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Artikel: Sea defence works in North Wales (UK)

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2. Sea Defence Works in North Wales (UK)

Owner:	*Welsh Office (Director of Highways, Mr. G. Mercer)*
Engineer:	*Travers Morgan & Partners*
Contractor:	*Sir Alfred McAlpine & Son (Northern) Ltd. – Fairclough Civil Engineering Ltd., Northern Division Consortium*
Period of Construction:	*3½ years*
Completion:	*December 1984*

The Llanddulas to Colwyn Bay section of the new A55 forms part of the Welsh Office's improvements to a high standard dual carriageway of the 90 km of trunk road between Chester and Bangor in North Wales.

In 1966 the Welsh Office set up a local study team to consider traffic problems in the towns of Colwyn Bay, Llandudno and Conwy, and concluded that a new route for the A55 was required. In 1969 Travers Morgan & Partners were appointed to carry out a detailed feasibility study over a length of 45 km. The problems of route location in this part of Wales are formidable and the prime routes had already been chosen by earlier engineers. Thomas Telford constructed the existing road in the early nineteenth century and Robert Stephenson built the railway to Holyhead in the 1840's. A total of 45 different routes were studied and the Welsh Office decided to proceed with the development of a coastal route. At Llanddulas this route runs along the foreshore for 1.6 km.

This section of foreshore is bounded by boulder clay cliffs which are continually being eroded by the sea and much of the foreshore has been subjected to deep-seated landslips. These boulder clays overlay limestone bedrock which can be seen in the vast quarries just inland from the existing road. The line of the new road runs between these cliffs and the shore line. Construction of this section started in August 1981 and formed part of a £ 35 m contract for 5 km of new highway; it was opened to traffic in December 1984.

The new roadworks embankment has been designed to add sufficient toe loading to stabilise the cliffs and prevent further landslips. Its seaward extent was therefore determined by the need to obtain adequate factor of safety against sliding.

The embankment is constructed mainly from rockfill materials which were readily available from local limestone quarries. However, the embankment faces due north into the Irish Sea and the water depth at the seaward face can be up to 7 m. In these conditions, the size of rock armour needed to withstand the predicted 5 m inshore wave height was not available and a precast concrete armour unit, the Dolos, was adopted.

Earlier in 1980 a trial embankment (Fig. 1) had been constructed at a cost of £ 2.5 m to verify the embankment design and evaluate the method and rate of construction to be adopted in the main works. The Dolos units were not placed in this trial.

A Dolos unit is a twisted H-shape, rather like a ship's anchor (Fig. 2 & 3). It has a high void to solid ratio, which is necessary for dissipating wave energy, and its shape causes neighbouring units to interlock with each other giving added stability to the armour layer. Thus, the unit served two functions in protecting the seaward face of the embankment and preventing unacceptable volumes of sea water over-topping onto the carriageway of the new A55.

The size of Dolos unit was determined as a result of model tests in a random wave flume at Hydraulics Research Ltd. A 5-tonne unit was adopted, placed at a slope of 1 on 2. In all, just over 22,000 Dolos units were used on the embankment.

The Dolos units were unreinforced. Photo-elastic analysis has shown that to be of any use the reinforcement would have to be close to the surface of the concrete and this is at variance with the cover required in a marine environment. If the reinforcement is given the depth of cover normally required, its inclusion can only marginally improve the resistance to breakage and this is insufficient to justify the considerable additional cost.

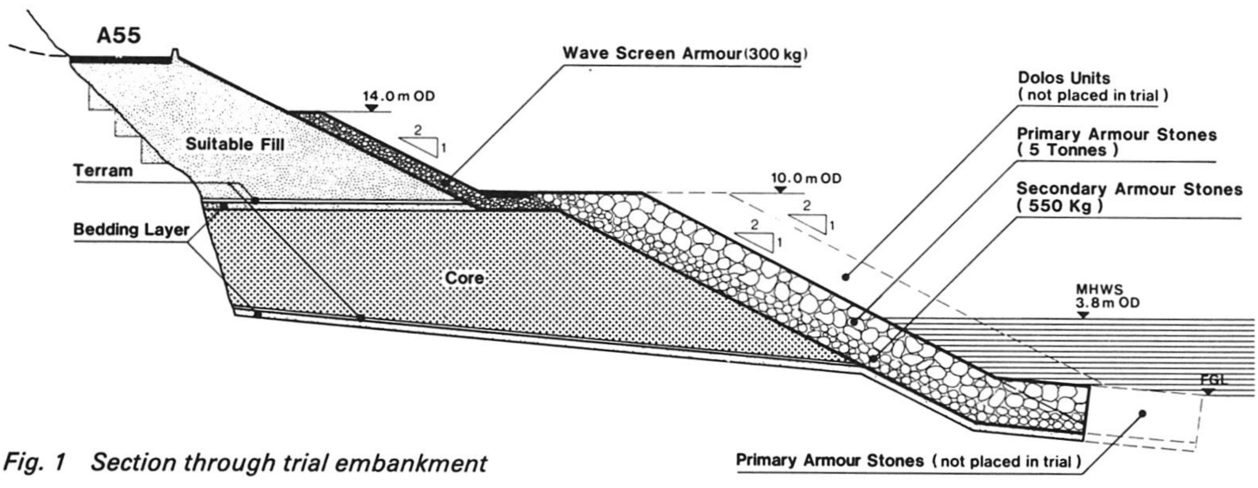

Fig. 1 Section through trial embankment

To reduce the peak stresses that occur at the junction of the flukes with the shank of the unit the corners were detailed with small radii. Photo-elastic analysis had again proved useful in indicating the optimum size of radius becomes too large then the interlock between the units can be affected.

