CURTIN UNIVERSITY TESTING OF CLASS L SLABS NEARS COMPLETION

Low ductility (Class L) 500 MPa steel mesh with ribbed bars produced in accordance with AS/NZS 4671 is used extensively as multi-purpose main and secondary reinforcement in suspended concrete floors (eg. see Figure 1) designed in accordance with the Concrete Structures Standard AS 3600.

Figure 1. *Suspended concrete floor constructed with Class L mesh.*

Curtin University of Technology Research Program

Since July 2008, the SRIA has funded a research program, with full-scale structural testing of monolithic, reinforced-concrete slabs incorporating Class L mesh, being conducted by the Department of Civil Engineering, Curtin University of Technology in Perth. The testing will soon be completed, and an unabridged Curtin University test report including all the details of the tests and a comprehensive set of test results and data files will subsequently be made generally available by the SRIA.

Peer Review Panel

To ensure the research program is conducted in an open manner, an independent Peer Review Panel has been established. Panel members consist of leading academics from a number of universities around Australia, as well as executive engineers from consulting engineering firms, all with an interest in the structural use of Class L mesh. Their role is to review the test procedures, witness critical tests, and review the Curtin University test report and test results prior to their public release.

Universal Test Rig

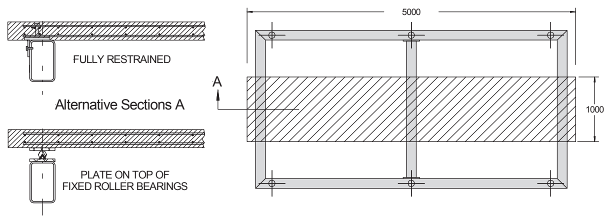
The slab tests are all being conducted using a flexurally and torsionally rigid, tubular steel ringbeam (see Figure 2) as a universal test rig. The behaviour of three types of slabs is being studied, viz. single-span one-way (SSOW); double-span one-way (DSOW); and a two-way (TW) slab.

As shown in Figure 2(a), slabs are constructed with edge support conditions that are either fully restrained (in rotation and translation), or unrestrained in rotation and horizontal translation.

The fully-restrained edge support conditions are intended to simulate practical cases like shown in Figure 1, where this condition can be achieved when slabs are cast monolithically with large beams or walls. It was much more economical to build the steel ringbeam and repeatedly use it in all the slab tests, rather than pouring and testing slabs cast into the sides of concrete beams. A steel plate was cast in the slab soffit at each end or side, and attached to the ringbeam according to the detail in Figure 2(c). Alternatively, in the slabs with the unrestrained edges, the end steel plates were seated on top of roller bearings like shown in Figure 2(d), noting that the bearings were fixed in position horizontally. These latter tests were performed in order to know the bending moments precisely, for example to make it possible to compare the ultimate moment reached in a test with the theoretical bending capacity based on real material properties.

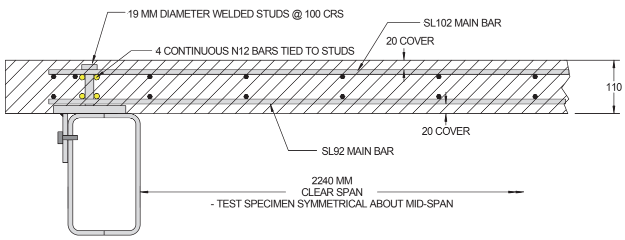
Membrane Action in Built-in Concrete Slabs

Membrane in-plane forces develop in built-in concrete slabs, and depending on the boundary conditions and amount of deflection, they can significantly enhance the load-carrying capacity above



(a) Plan and cross-sections (DSOW slab).

(b) Ringbeam being used in a SSOW test with fully restrained edges, and central cross-beam in (a) present.



(c) Detail to achieve full rotational and translational edge restraint in a restrained test like shown in (b).

(d) Roller bearings used, fixed in horizontal position.

Figure 2. *Tubular steel ringbeam and supports built by Curtin University, used as a universal test rig for all the slab tests.*

the normal design values based on pure flexural strengths assuming a plastic mechanism. Compressive membrane forces develop initially, like shown in Figure 3, with the maximum deflection less than about half the overall slab depth.

