



FLOORS AND PAVEMENTS

CBI 3121

November 2009



FIRTH STEELCRETE™ APPLICATIONS

Firth Steelcrete™ combines a specifically designed Firth Certified Concrete® mix with purposely manufactured steel fibres. The end result is a product ideally suited for use in floors and pavements.

Some of the advantages of Firth Steelcrete™ floors over conventionally reinforced floors include:

- Reduction in the floor thickness of up to 25%.
- Improved impact resistance.
- Greater distance between joints.
- Less edge damage as fibres are distributed through the entire matrix.
- Eliminates concern that mesh is in the correct place.
- Trucks can be driven up to pour potentially eliminating the need for pumps.

HOW FIRTH STEELCRETE™ WORKS

The inclusion of steel fibres provides concrete with post cracking load carrying capacity. Figure 1 illustrates that in plain concrete sections the load carrying capacity drops to zero after the concrete has cracked. However, as figure 1 illustrates, the inclusion of steel fibres provides the concrete with post cracking strength, the magnitude of which is dependent upon the fibre dose and the type of fibre. This post cracking strength greatly increases the load carrying capacity of the floors as it allows redistribution of load and the development of a yield line failure mechanism.

The area beneath the load-deflection graph is a measure of the energy required to achieve a certain deflection and leads to the concept of "toughness" for steel fibre reinforced concrete. This toughness can then be used to determine the equivalent flexural strength "f_e" for use in determining the load carrying capacity of Firth Steelcrete™. Typically f_e is calculated associated with a deflection of the test beam of 3mm and given the nomenclature of f_{e,3}. R_{e,3} if the ratio of f_{e,3} to the flexural strength at first cracking.

P₁ - First crack load
P_{max} - Ultimate load capacity


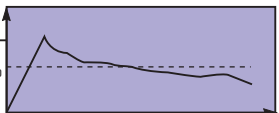
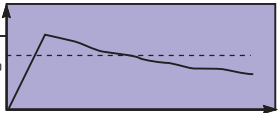
		P ₁ (kN)	P _{max} (kN)
Plain Concrete		180	200 (120)
ZC 60/1.00 30kg/m ³ f _o = 3.48N/mm ²		240	340 (190)
ZC 60/0.80 30kg/m ³ f _o = 4.79N/mm ²		290	410

Figure 1. Full scale testing verified that the limit state approach proposed to account for live load in accordance with the UK Concrete Societies report TR34 gives a conservative design.

Equivalent Flexural Strength - f_{e3}

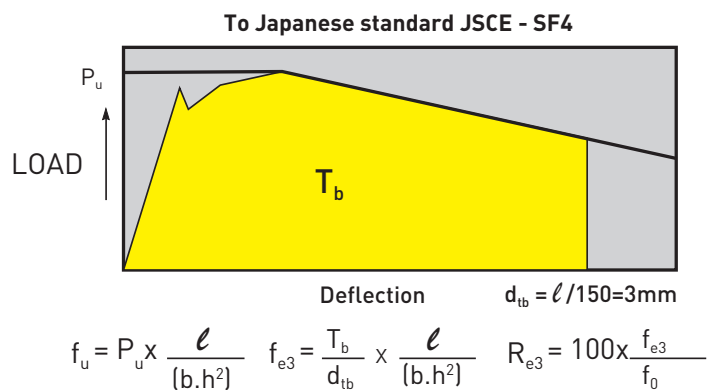


Figure 2. Deflection curve for the fibre reinforced beam is the basis of the ASTM and Japanese standards for steel fibre reinforced concrete testing. Calculation of the equivalent flexural strength for JSCE SF4 as shown.

The demands on industrial floors and pavements have increased enormously over recent years. Often conventionally reinforced pavements with shrinkage reinforcement have become very thick. This is due to the high localised stresses caused by point loads such as vehicle loads or racking systems. With Steelcrete™, the bending moment remains almost constant with increasing deformation as a plastic hinge is formed allowing for redistribution of bending moments and the formation of a classic yield line pattern at failure. The moments induced in Steelcrete™ floors are significantly lower than the moments in plain concrete for the same load.

