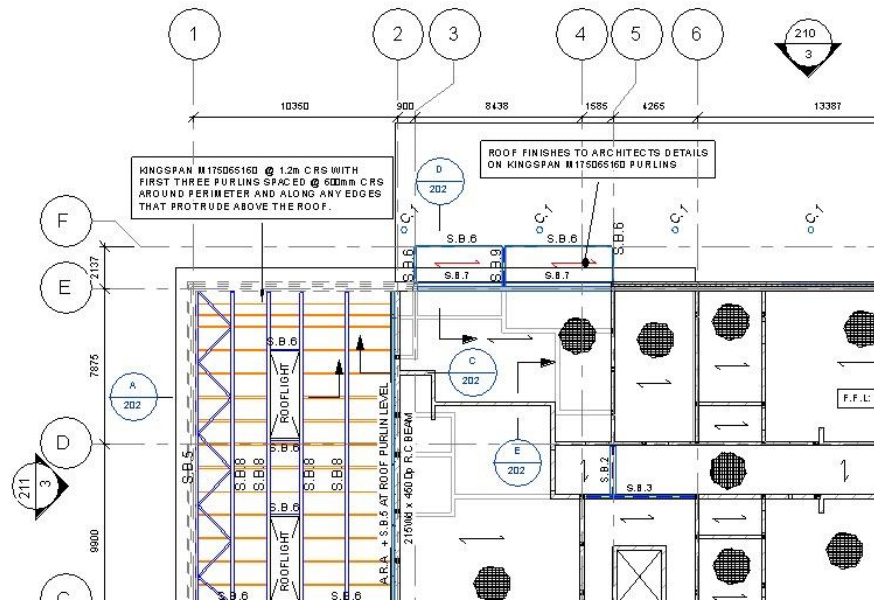


Fig. 19: 1st Floor Slab of Downes' structural model

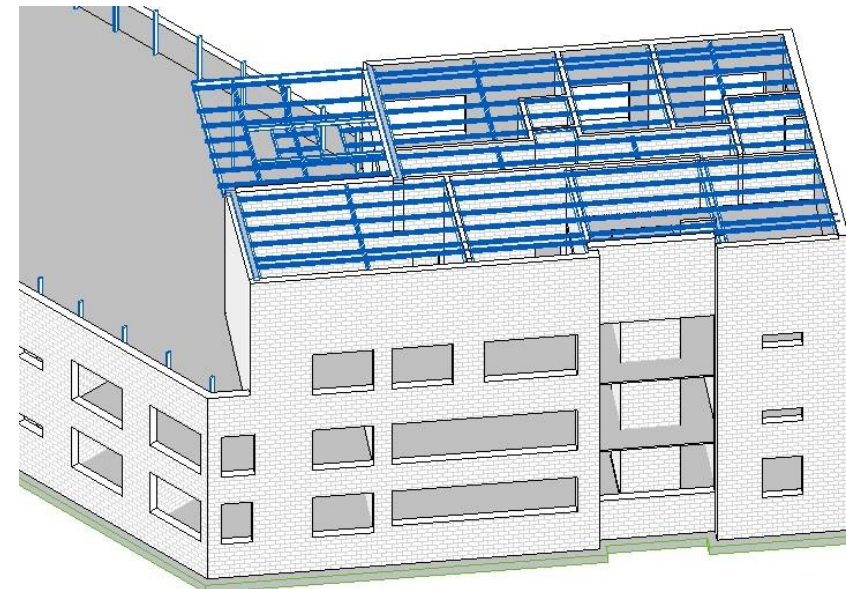


Fig. 20: 3D View of fragment of Downes' structural model



Downes' model contained a number of structural sections with a series of construction annotations.

