STRUCTURAL ENGINEERING DESIGN

Innovation in Structural Design typically involves the use of pre-existing forms and materials in a new form or combination. (New forms and materials in construction are actually rare). In some cases analysis may be innovative. The achievement of simplicity and elegance typically involves a fluency in concept and a painstaking approach to detailing.

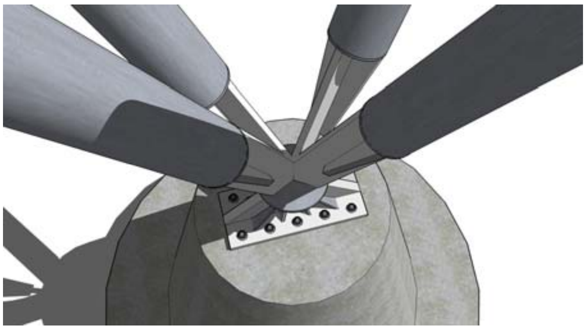
The following examples demonstrate the innovative use of state of the art software tools for visualisation and analysis and surprising combinations of detailing leading to simple but elegant forms. The two projects featured are just a sample to illustrate our approach.

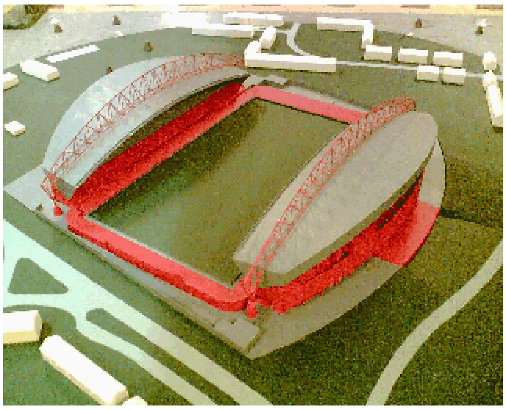
Thomond Park Stadium, Limerick

This 25,000 seater stadium features a 150m clear spanning roof structure.

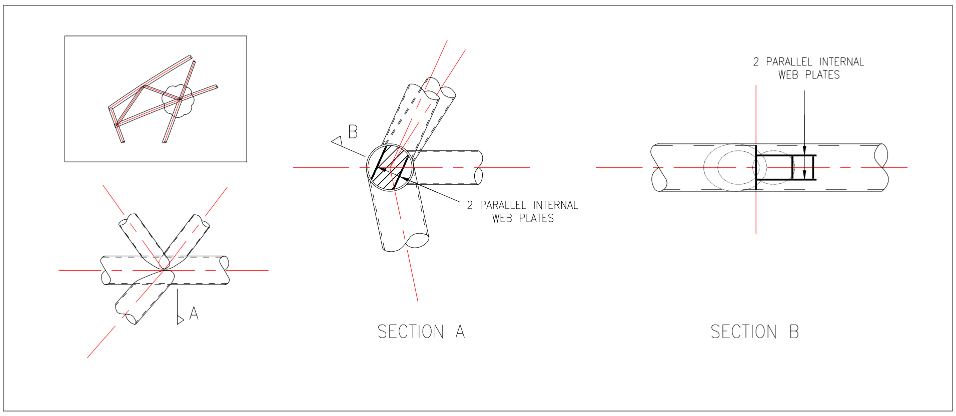
The ground enclosure and stand geometry are such that an ideal pin ended arch form would have required enormous, indeed overpowering tall massive plinths at each stand gable.
The idea of combining the structural action of a truss and portal frame was developed to generate a manageable and elegant pin detail close to ground level.

Following on from this development of the high level truss to column junction, lead to a need for local reinforcement. Following detail design development with the fabrication a secret detail completely concealed within the tabular steel members was developed respecting structural needs, fabrication welder access and ensuring clean external architectural lines.