The Dolos units were mass produced in a casting yard on site and production averaged some 70 units per day in order to keep to the 15 months casting schedule. The units were cast in steel moulds with the shank in the vertical position. The moulds were designed so that the top half could be removed leaving the Dolos unit fully supported by the remaining bottom half of the mould. This design enabled the top half to be removed, cleaned and reused on another bottom half without having to wait for the unit to gain sufficient strength to be lifted clear.

Because of the shape of the Dolos unit the moulds were provided with compression joints midway along the shank to reduce the amount of restraint on the hardening concrete. The concrete used was grade 45/37.5 with a minimum 400 kg of cement per cubic metre and a maximum water/cement ration of 0.4. An air entraining agent was used to give an air content of 4.5 per cent and this was found to be beneficial in eliminating cracking at the junction of the flukes and shank.

The concrete was designed for durability in the marine environment, but it also achieved a high early strength to enable the units to be lifted clear of the moulds within 24 hours. The units were coated with a spray-on curing membrane and left to cure in the open air.

The placing specification called for an overall density of 45 Dolos units per 100 sq.m. These were to be placed in two layers with slightly more than half of the total number (55 per cent) in the bottom layer. Both previous prototype experience and the model tests had indicated that the Dolos armour layer is more stable if a significant number of units is placed with their vertical legs to seaward. This was achieved by placing at least 50 per cent of the units in this orientation.

The Dolos units were all placed by land based plant working from the new embankment. The site is intertidal and the whole of the works are exposed at low water, which faciliated the placing of the critical units at the toe of the embankment.

Since placing of the Dolos units, breakages have been monitored. Up to the end of 1985 some 200 units have been noted as damaged; 34 of these have been replaced during the contract maintenance period. It is inevitable that some units would be in relatively unstable positions and therefore susceptible to damage. Allowing for an initial settling down period, this level of damage accords reasonably with experience of the use of Dolos units elsewhere.

The 22,000 Dolos units required 44,000 cu.m. of concrete and the total cost of the Dolos layer was £ 3.7 m.

(S.J. Wood)

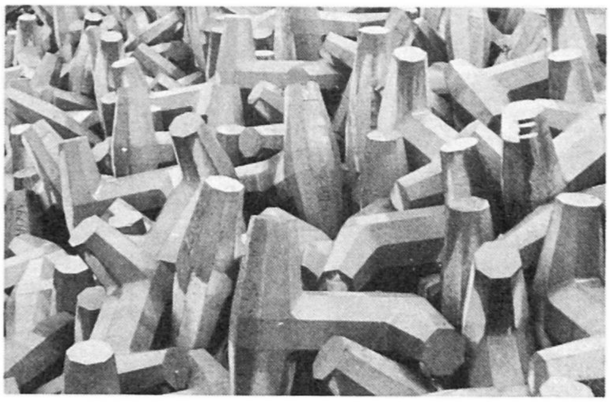

Fig. 2 Dolos units

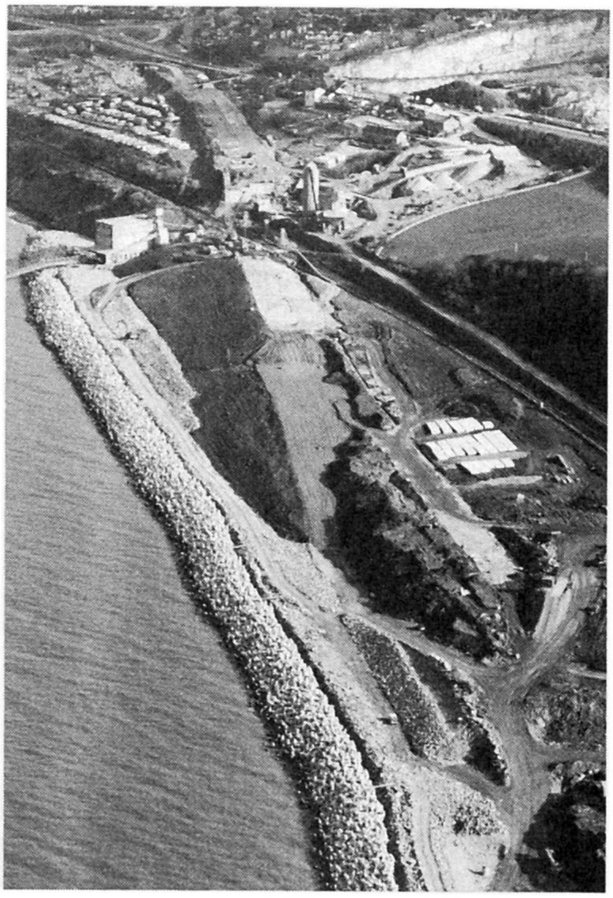

Fig. 3 Aerial view of foreshore on completion of placing Dolos units