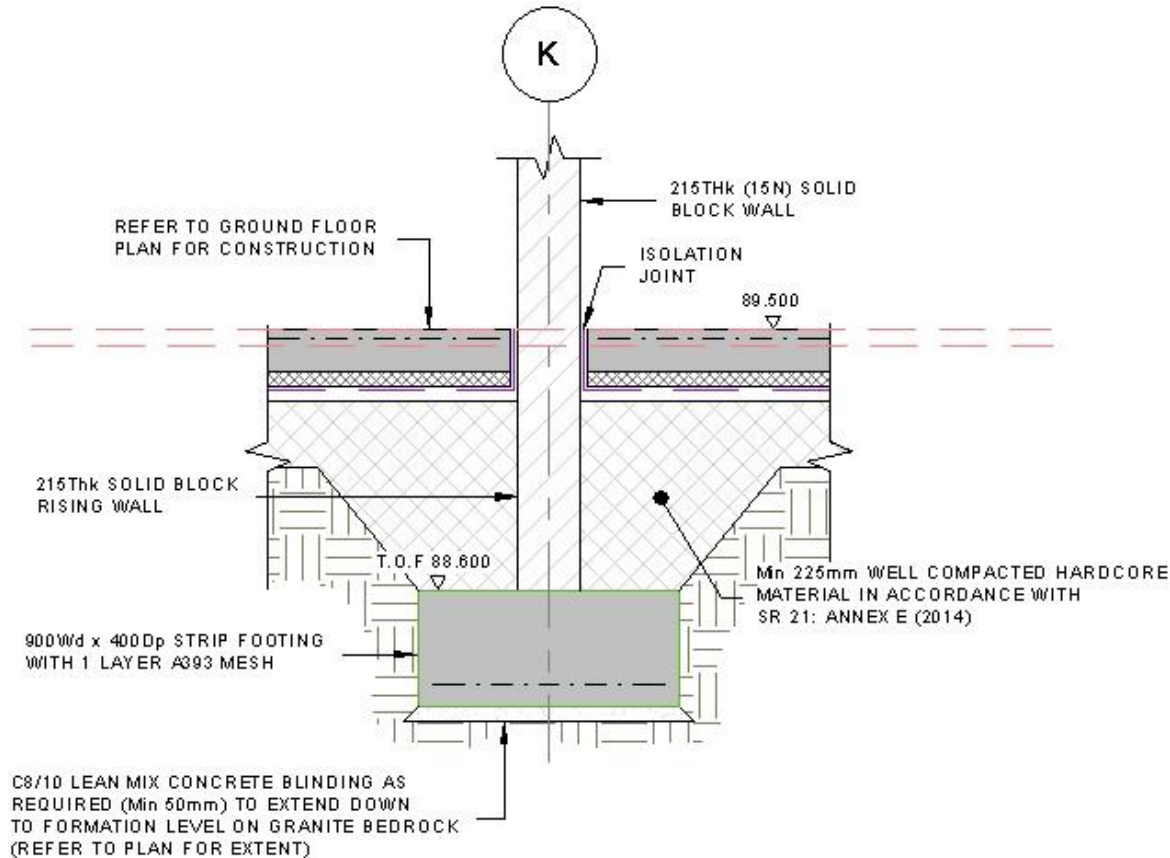


Fig. 21: Section F-F through foundation footing

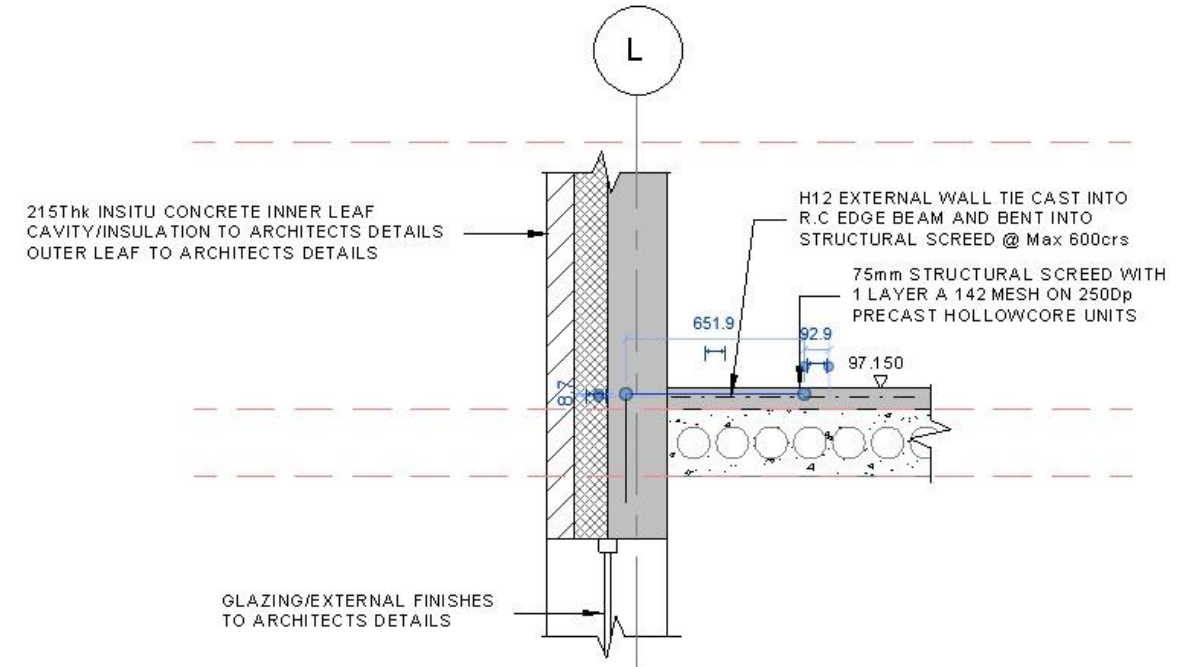


Fig. 22: Section J-J through 2nd floor slab and external wall