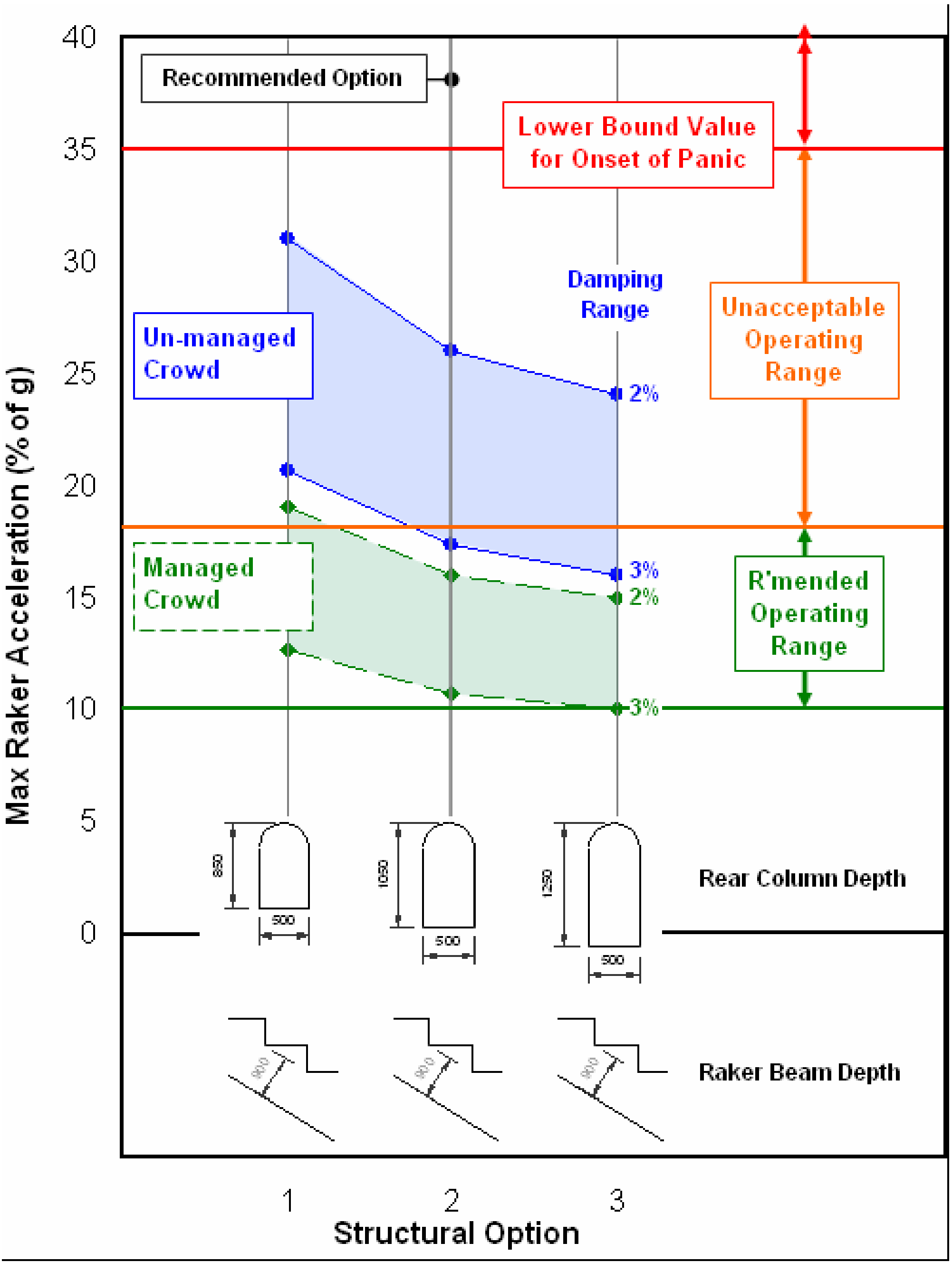


As part of the giant truss design process a boundary layer wind tunnel test was procured to deliver significant savings on overall structural design loads.
While not a new technology this initiative is as far as we know the first use of wind tunnel testing for any structure in Ireland. We are currently exploring the use of this technology to generate savings on foundations and cladding supports on a number of projects in Dublin.



