May 2009 Newsletter No. 21

Edited by:
Sadhbh Ní Hógáin
sadhbhie@gmail.com

The Institution of Structural Engineers

Republic of Ireland Branch Newsletter

Main website: www.istructe.org

Branch Website: www.istructeroi.org.uk

Chairman's Review

At this stage our Centenary year is behind us and for the Republic of Ireland Branch it has been a most successful one. As always a number of high quality evening/night lectures were presented and all of them were very well attended. A previous Newsletter (April '08), referred to a successful seminar on "Deep Basements" and an evening course on Structural Engineering Design, both of which took place during the Centenary.

Two of the lectures that were held during the year were awarded branch prizes. These were for, the Elysian Project in Cork, presented by Sean Carrigy, Director, P J Hegarty and Sons and Hugh O'Dwyer, Associate Director, Arup Consulting Engineers; and for the design and construction of the Millau Viaduct in southern France, presented by Dr Vincent de Ville de Goyet, Director, Bureau Greisch Consulting Engineers, Liège, Belgium. The committee decided to award two prizes due to the change in the Institution's programme from its traditional year to a calendar one. This resulted in the Branch extending the Centenary over a period of 16 months.

As in previous years a Graduate evening was held in Dublin and a Student prize was organised for third level civil/structural engineering students. The Student Prize was awarded to Paul Doyle, now with Arup and previously a student of the Dublin Institute of Technology, for his final year project entitled "Steel Plate Girders with Corrugated Webs".

Also, because of the change to the calendar year, the Branch decided to move the Annual Dinner from November '08 to February '09. Despite the economic downturn the event proved to be very well attended, with numbers up on the previous year. Christy Kenneally, the guest speaker was well received. He reminded the audience of the great achievements of the structural engineers of the past and advised that these individuals and their works should provide us with inspiration and hope for the future.

Our President, Dr Graham Owens, and his wife, Margaret, were in attendance. In a short address the President referred to the challenges facing the profession in the current economic downturn. However, he was confident that our profession was better prepared than most to overcome the difficulty situation that is confronting us.

On the day of the Dinner, he and his wife had the opportunity to visit Trinity College. The President was also taken on a tour of the civil/structural engineering facilities, courtesy of Dr Roger West, who hosted a lunch in the visitors' honour.

Members might note that the 2010 Dinner is fixed for Friday 5th February.

In the past, I stated that we would like to hold events outside of Dublin. I would therefore appeal once again to members to forward suggestions for events that might be provided outside of Dublin and Cork.

It is doubtful if any of us need reminding that we are facing into a very serious economic downturn, which is compounded by the fact that it is global. However, it is vital that our members do not lose hope. They should first of all be proud of their past achievements and should build on them for a future that will eventually return to a period of growth. For those either not in employment or who are not fully occupied in the workplace it is most important that they keep up their CPD. This can be accomplished in many ways, including pursuing post-graduate qualifications and short courses, some of which may be undertaken through distance learning. The Branch intends to play its part with planned seminars on the structural Eurocodes; Health and Safety issues, etc. We will of course continue to offer the usual range of high quality evening/night lectures. In fact some of you may wish to become more active in Branch matters and if so please make contact with our Honorary Secretary, Colin Caprani. Members should remember that the Institution is represented in over 100 countries and this may be of assistance to those attempting to find employment abroad.

In conclusion, I would like to thank you, our members, for the support you continue to give to our events. I would also like to thank our committee. This small group of members put considerable time and effort into organising our events in order to ensure members are kept fully abreast of the latest developments in structural engineering. I would like to say a special "thank you" to our outgoing Honorary Secretary, Peter Finnegan. Peter has given tireless service to the Branch Committee over several years and we all owe him a great debt of gratitude.

Martin Mannion

Republic of Ireland Branch Committee Members 2009:

- Martin Mannion (Chair)
- Pearse Sutton (Vice Chair)
- Jonathon Billings
- Paddy Butler
- Colin Caprani
- John Dunny
- Peter Finnegan
- Sadhbh Ní Hógáin
- Gavin Hughes
- Victoria Janssens
- Joe Kindregan
- Henry Mullen
- Joe Ryan
- Paul Sexton
- Don Twomey

Inside this issue:

Appropriate Technology, Niger

The Republic of Niger is a landlocked Sub Saharan country. It is one of the largest countries in Africa with over 80% of its territory covered by the Sahara desert. It is heavily dependent on international aid and emergency food relief. 63% of the population of 13.3 million people live on less than a $1 a day.