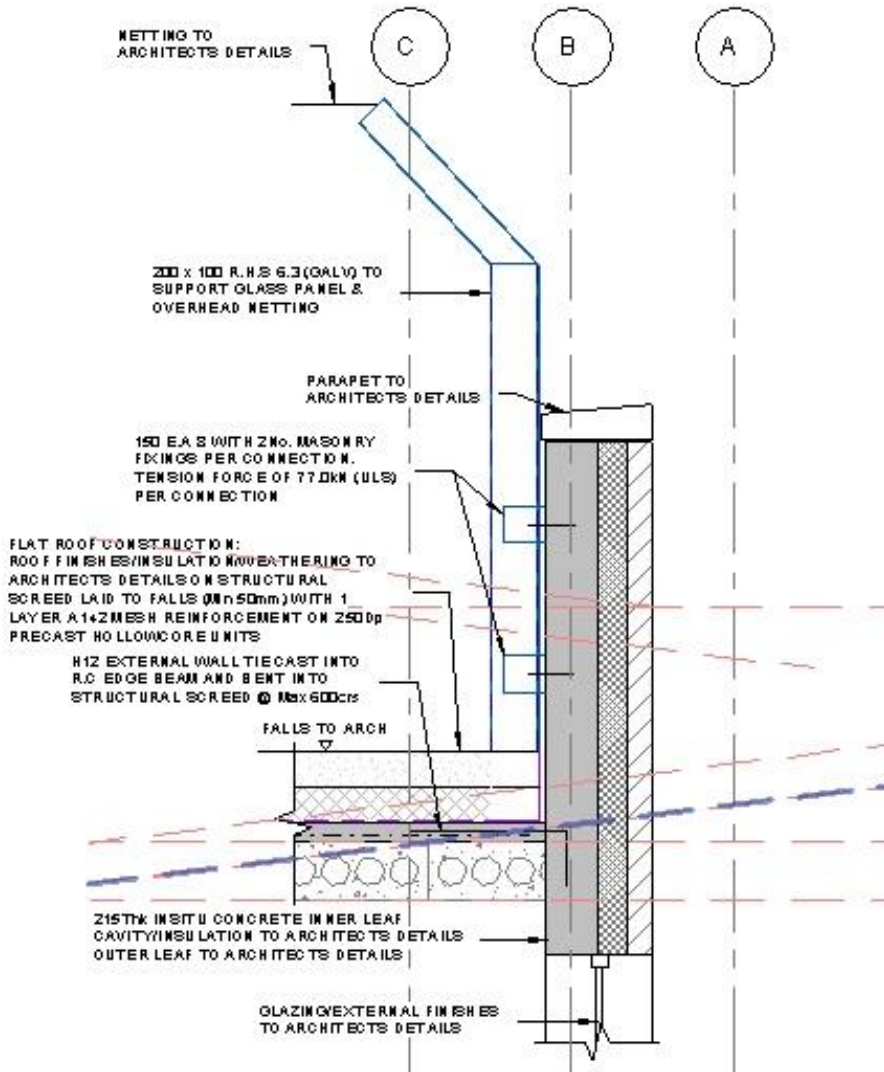


Fig. 23: Section E-E roof slab in play area and mesh proposed nett

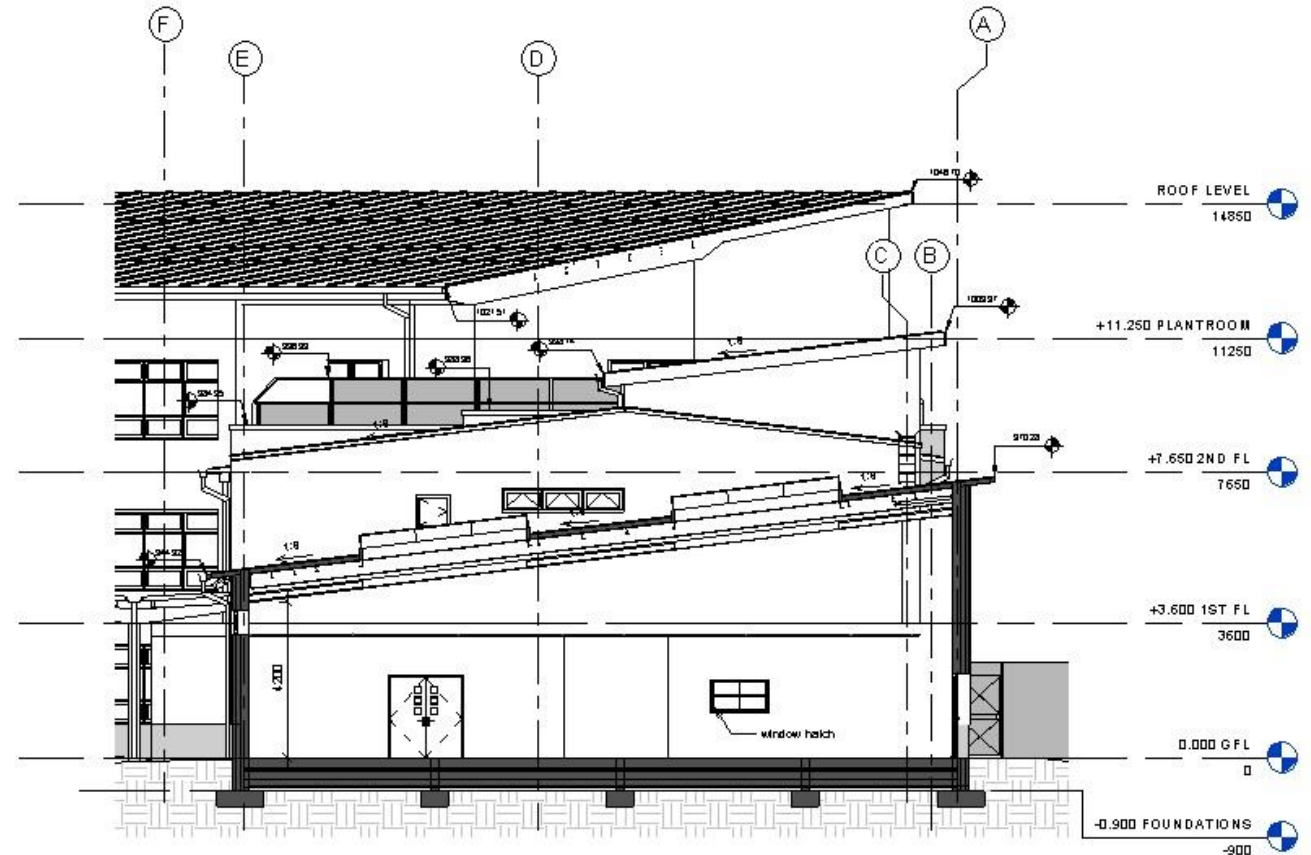


Fig. 24: JSA's Section C-C with incorporated Downes' structural design



The structure design by Downes has been incorporated into the Architectural Model of the school. It included foundations, 250mm deep hollowcore slabs with a minimum 50mm concrete screed, steel girders, roof purlins etc.