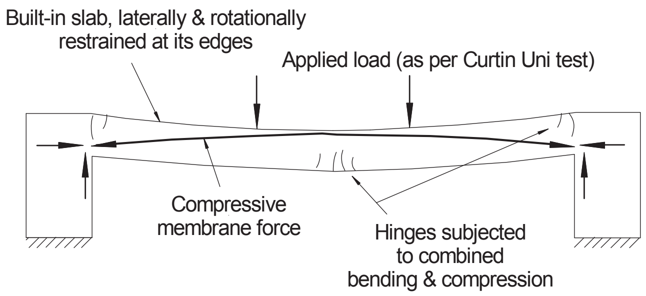


Figure 3. *Membrane action involving in-plane compressive force.*

Scope of Curtin University Slab Tests

All of the SSOW, DSOW and TW slabs tested (see description of each series below) have been designed and detailed in accordance with the latest provisions of AS 3600–2001, so that direct comparisons can be made between the test and design strengths once the Curtin University report is published.

Figure 4. *Mixing Class L mesh and Class N bars in a SSOW slab.*

The nominal overall depth of each of the slabs is 110 mm, which all contain normal ribbed SL92 and/or SL102 meshes, and in some tests N12 supplementary bars – see Figure 4. Mixing reinforcing steels of different ductility classes (Classes L and N) occurs in practice, e.g. when the cross-sectional area of a mesh needs to be increased; or when transverse slab and main beam reinforcing steels act together. The standard strength grade of the normal density concrete used in all the tests is 25 MPa, representative of interior floor construction in concrete buildings.

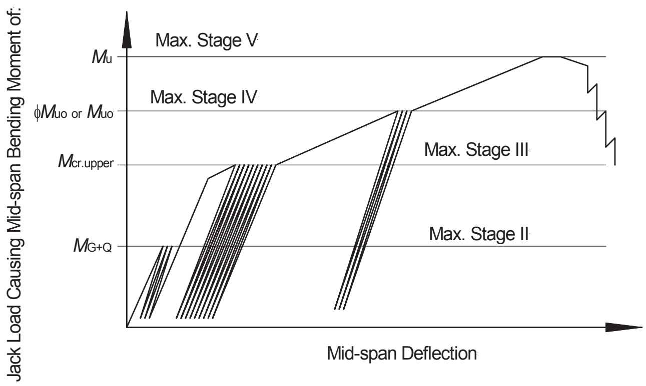


Figure 5. *Primary SSOW slab test procedure.*

SSOW Slab Tests (10 in total, including 2 trial slabs)

A total of ten SSOW slabs, each 1000 mm wide with a minimum clear span of 2140 mm, have been tested to failure, two with restrained edges as shown in Figs 2(b) and (c). Other test variables include: the loading pattern (one, two or normally four line loads); the size of the mesh; and the number of N12 bars. The primary test procedure followed in the tests is shown diagrammatically in Figure 5, and comprised five loading stages, viz.: I – mid-span jacking from underneath (uncracked); II – initial cyclic loading (uncracked); III – transition (uncracked to cracked); IV – subsequent cyclic loading; and V – monotonic loading to failure. Similar procedures were used in the DSOW & TW tests.

DSOW Slab Tests (4 in total)

In the four DSOW slab tests being conducted, e.g. see Figure 6 where each clear span is min. 2145 mm and the specimen width is 1000 mm, the central support beam in Figure 2(a) can be moved up or down relative to the ends to simulate differential settlement, and the central vertical reaction measured in order to calculate the bending moment diagram at any stage of loading for two of the slabs with their ends supported on the roller bearings shown in Figure 2(d). Differential settlement can cause significant amounts of moment redistribution, which is not necessarily taken into account in design, and its potential effect on the ultimate strength of the slabs tested is of primary interest.

Figure 6. *A DSOW slab test in progress.*

TW Slab Test (1 in total)

A two-way slab with fully restrained edges was tested with the central support beam in Figure 2(a) absent, and therefore the clear spans were 2140 and 4440 mm in the short and long directions, respectively. Water retained by a pool liner was initially used to uniformly load the slab as part of a proof-load test conducted in accordance with AS 3600–2001, firstly for serviceability (10 kPa) and then factored ultimate load (15 kPa) conditions – see Figure 7(a), after which in the test the slab remained uncracked. Next the slab was tested to failure using four hydraulic jacks, which each applied a vertical point load distributed over a 200×200 mm patch area symmetrically positioned about the slab centre – see Figure 7(b). Like in all the test series, numerous electronic measurements of force, deflection and strain were taken for subsequent processing when the results are released. Photographic records were also taken, including some video footage.

(a) Two-part proof-load test using water to 15 kPa (full height of tank), shown after test with liner wrapped up.

(b) Testing to failure using position-controlled jacks.

Figure 7. *TW slab tested in two stages.*