The question of spectator comfort has become critical in recent years. A number of sports stadia in the UK when used as concert venues have shown vibration response to rhythmic crowd loading sufficient to cause panic.

The most recent dynamic analytical methods have moved beyond determination of natural frequency as a crude criterion to a performance evaluation using modal and harmonic analysis.



We have implemented findings published in research papers as recently as late 2006 and have thereby been able to advise the client on specific crowd management requirements associated with possible concert usage.
This work now allows us to evaluate longer span or exceptionally shallow or soft structures generally for dynamic response and evaluate this response in terms of human comfort.

The manufacture of the entire stand superstructure frame is using self-compacting concrete. This has provided us with unique experience of this new material applicable to concrete structures generally but especially to fairface concrete.

For visualisation, resolution of details and dynamic and static analysis 3D modelling has been used throughout. We are currently evaluating new 3D software tools to integrate the analysis and visualisation functions. This will deliver significant problem solving and time benefits on a whole range of projects from now on.

KILDARE COUNTY COUNCIL OFFICES

Sustainable Energy Award 2006 Excellence in Design or Specification

Opus Award Winner 2006 – Over €7million category

RIBA European Award Winner 2006

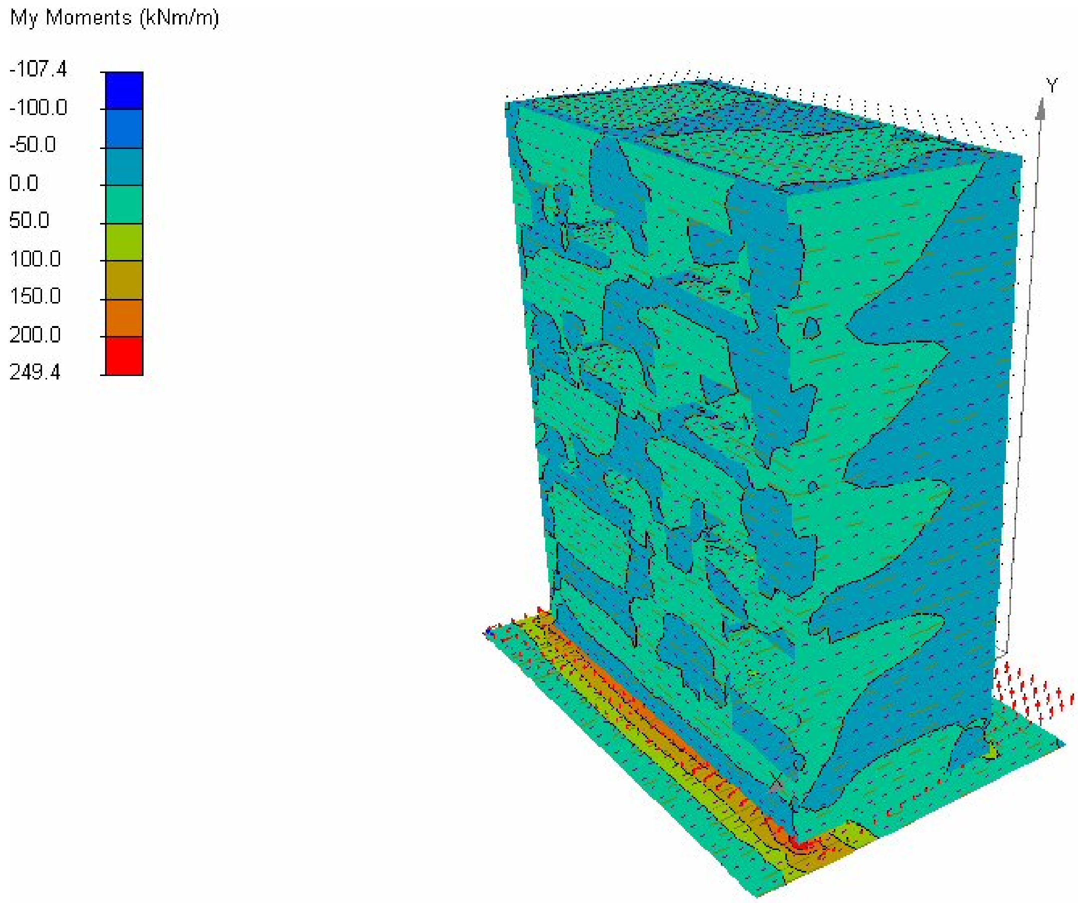
Awarded "Best Public Building" RIAI Awards 2006

