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Improvement of Shear Capacity of Composite Structures

S. S. Gowda* and P. Hassinen
Technical Research Centre of Finland, Laboratory of Structural Engineering, Espoo, Finland

INTRODUCTION

Many kinds of Arctic structures have been built during the past two decades to exploit the resources of the ice-infested waters of the Arctic region. The exterior walls of such offshore structures must be designed to resist the high external loads exerted by the moving ice floes and icebergs. Such structures, in addition to being economical, should be designed to possess a high degree of safety, durability and stability. Sandwich-type steel-concrete composite structures are a new concept designed to resist high external loads. The composite walls are found to be effective in transmitting large lateral forces due to ice or earth pressure to support bulkheads (Adams et al., 1988). The basic composite system consists of two thin continuous steel plates, placed concentrically with a filler material such as concrete between them. The other interesting types of steel-concrete composite structures are the double-skin sandwich structures, in which the two steel face plates are connected by studs with a concrete core between the steel plates.

This paper presents the load-deformation behaviour of steel-concrete composite members and their shear load-carrying capacity under static and cyclic loads. The new parameters included in this second test programme are steel fibre reinforcements, bar reinforcements, thin high-strength steel face plates and stainless steel face plates. The ultimate shear capacities of beam specimens are compared with the calculated values using empirical and upper-bound plasticity methods developed by the Centre for Frontier Engineering Research (C-FER).

The test results presented in this paper are from the second phase of the experimental programme on composite members. The specimens in the first phase were all made from normal steel and ordinary concrete without adding any reinforcing materials, and were similar to specimen VTT-05 of the second phase of the test programme. In the second phase, the influence of steel fibres and bar reinforcements in the concrete and the face plate thickness to the shear capacity have been studied. The more detailed version of this paper has been published in Gowda and Hassinen (1991).

DETAILS OF SPECIMENS AND TESTING

A total of 14 specimens were tested in this programme under two loading conditions; 12 specimens were tested under static loading, while the remaining two were tested under triangular cyclic loading. The details about the nominal dimensions of the specimens, strain gauge locations and the loading system are elaborately given in earlier publications (Gowda et al., 1990). However, the schematic of loading and nominal dimensions are given in Fig. 1.

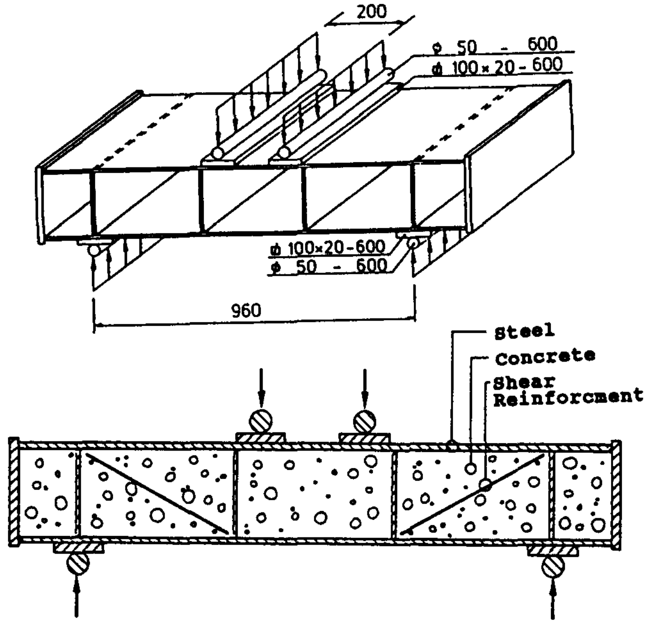

Fig. 1 Loading and nominal dimensions of specimens

The five groups of specimens tested in this experimental programme and the details of the parameters in each group are given in Table 1. The parameter w shows the dominant component to the shear capacity of specimens (Stephens et al., 1989). The previous tests carried out on specimens VTT-01 to VTT-04, which were made of normal steel and normal concrete, had slightly different geometrical dimensions compared with the new reference specimen VTT-05. The details of shear reinforcements are given in Table 2.

All the specimens were tested under four-point line loading using a distribution beam and a roller assembly. Three loading stages were followed during the testing of the specimens: The monotonically increasing load until the appearance of diagonal shear cracks in the concrete; decreasing load after diagonal cracks; and reloading incrementally until the ultimate failure of the specimen. During all these three stages of loading, strains and displacements were measured continuously at specific intervals. The deflection at midspan was measured with dial gauges at two locations, at the front and the back of the specimens. Load control was used during the first and second stages of loading, while stroke control was used during the third stage of loading.

The behaviour of the specimens with these parameters was compared with reference specimen (VTT-05). The ultimate load capacity and the load corresponding to the appearance of the first diagonal crack on each specimen is given and compared with the capacity of the specimen VTT-05 in Table 3.

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*ISOPE Member.

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