RESEARCH AND DEVELOPMENT IN SUPPORT OF THE DESIGN OF A PRESTRESSED CONCRETE PRESSURE VESSEL FOR A WORKING PRESSURE OF 69 N/mm^2 (10.000 p.s.i.)

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A design has been developed for a pressure vessel, with a chamber 3.05 m (10 ft) in diameter and 9.15 m (30 ft) high to be used for hydraulic tests on marine components to very high working pressures up to 69 N/mm^2 (10,000 p.s.i.). The main chamber consists of a free-standing vertical steel cylinder with independent end plates, contained within an external prestressed concrete structure. Clear access to the chamber is achieved by providing a removable prestressed concrete closure plug over a flat steel plate which is structurally independent of the cylinder.

Loads on the top plate are transferred through the prestressed concrete closure plug and a system of inclined struts into a reaction ring. Loads on a bottom plate are transmitted directly on to a bottom cap. The reaction ring is tied to the bottom capby prestressing tendons passing through the barrel section of the concrete structure. Both reaction ring and bottom cap are prestressed with wire windings to contain hoop bursting forces.

The design concepts for the structure place it outside the scope of existing standards and Codes of Practice. The absence of recognised codified criteria for this type of structure necessitated an approach substantially based on model analyses to be used for designing the structure. Thus to aid the design of each of the constituent parts (the bottom cap reaction ring and closure plug) three separate small scale model test programmes were initiated to investigate the effects of various parameters on the ultimate behaviour of each concrete component. These were followed by analytical studies to confirm the overall behaviour of the structure.

When the design of the concrete structure was substantially complete fully-representative fifth-scale models of the bottom cap, reaction ring and closure systems were constructed and tested to confirm the behaviour of these components under operating conditions and the reserve of strength.

This paper describes and discusses the results of the extensive test programme on 180 scale models carried out to provide design data for the concrete structure. Information from these model tests enabled the primary dimensions and optimum level of circumferential prestress to be established. The paper also describes the behaviour of one-fifth scale models of two structural assemblies which have been tested to establish the overall behaviour.