Only 31% of females and 36% of males attend primary, school with national literacy rates of 9% for women and 20% for men. Theis is due to the shortage of schools forcing children to travel long distances, the high proportion of untrained teachers, the scarcity of those prepared to work and live in rural areas and undeveloped teacher support structures. These factors have knock on effects and result in a low demand for education as parents see little value arising from their children attending school.

The government of Niger, with assistance from international donor funds, are currently implementing an intensive school construction program throughout the country. The standard school design comprises a single storey reinforced concrete two classroom block with office & storeroom. A typical completion program for a two classroom school is 12 - 18 months. Communities are not involved in the construction process.

The remote site locations, limited material and human resources and limited capacity within the construction sector means that the government targets will not be achieved within the existing 5 year program timeframe. A mid-term review focused on developing an innovative public private partnership model using traditional materials and skills indigenous to Niger.

The challenge was to develop a link with local communities to empower them to adapt technologies to meet economic, environmental and social preferences. In order to achieve this communities need to be integrated into the design, planning, construction and operational phases. A pilot model for community build classrooms in remote regions was developed to complement the existing contractor program

In order to withstand the harsh desert environments, the low cost design uses a galvanized structural steel framework with local materials used for walls and floors. Doors and windows comprise prefabricated metal frames and zinc alum sheet. Roof covering is also of zinc alum sheeting. All site connections are bolted. The metallic framed units incorporate ventilation under the roof structure and in addition can incorporate an aluminium foil faced thermal barrier under the roofing sheets that reflects 97% of the radiant heat away from the building. A traditional 300mm thick mud wall of dry density 1900kg/m^3 has a thermal capacity of 450-570kJ/m^{2}K. This will further ensure that the buildings are thermally resistant to temperature effects.

Republic of Ireland Branch

This community build design breaks down the complexity of school construction into a series of phases:

Phase 1: Fabrication of structural steel components off site in local workshops.

Phase 2: RC Pad Foundations – constructed in situ

Phase 3: Erection - delivery to site & erection of structural frame & roof

Phase 4: Finishes - these are variable and are adapted by the communities to suit their needs.

Typical finishes selected by communities are as follows:

Walls – Banco / Mud / Concrete Block work.

Cladding – Straw Mats / Zinc Alum sheeting / Metal grills.

Floor – Compacted earth with concrete render.

Thermal cooling – reflective foil with roof vent system.

Some conclusions of the program to date are as follows?

- Significant Cost & Time Savings
- Flexible design can be adapted to suit site constraints
- Consistent high quality product achievable with minimum site supervision
- Maintenance can be managed by community
- Sustainable use of local material and human resources
- Minimises use of water / sand / cement
- Contractors oppose program concept
- Some communities prefer concrete building

This pilot program has shown that when communities are integrated into all phases of project development, a more sustainable engineered design suitable to the local environment can be achieved.

Liam McCarton, DIT

Steel Plate Girders with Corrugated Webs

This project investigated methods for determining the shear buckling capacity of steel plate girders with corrugated webs. A corrugated-web steel plate girder consists of top and bottom flange plates and a corrugated web, which resist applied moment and applied shear respectively. The corrugated web provides a greater out of plane stiffness and buckling strength. The elastic critical buckling stress depends on a local shear buckling coefficient. There are several theoretical approaches to the calculation of this buckling coefficient in the literature, two of which were compared, Abbas et al and Elgaaly et al.

For three sample girder designs, the theoretical load to cause local shear buckling of a corrugated web was calculated from the competing theories, and from finite element analysis (FEA). LUSAS, an FEA program, was used to determine the failure mode and the failure load of the girders. The test girders were designed, fabricated and tested to failure. For each specimen, the depth of web corrugation increased, theoretically increasing the local shear buckling capacity of the girders.

The failure load predicted by FEA proved to give the closest estimate of the failure load, with an error of around 0.25%. The FE models' predicted buckling position also proved quite accurate. Further, the theoretical method outlined by Abbas et al was found to be an appropriately conservative approach in designing steel plate girders with corrugated webs. The use of FEA was also shown to provide an accurate representation of the failure mode and load.

Paul Doyle, ARUP

Winner of the Republic of Ireland Branch Student Prize 2009.

The Elysian Development

Displaying a confidence in, and commitment to, the future of Cork, O'Flynn Construction has created Ireland's tallest building as part of a landmark development at the southern entrance to Cork city. The 3 acre brown field site accommodates a mixed use development, incorporating 211 high quality apartments; 4,000m² of retail space; 2,000m² of commercial office space; and 550 car parking spaces over three levels. Arup Consulting Engineers provided full engineering design services for the scheme with construction by P.J Hegarty & Sons.

