

Research update

Dr Nutan Subedi, member of the Institution's Research Panel outlines four research projects at Dundee University covering composite action, neural networks, and light-weight structures:

Punching resistance of reinforced concrete slabs

The aesthetic value and the cost benefit of having clear space between the floor and the ceiling and without the provision of column head in a flat plate type flat slab construction is always appreciated by the client and architect alike. The attraction however always creates a major problem for the structural engineer with regard to ensuring adequate and guaranteed safety against possible punching at the slab-column junctions. A recent Best Practice Guide (Ref 97.376 – 2000) published by the BCA suggests that the use of proprietary shear systems, such as stud rails and shear ladders, appear to



Fig 1(a) Detail of NUUL system connection

good overall stiffness and resistance to abrasive elements. The original concept suffered due to lack of full composite action between the skins (top and bottom plates) and the core (concrete). The design was mainly governed by the buckling characteristics of the compression skin (Fig 2(b)) making the elements unattractive on the grounds of efficiency. The new concept utilises the plates acting as skins with designed surface preparation, which provide keys at the interface. The keys could be formed either by welding a layer of wire mesh, such as expanded metal mesh (Expamet) and similar, or by preforming indentations at manufacture on the inner face of the plates. Research has

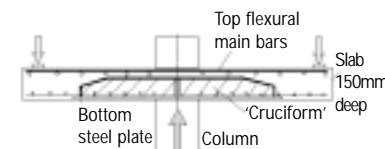


Fig 1(b) Preliminary test slab (staples detail not shown)

be almost always worthwhile. However, the cost features as a main criterion for selecting a particular system. It is believed that the main criterion for deciding a particular system should be the safety and complete elimination of punching from such vulnerable sites as the slab-column junctions. The mode of failure based on flexural capacity, but with remote possibility of punching should be the design criterion for flat slabs. With this as the main objective a series of test was conducted on various configurations of a new detailing system. The research has led to the development of a composite system utilising plate, crossbars and staples (Fig 1). Test so far suggests that this is a robust system, which provides a very high degree of punching resistance and thus eliminates the possibility of punching in the normal design of flat slabs. Further tests and field trials are being considered.

- *Further information:*
n.k.subedi@dundee.ac.uk

Steel-concrete-steel double-skin composite construction

The concept of steel-concrete-steel double-skin composite construction utilising various inter-connecting elements (Fig 2(a)), has been around for sometime. The application of such elements range from seawalls, underwater tunnels, blastwalls, aircraft hangars, building components, wave energy generating structures and bridges. The main advantages are the impermeability of the external surfaces,

shown that such elements provide full composite action (Fig3) enhancing the performance of the structural elements to its full capacity. A comprehensive range of tests has recently been completed funded by a PiI programme.

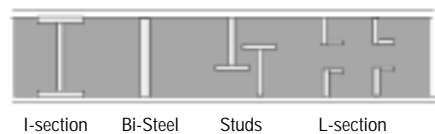


Fig 2(a)

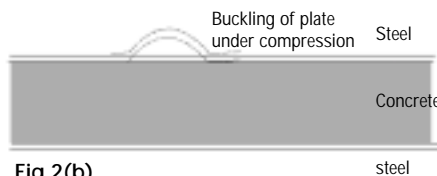


Fig 2(b)



Fig 3 Steel-concrete-steel double-skin composite construction: full composite action in flexure

Neural networks in design of cold-formed steel members

Cold-formed steel members have a wide range of possible cross-sectional profiles, aspect ratios and sizes. While this flexibility gives the designer almost unlimited freedom in shaping the members, it makes the selection of the most economical design for a particular application quite difficult. What matters worse are the complex rules that govern cold-formed member analysis and the vulnerability of cold-formed members to different failure modes. In a research project being conducted at the University of Dundee, neural network technology is used to develop a new design methodology that can overcome the complexity of design and arrive at the most efficient sections for different applications. After being trained with a large database of best section designs, the neural networks can choose the profile and size of the most efficient section accurately (Fig 4).

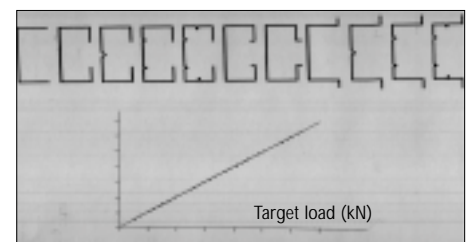


Fig 4. Neural networks: Design of cold-formed sections

- *Further information:*
a.i.e.elsheikh@dundee.ac.uk

Rapid deployable light-weight roof structure

The demands for light-weight roof structures for temporary shelters and accommodation has led to the development of a cantilever canopy structure through a collaboration between the civil engineering and architecture departments (Fig 5). This novel structure provides an elegant cover to grandstand seating that can be erected quickly and safely. It follows on from the development of a rapid erect military shelter that uses a pultruded fibre glass rib stiffened fabric web. When prestressed this produces a stiff arch rib to support the doubly curved membrane shell of the shelter.

- *Further information:*
n.burford@dundee.ac.uk,
f.w.smith@dundee.ac.uk

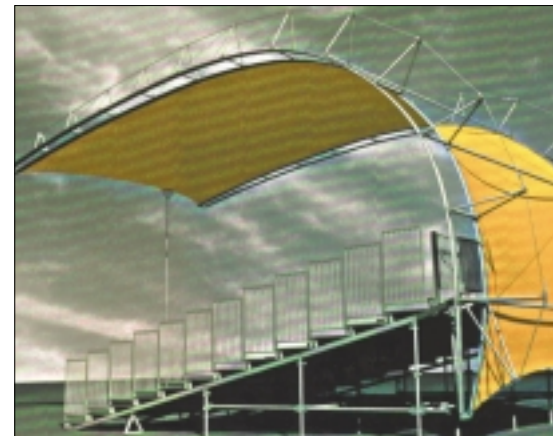


Fig 5. Rapid deployable light-weight structure