From the leaning concrete frame to the daring Council Chamber cantilever, from the cable stayed glazing link (made possible by a concealed ground anchor adaptor), to the ramp landing support frames this building is innovative in its conception, analysis and in its execution.

Geometry

The buildings are not vertical – the end sections are inclined at 1:6. This posed a tremendous challenge in terms of stability - it means that for every 6 tons of vertical weight there is 1 ton acting horizontally wanting to tip the building over!
The architects did not want any internal shear walls - the stair cores were the only available elements providing stability. However, these cores are located within the building, not at the extremes. This means that the cores take eccentric horizontal loads that produce not only bending but also torsion in core walls that are only 200mm thick.

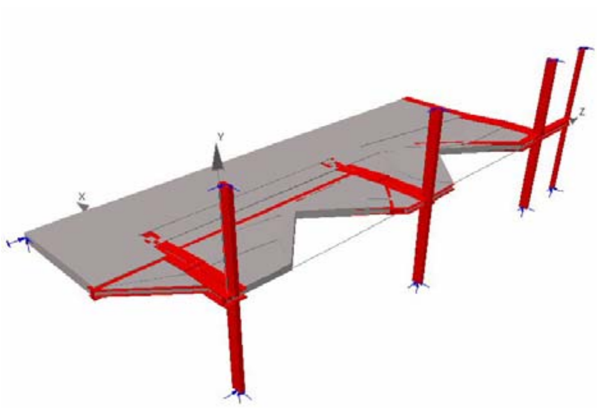
The cores were optimized and analyzed by means of a 3-dimensional finite element computer model using PROKON software. This allowed for a detailed method of calculation, enabling the engineer to minimize the size of the elements and optimize the material requirements.



The Link Ramp Structure

The design involved a series of tensioned cables that support the ramps and the glazing. These cables were attached to bored tension piles (friction). The glazing designer specified “zero” tolerance between the cables and the piles. This is impossible to attain in practice, and the structural engineers developed an innovative connection detail that catered for construction eccentricities up to 80mm between the tension cables and the friction piles. The resulting moments from the eccentricity were transferred into the ground slab. This designed and engineered glazing system was cost effective and unobtrusive, giving a transparent uncluttered glazed surface and the illusion of floating ramps.

The ramp support points were a major design challenge. The sloped and skewed approach of the ramps involved cutting away most of the supporting concrete.



No supplementary elements were to appear on the soffit. A skeleton of stiff steel ribs, cranked and skewed, were cast into the concrete flesh with the reinforcing bar ‘tendons’ threaded through the skeleton.

The result is geometrically fine structurally light and visually elegant.

Atrium

A 11m high atrium space void, 45m long. The steel columns in the atrium are very slender (200x100 RHS), they have a free-span of 11m and support the weight of 2 floors from above, plus facade and curtain wall. This was achieved by designing a full moment connection at the base using pre-tensioned holding down bolts.

Council Chamber

The 9.0m cantilever of the Council Chamber with asymmetrically cranked curtain walling enclosures offers no opportunity to hid massive or awkward detailing.

The combination of 3 Dimensional analysis and drawing tools made this space possible. The exceptional element slenderness could only be justified by recourse to dynamic modelling to verify an adequately stiff dynamic response for human comfort. 3D Finite Element modelling was employed for static, modal and harmonic analysis.