(Photos: F22 Photography and RORSA.)

Figure 1: Formwork in position at 'Atlantic Edge'.

Ireland's Cliffs of Moher Visitor Centre

The Cliffs of Moher are a stunning geological feature on the West Coast of Ireland, which have become a world-renowned tourist attraction. Reddy O'Rioardan Staehli Architects (RORSA) won an international architectural competition with its design for 'Atlantic Edge', an underground Visitor Centre set into the barren landscape of West Clare, close to the edge of the cliffs.

Alastair Seaton, Cordek, West Sussex, UK

Ranging from 214m high at the highest point, the area covers 8km of the magnificent western seaboard of County Clare, and is famous for its megalithic tombs and monuments that pre-date the Egyptian pyramids. The €30m (US$43.3m approximately) centre features a literally 'ground breaking' design by architect RORSA – the reinforced concrete structure is built into the hillside and landscaped over to minimise visible presence.

Design concept

Given the unique and sensitive nature of the site, the key design priority was that the existing landscape and organic forms took precedence over any building located there. The project was therefore developed on the concept of a subterranean building, taking its design and influences from the natural materials and forms of the area. The completed building included exhibition areas, an auditorium, a restaurant and support facilities all accessed by a new ramped walkway, which threads its way through the building.

Figure 2: Illustration showing how the Cordek formers were assembled in layers to create the 3D profile. Note the crescent-shaped roof light emerging through the dome.

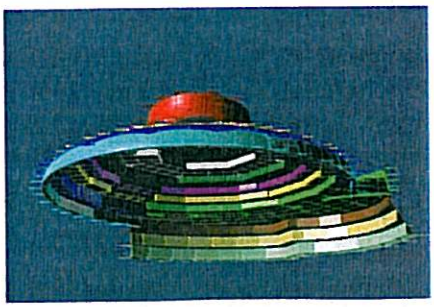

Figure 3: Image of the underside of the digital model showing how the formers were designed to be supported on horizontal layers of falsework.

Figure 4: Colour-coded image of the different layers of Cordek formers as constructed in the digital model.

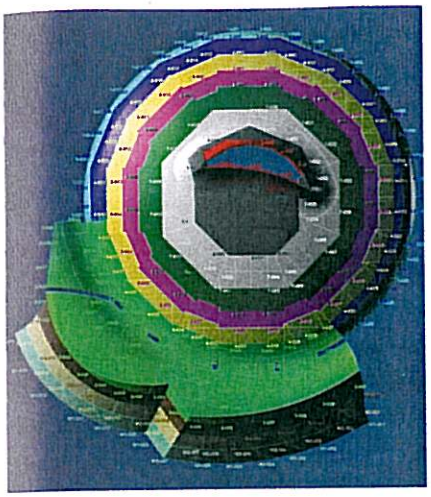

Figure 5: Plan view of the formwork layout showing crescent-shaped roof light.

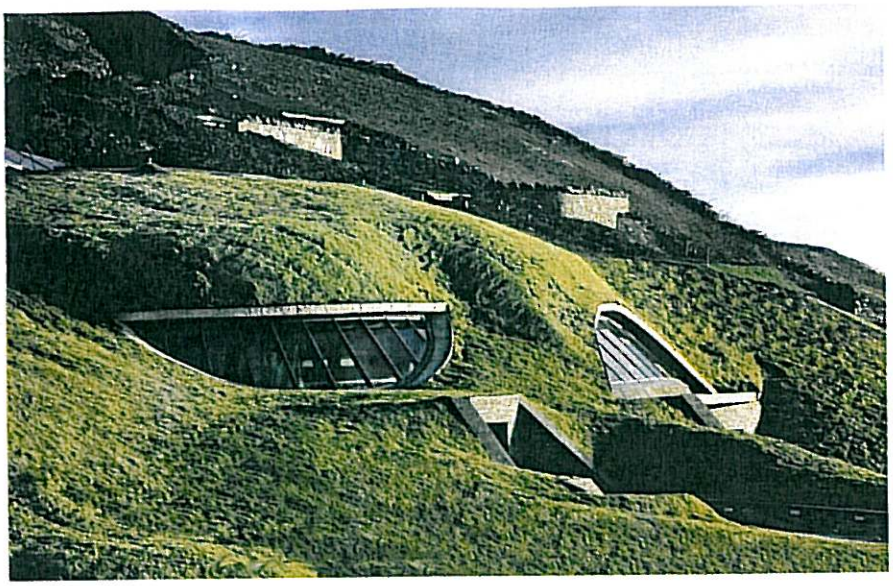

Figure 6: Blending in with the environment.