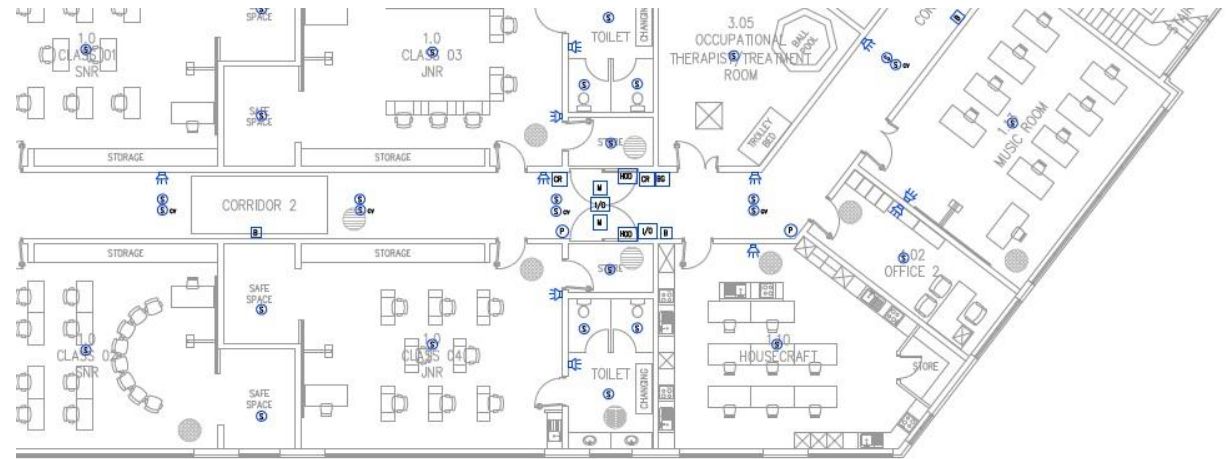
Fig. 25: JSA's Southeast Elevation (Classrooms, Offices, Plantroom)



IX. Mechanical & Electrical Input



Varming were appointed as M&E Consultants for this project. During Stage 2a they were responsible for Daylight calculations (which affected the size of the windows in classes) and ventilation (deciding which of the windows were openable). Varming delivered the design for the Hot Water, Heating, Soil & Waste Services as well as for the Electrical installation, based on previous Design Stage inputs. The M&E Consultant used BIM Level 0 approach (CAD) only, but based on Revit architectural model.



Prepared by JSA ARCHITETS 12 Wellington Avenue, Blackrock, Co. Dublin Project Title SNS - GROSVENOR ROAD / OAKHILL / BALLINTEER	Drawing Title PROTECTIVE SERVICES LAYOUT FIRST FLOOR		Dublin D18 2E28 01 452 2828 Email: info@varming.ie Website: www.varming.ie Engineering for the Future	Revision A	Drawing Reference 12674-E-501
				Date SEP 16	Project Engineer D. WILSON

Fig. 26: Varming's 1st Floor, Protective Services Layouts (fragment)



After the consultation with Varming, JSA has increased the sizes of several windows and added more openable sections. Varming did Daylight calculations which contributed to the increased windows sizes in the classes and offices.

