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Newsletter No. 4

10 Years of Structural Steel Fibre in Australia

The use of Structural Steel Fibre Concrete (SFRC) systems for slab on piles, structural rafts and free elevated suspended slabs has been developing in Europe since 1991. Full scale tests have been conducted with fibres providing the sole reinforcement for the 160mm slabs in Ternat Belgium 1991, Townsville Australia 2003 with Twincone 1/54 and also in Bissen Luxembourg 2004 using Tabix 1.3/50 undulated fibre. (Notes 1, 2, 3)

The correct use of SFRC in suspended slabs on piles is closely related to the fibre anchorage and the different loads that are imposed. By using a fibre that has 100% anchorage the Twincone or a continuously deformed undulated fibre has been found to give the best results.

SFRC in piled floors and engineered structural applications is referred to in Technical Report 63-UK(Note 4) and table 2 on page 10 outlines extensive use of SFRC in the UK. This design approach has been developed through the above full scale tests and over 6,000,000m^2 of slabs on piles. It is also important to note that this design approach is defined as "design aided by testing" and as such should not be a broad scale approach, but be specifically analysed for each project. So, for fibre purveyors to purport that 20-40kg/m^3 of their fibre will be sufficient for such applications it is important to compare the information with full scale test results of Townsville, Ternat and Bissen. What designers and contractors realised was that a small beam test, such as CMOD, will not provide sufficient information that can be used for design of such applications.

Many results obtained in lab tests are heavily in favour of SFRC and yet seem to be unable to be reproduced in a real scale environment. This is often because tests in labs are not the actual environment the concrete will exist in, and therefore often produce results in the order of 20-40% variation in real life.

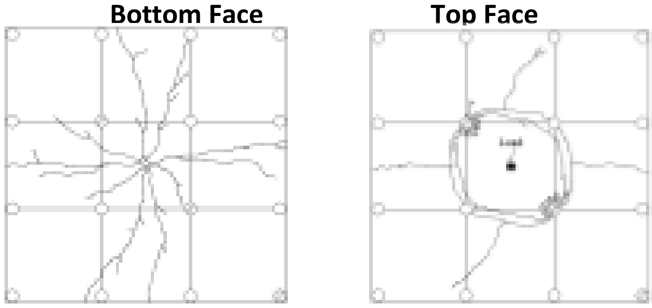
For the use of SFRC in such applications the dosage of fibres will vary depending upon the fibre anchorage and suitability for mixing with even distribution.

Full Scale Test 2003 James Cook University (JCU)

Construction and testing of fully suspended slab, JCU.

The crack patterns for the top and bottom of the centre bay are given below: All 160mm Slabs

Bottom Face **Top Face**



Slab Results

Max load capacity centre bay	=	400KN
Max deflection centre bay	=	29.64mm
Max load corner bay	=	300KN
Max deflection corner bay	=	31.16mm

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SFRC & Steel Combinations

Tilt panels for Concrete Aggregate Bins

Testing of a one way slab with fibre and L Class Mesh

The use of steel fibre in combination with conventional reinforcement is not new and has been used in many projects from Tilt Up load bearing walls, slabs on ground and raft foundations since the 1990's.

Many fibre purveyors profess that their steel fibres are able to be used instead of steel reinforcement, or in combination with "L" class fabric to improve its ductility during failure. Therefore in 2010 and 2011 research was conducted at JCU to assess the ductility of SFRC in combination with "L" class fabric.

The tests conducted were a replication of the one way and continuous slab tests by *Gilbert & Sakka (Note 5)* with a difference of combining various steel fibres at different dosages with the SL82 fabric.

The results showed that even 40kg/m^3 of crimped and hook end fibres were unable to provide enough additional distribution of stresses and the slabs all failed in a brittle manner, as reported by *Tuladhur, Lancini & Collister 2011 (Note 6).*

Only the Twincone fibres or total anchorage fibres were able to provide the stress redistribution to give a ductility factor greater than 2 as per AS3600.

Interested?

Fibercon can provide references and advise on applications that are suitable

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Results from Fibres and "L" Class Mesh

Δ_1 = midspan deflection when the longitudinal tensile reinforcement begins to yield, and

Δ_2 = midspan deflection when the slab first began to unload

Slab Specimen	Δ_1 (mm)	Δ_2 (mm)	$\mu = \Delta_2/\Delta_1$ (mm)
3xN12	13.40	55.17	4.12
SL82	9.91	15.85	1.60
30kg 38mm crimped	9.64	17.27	1.79
40kg 38mm crimped	10.50	17.35	1.65
30kg 65/60	Not Recorded	18.78	Not Recorded
40kg 65/60	11.43	21.45	1.88
30kg Twincone	10.70	21.62	2.02
40kg Twincone	9.83	20.28	2.06

Two-Span Continuous Slab Test at James Cook University (JCU)

Notes

1. Using SFRC to Advance the Performance of Industrial Concrete Floor Slabs - Eddy, Alexandre - Concrete 2011, Perth
2. Structural Application of Steel Fibre as Only Reinforcing in Free Suspended Elevated Slabs: Tab-Slab Conditions – Design examples - Xavier Destree
3. Concrete 2007 Structural steel fibre reinforced concrete construction - Xavier Destree
4. Technical Report 63 - *Guidance for the design of steel fibre reinforced concrete*
5. Effect of Reinforcement Ductility on the Strength, Ductility and Failure Mode, etc - 2008 - Gilbert & Sakka
6. Structural Behaviour of SFRC slabs with "L" class reinforcement - Tuladhar, Lancini, Collister - Concrete 2011, Perth