The scheme includes an 18-storey tower at the southwest corner of the site with 5/6-storey residential blocks surrounding a central elevated courtyard.

An application for planning permission was submitted to Cork City Council in October 2004. Planning permission was granted in July 2005 and the building works contract was awarded in February 2006. Show apartments were opened in September 2008.

The ground conditions on site comprised a varying thickness of fill over soft clay and silt, overlying gravel and sand on a bedrock of weak-to-strong limestone with evidence of karst weathering. The groundwater on the site was tidal, influenced by the level in the adjoining River Lee.

The construction of a two-storey basement car park over the full site area involved the excavation of approximately 100,000m³ of soil. Perimeter steel sheet piles were driven to a depth of approximately 7m below the proposed lower basement level. The sheet piles were temporarily anchored at ground floor level and basement -1 level. The ground water level was temporarily lowered by pumped wells installed around the perimeter, which discharged 400l/s to the River Lee.

A raft slab, ranging in thickness from 1m to 1.7m provides the foundations for the buildings. Seventy per cent GGBS was used as a cement replacement in the 16,000m³ of raft slab concrete with water penetration through the raft foundation prevented by an external waterproof membrane. Additional support for the tower is provided by 900mm diameter piles installed under the raft slab, extending 14m to rock. The perimeter sheet piles, propped by the basement and ground floor slabs, form the permanent basement walls.

The objective of the selected structural scheme was to optimise the structural grid and facilitate overlapping uses of basement car parking, ground floor retail and upper level apartments, in the most cost efficient way.

The typical structural grid within the basement car park is 10.6m x 8m. This grid extends from the foundation through the car park and retail areas to the soffit of the first floor slab. The first floor slab acts as a transfer structure for the residential units and the central landscaped areas. Based on the opportunity to accelerate programme and reduce reinforcement quantities the contractor proposed an alternative of a post-tensioned slab for the basement level, ground floor and first floor transfer slabs.

The tower is approximately 25m x 20m on plan with a roof level of 69 metres above adjacent street level. The centrally located reinforced concrete core runs the full height of the building. The superstructure floor slabs are of reinforced concrete construction, generally with a flat soffit supported on the core walls and *in-situ* reinforced concrete columns. Party walls are constructed of solid concrete blockwork with perimeter liner walls and internal walls of studwork construction.

Foundations comprise a raft slab with compression and tension piles locally below the high-rise tower. The superstructure extends from basement for the height of the building without the requirements for a transfer structure.

Lateral stability is provided by the in-situ concrete core and coupled shear walls located approximately at the centre of the tower on plan. Building lateral stability analysis was carried out using OASYS GSA, Arup's in-house structural analysis software.

The tower superstructure is separated from the adjacent low-level residential buildings by a bi-directional horizontal movement joint. The presence of this joint ensures that lateral deflection of the tower takes place without any resultant transfer of lateral load to the adjacent structures.

A number of temporary condition design checks were carried out. Of particular importance were the checks on the stability walls, which were formed using slip-form construction carried out on a continuous 24-hour basis, with the sliding shutter rising at a rate of approximately 3.5m in each 12-hour period.

The dual aspect regular grid of the east, west and south residential areas lent itself to an efficient cross-wall construction. Above the first floor transfer slab the superstructure typically comprises a 150mm structural concrete screed on 100mm pre-cast concrete wide-slabs supported on cross wall construction. Cross walls are typically constructed of high strength block work and, where feasible, the residential layouts were modified to ensure a vertically aligned path for load transfer.

This development utilised a variety of structural systems to deliver an economical structural scheme within budget. The combined overall effect of this unique engineering design is to deliver a contemporary scheme in a central city location. The newest addition to Cork's skyline, The Elysian is a testament to a confidence in urban development in Cork city.

Hugh O'Dwyer, ARUP

NAWIC

National Association of Women in Construction

www.NAWIC.co.uk

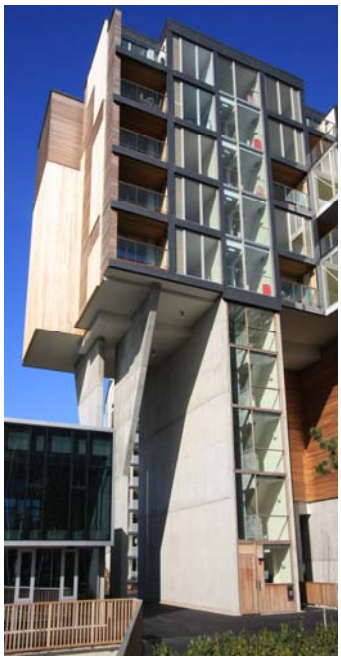
The National Association of Women in Construction (NAWIC) aims to:

- raise the profile of those professional women already working in the industry,
- encourage best practice
- provide mutual support.