Design detail

To achieve the organic forms fundamental to the design concept, the building structure was designed as a cast-in-situ waterproof concrete shell. Internally the structure has been exposed and finished with a moulded 'worm trail' imprint from local Liscannor flagstones to provide a direct reference to the natural material in which the building is constructed. The domed central exhibition area presented the greatest structural challenge. It involved a 25m clear span, incorporating a complex crescent-shaped roof window. The span and the considerable loads imposed from the backfilling of the finished structure resulted in structural concrete sections up to 750mm thick.

Construction of the concrete superstructure

To form the complex shape using traditional formwork techniques would have been virtually impossible. The irregular double-curvature surface would have required carpentry skills associated more with traditional boat building than with the construction industry. The scale of the project, the very exposed environment on the west coast of Ireland and the contract programme therefore led the project team to consider off-site fabrication of the formwork.

From the success of a previous project at its head office in Fitzrovia, the project engineer Arup Consulting Engineers (Cork), recommended Cordek as a possible supplier for the complex formwork. Cordek has been a supplier of formwork to the construction industry for over 30 years and has more recently developed skills and techniques to meet the formwork demands of the complex structures now being designed.

Working from the architect's and engineer's 2D general arrangement drawings, Cordek created a 3D digital model of the complex structural shell of the building. John Leane of RORSA says, "In simple terms, Cordek produced a virtual mock-up of the entire finished organic structure, accurately reflecting what we aimed to achieve and this gave us great confidence that it would be delivered precisely by the contractor."

Formwork and falsework system

Cordek then teamed up with Rohcon, main contractor for the project, to develop a practical falsework and formwork scheme for the construction of the concrete shell. Using a proprietary falsework system from RMD, Rohcon erected a traditional timber and plywood deck stepped in horizontal layers to suit the proposed formwork layout, which Cordek derived from the digital model. Cordek's shaped formers were then placed onto this falsework.

Manufactured from high-density expanded polystyrene, the formers created a 3D jigsaw to accurately recreate the profile of the architect's design. Each former, of which there were approximately 300, was individually machined to a unique profile using five-axis routing technology developed for the aerospace industry. The 907m² of double-curvature formwork was manufactured by Cordek in its West Sussex-based factory over a 12-week period. The formers were then delivered to site in 40ft lorry loads on a predetermined delivery sequence, to suit the falsework erection programme.

When all the formers had been positioned, Rohcon then bonded flexible rubber mats onto the curved surface. The mats served two functions: they provided a durable working surface – which would also debond from the concrete – and the textured surface of the mats created the featured surface on the concrete required by the design concept. The rubber mats were also used on traditional timber formwork for the casting of the walls. The textured surface was created by taking a casting from a locally sourced piece of stone.

Casting the dome

The dome was cast in 11 concrete pours, working up towards the final pour for the roof light. The concrete was placed traditionally, using a concrete pump and standard methods of compaction. The main dome roof slab was 750mm-thick 40MPa concrete. A concrete pump was used for the early stages of each pour. The upper sections of each of the pours were poured using a 150-tonne crawler crane and concrete skip. This allowed for concrete with a slightly stiffer slump to be used for the final stages of the pour. As a result, it was possible to achieve the specified curved and sloping finish with no outside shutter. A double key piece stop-end with hydrophilic strip was used to waterproof the construction joints.

The accuracy of fit of each of the formers ensured there was no movement of the formwork once installed, even with the considerable loads imposed upon it. The block coding system and layout drawings also greatly reduced the time involved in formwork assembly. Once struck, the polystyrene formers were reused as voidformers above the dome thereby reducing the amount of backfill required and therefore the load transmitted to the concrete roof – a good example of sustainable construction.

Cordek MD Rodney White comments, "This was a fantastic project with which to be involved. We see great potential in the future for this type of formwork and are continuing to invest in equipment and materials to further develop the system."

Conclusion

Despite the complexity of the project, the building works were awarded in April 2005 and practical completion achieved, on programme, in November 2006. All parties worked together to complete a taxing but rewarding project on time and on budget. ■