

The Eden Project, Bodelva, Cornwall

The Eden Project, a showcase for global bio-diversity, is one of the most innovative and high profile Millennium Projects. Its network of "biomes", a sequence of great transparent domes that encapsulate vast humid tropic and warm temperature regions, make it the largest plant enclosure in the world built in the lightest and most ecological way possible.

The Biomes

The design, inspired by the Buckminster Fuller geodesic principle, evolved as a collaborative series of adjustments to a working 3-Dimensional computer model passed digitally between the architects, engineers and contractors. The final structure, the perfect fulfilment of Fuller's vision of the maximum enclosed volume within the minimal surface area, emerged as a sinuous sequence of eight inter-linked geodesic domes threading around 2.2 hectares of the site: a worked-out Cornish clay pit. These "Bucky balls" (named after Fuller) range in size from 18m to 65m radius in order to accommodate the varying heights of the plant life. Form follows function, a tangible expression of the client's aim to draw global attention to human dependence upon plants.

The biomes are an exercise in efficiency, both of space and of material. Structurally, each dome is a space frame reliant on two layers. The first, an icosahedral geodesic skin, is made up of hexagonal modules that range in diameter from 5m to 11m. Each comprises six straight, compressive, galvanised steel tubes that are light, relatively small and easily transportable. This makes it possible for each hexagon to be pre-assembled on the ground before it is craned into position and simply bolted to its neighbour by a standard cast steel node.

The primary layer is joined to a secondary one by diagonal Circular Hollow Section members at the node points. Structural stability is guaranteed by the "shell action" of the intersecting domes, that is, meeting of inner and outer structural members to form pinned connections. These are anchored to reinforced concrete strip foundations at the perimeter.

The exact location of the biomes on site has been determined by Solar Modelling, a sophisticated technique that indicates where structures will benefit most from passive solar gain. The architects have capitalised upon this gain by cladding the biomes with ETFE (Ethylene Tetra Fluoro Ethylene) foil.

ETFE represents less than one percent of the dead weight of equivalent glass. It is also strong, anti-static and recyclable, contributing to the overall realisation of the Eden biomes as tangible examples of energy-awareness in action. Elsewhere on the site, energy-awareness is manifest in both the Biome Link building and the Visitors' Centre.

Biome Link

The Biome Link primarily functions as the entry to the biome complex, and has thus been designed with the ease of visitor movement in mind. It is essentially two structures within one: a front-facing public facility and a two-storey service area to the rear.

The front-of-house element, incorporating a raised steel and timber walkway into the biomes, is of a sloping convex truss system. The trusses consist of curved top and bottom booms with pinned jointed internal strut and tie members. They are supported by raking columns at the front that have expressed pinned joints top and bottom and are stabilised by the building to the rear, a two-storey braced steel-framed structure. The main cellular beams are set out on a radial grid, which can accommodate variations in the span between columns. The secondary beams are at 2.75m centres.

The roof plane is "warped" at both ends, and its profile steel decking supports a green roof system that allows the Biome Link to seemingly melt into the "cool temperature zone" of its surrounding environment. Access is by way of a path that winds down through this zone from the Visitors' Centre.

Visitors' Centre

The Visitors' Centre is primarily an educational facility, with multimedia exhibits serving to introduce the aims and objectives of the project. The structure itself is equally informative. Dramatically curving to complement the contours of the quarry, it consists of two single-storey buildings linked by a partially covered courtyard. While the smaller (service) building nestles into the quarry, the main building thrusts outwards, offering a panoramic view of the biomes.

The main building is steel framed, with the roof beams spanning up to 20m between columns. The beams are set out on a radial grid and slope down at approximately 5° towards the service building at the rear. The roof structure, a steel deck capped with aluminium, forms part of the shallow cone resulting in a radial beam spacing of approximately 5m at the rear of the building and 6m at the front. To the south of the main building, it forms an overhang that shelters a rammed earth elevation. The use of rammed earth walling as a construction technique is local to Cornwall. It is also very much in keeping with The Eden Project's emphasis on recycling. The material used is the excess from excavation work carried out elsewhere on the site, geologically identified as containing the required range of particle sizes.

The building is stabilised at each end by columns that cantilever from pad foundations. The central section is loaded laterally by the fabric roof, in addition to the wind load. In this section, a truss system in the plane of the roof transfers the lateral loads to braced frames. The truss members are generally sized to limit the deflection of the horizontal truss where it cantilevers at each end.

Architect **Nicholas Grimshaw & Partners Ltd**

Structural Engineer **Anthony Hunt Associates Ltd**

Steelwork Contractors **Biomes - Mero (UK) plc
Link Building - Pring & St Hill Ltd
Visitor Centre -
Snashall Steel Fabrications Co Ltd**

Design & Build Contractor **Sir Robert McAlpine Ltd / Alfred McAlpine
Construction Ltd - Joint Venture**

Client **The Eden Project Ltd**



Picture courtesy of Simon Doling

Judges' Comment

The size and scale of this complex and visionary engineering project is truly breathtaking. Its success has the hallmark of dedicated and committed teamwork.