Further Information Contact: **sbryson@MHC.ie**

Elm Park Development- Merrion Road-Dublin 4.

The Institution of Structural Engineers



Project Team
Client - Radora Developments
Design and Build Contractor - Michael Mc Namara & Co.
Architect - Bucholz McEvoy
Consulting Civil and Structural Engineer - O'Connor Sutton Cronin

The site is 14 acres with 220m frontage onto Merrion Road, and slopes gradually from West to East.

The Architects Bucholz McEvoy developed a concept of a large mixed use development which would retain the parkland and tranquillity of the original agricultural site setting. The crucial layout decision to achieve this was the decision that all servicing of the site would be below ground. This led to the development of a large basement which would occupy the majority of the site. This basement is designed to take all vehicles. The Buildings are orientated to maximise sustainable principles throughout the development and this was to be Irelands first sustainable large scale mixed use private development.

The Architectural concept was for a series of buildings suspended above the landscape with visual permeability through ground floor. The ideal would have been no structure at ground floor. We worked closely with the Architect to develop a series of mechanisms which limits the visual intrusion of the vertical support structure. The structural frames were designed to cantilever at the ends of the buildings, fin walls, Y and V shaped jumbo columns were used as vertical transfer frames. The balconies, elevations and cantilever rooms all give the impression of lightness while maintaining a buildable solution which is standardised in 95% of the area.

A systematic testing of designs, construction methodology and interfaces was one of the cornerstones of the success of Elm Park.

The development comprises 336 apartments, 110 senior citizen housing units, 28,500 square meters of office space in 3 blocks, 22,500 square meter hotel and medical day care centre, crèche, leisure centre, swimming pool, conference centre above a 45,000 square meter basement with parking for 880 cars, delivery areas, coach parking, plant and utility areas.

The buildings were supported on conventional pad and strip footings founded in the limestone bedrock or black boulder clay. The options of grade of basement slab were discussed with the client and it was agreed that a grade 2 basement was suitable. The basement slab resists hydrostatic pressures by spanning between the pad footings and rock anchors. The car park at basement level was generally constructed on a 7.5m by 8.8m grid.

Each residential block has distinguishing elements but all fit a general pallet of structural systems chosen for their efficiency and buildability. The critical requirement was to achieve these visual structural effects but to devise a system which was economic and could be constructed within programme. The residential blocks are 8 storey buildings. All buildings are arranged with 3 apartments per floor around a lift and stair core. This allows two of the three apartments to be dual aspect with the last single generally West facing. Above the basement there is a transfer slab changing from the car park grid to the load-bearing cross wall construction of the apartments. The walls are generally in situ reinforced concrete with simplified mesh reinforcement. The floor construction is pre stressed precast wide slab units with an insitu concrete structural screed.

The office buildings were designed as naturally ventilated buildings with an exposed concrete finish to allow air flow over the surface to exploit the thermal mass of the structure as part of the natural ventilation system. The coffered slab is supported on upstand edge and spine beams typically on a 7.5m longitudinal grid. The floors were cast insitu on fibreglass specialist moulds. The general system is quite repetitive but there are small differences in orientation and edge condition to suit different areas of the different buildings. One office block has a large winter garden in the centre of the building from third floor to roof. This area is framed using glulam timber sections. The glass walls and roof are all framed in composite glulam and tension steel cable system, The intermediate floors are constructed of solid glulam landings and stairs suspended from the roof. A second office block has cantilever end bays achieved by cantilever upstand beams within the raised floor which have been coordinated with the mechanical and electrical installations. There are also Y shaped concrete columns from ground floor to create clear areas.

Before Elm Park the perception of sustainable buildings within the industry was strictly for the bespoke client seeking a signature statement building. Elm Park has been ahead of its time and the remarkable achievement of the whole development is that these principles have been achieved in a commercial developer lead team. This development at Elm Park will be viewed in years to come as a turning point in building design using sustainable principles in Ireland.

Martin Mc Grath
Director O'Connor Sutton Cronin

This Newsletter was sponsored by:

O'CONNOR SUTTON CRONIN
Consulting Engineers