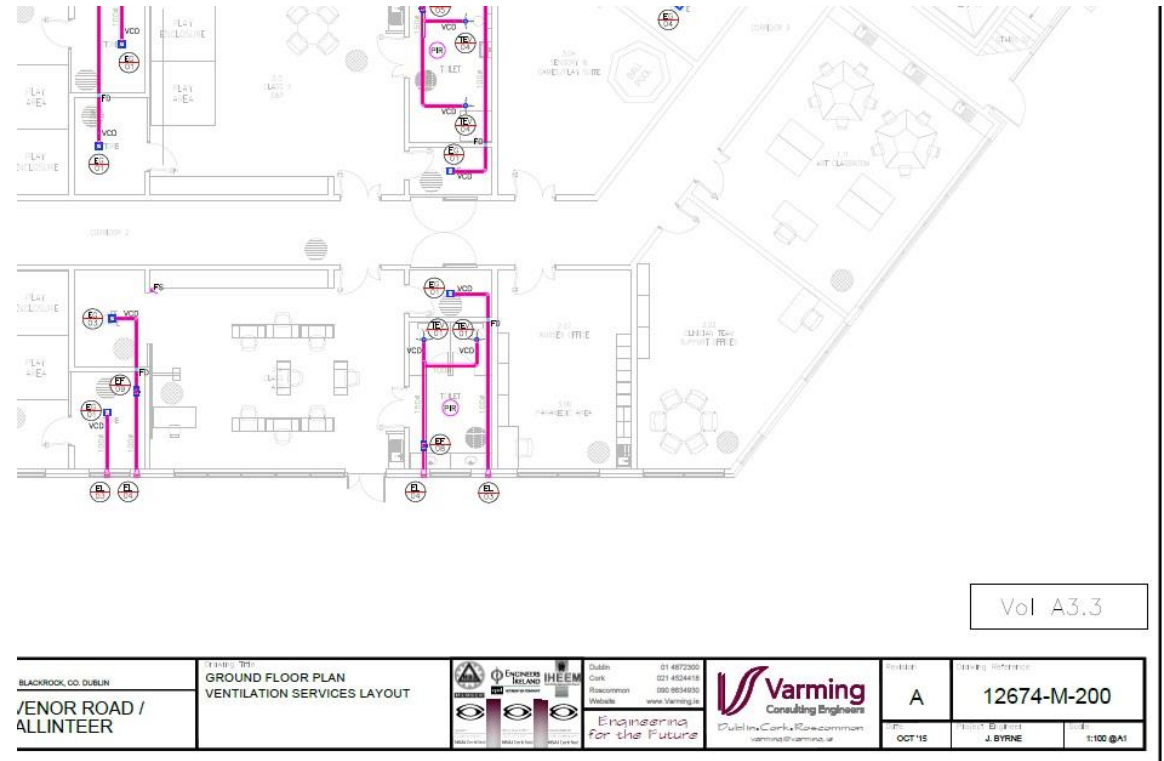


Fig. 27: Varming's Ground Floor, Ventilation Services Layouts (fragment)



X. Quantity Surveyor / Costs



The Quantity Surveyor used the Revit model for the material calculations, however in specific, i.e. IFC format. That format enabled him to calculate each element in the model regardless of its UniClass. The Model had to be exported through the *Application Menu* using 'Export as IFC file' tool.



Fig. 28: Export Revit model as IFC file



XI. Conclusions



It is clear that using Revit software increases the pace of work, particularly when compared with traditional CAD drafting software. It also minimises the risk of human error-the programme highlights the warnings to the users if it detects any clashes within the model. Therefore it provides better interdisciplinary design coordination. All the elements in the model are internally linked, enabling the extraction of any Material Take-Off in a spreadsheet form. The creation of a complete digital model of the building generates a variety of 3D views for presentation.

“The real value in BIM is the interoperability of model geometry and metadata between applications (...) Using Revit (...) ensures consistency because the model is the sole source for design geometry”¹.

Fig. 29: 3D View from north with context





The conversion of the project data from CAD to BIM –based software environment:

- enabled to assess the visual impact of the Project on the surrounding area
- allowed to calculate and control the areas of the rooms proposed in the project (even when project was changing)
- enabled the exchange of the information between the Design Team Members on BIM based platforms,
- enabled to detect and resolve the clashes between architecture and structure,
- enabled to assess and correct the amount of fresh air entering the building through the windows
- enabled to calculate and correct the green roof area with overall percentage of green area on the site
- allowed to present the model of the school to the Client without the necessary outsourcing
- allowed QS to extract material take-off from the model by saving the file in .IFC format.



Through this article I wished to show that Small and Medium Enterprises (SME) can avail of many of aforesaid benefits using BIM based software. Also, in my opinion the transition process from CAD to BIM does not have to be long and expensive.

Revit is a programme which is internally linked and can save you a lot of time and costs. BIM can also be a perfect tool to convince the Client that the design is visually and commercially attractive.



Fig. 30: 3D View from south



XII. References



[1] Read P., Krygiel E., Vandezande J., *Mastering Autodesk Revit Architecture 2013*, John Wiley & Sons Inc., Indianapolis, Indiana, USA, 2012, p.8.

CitA
BIM GATHERING



Thank you

Piotr Nabzdyk, JSA Architects