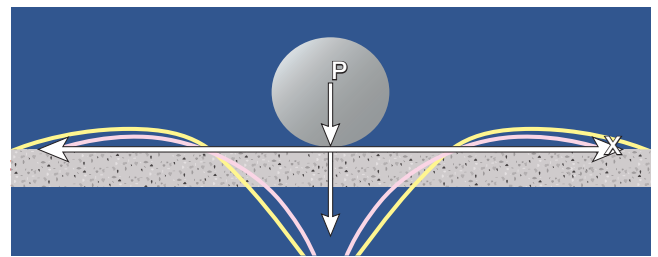
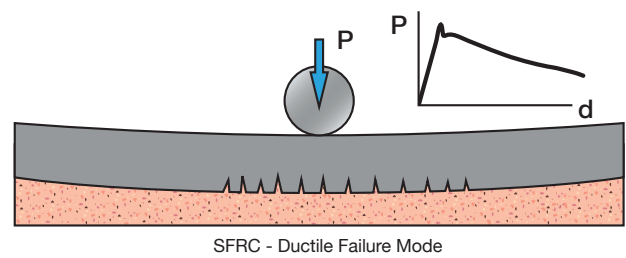
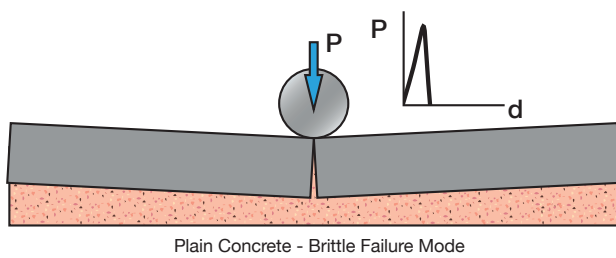


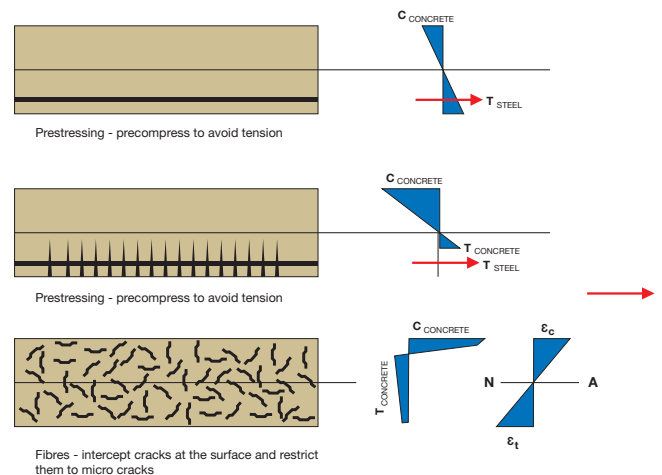
Figure 3.

- Unreinforced concrete deforms, reaches ultimate moment and a macro crack forms.
- Fibre reinforced concrete deforms, the load is spread and the moment is redistributed as plastic hinges develop. Micro cracking over a distributed area develops instead of a macro crack.



Steelcrete™ also gives better crack control than mesh. In the case of a mesh reinforced floor, macro surface cracks will develop before they reach the depth of the mesh. Steelcrete™ has fibres near the surface and crack control commences immediately leading to the formation of micro rather than macro cracks (figure 4).

Figure 4. Cracks must run to the depth of mesh before they are interrupted and macro cracks form. In Steelcrete the fibres at the surface curtail cracks and only micro cracks are formed.



The distribution of fibres throughout the matrix also gives protection to joints and edges, areas that provide the majority of problems in floor slabs (figure 5).

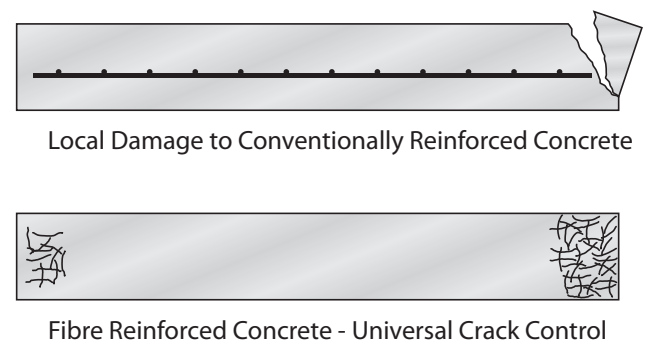


Figure 5. Steel fibres are throughout the slab and they help prevent joint and edge failure. However, a semi rigid epoxy is still recommended for hard wheels.

STEELCRETE™ SPECIFICATION FOR INDUSTRIAL FLOORS AND PAVEMENTS

The Cement and Concrete Association of NZ (CCANZ) provides a guide for the specification for concrete production and concrete construction. This guide has been developed for an industrial floor slab so covers many of the typical specification clauses associated with concrete supply, placing and finishing, curing, protection of concrete slabs, and construction tolerances. It can be down loaded from www.cca.org.nz

When using Firth Steelcrete™ the CCANZ specification should be modified to include:

1. The Concrete shall be Firth Steelcrete™, mix code _____. *Firth is able to provide technical assistance to determine the most appropriate mix code (Strength, fibre type, fibre dose) for your project.*
2. Preference should be given to the use of vibrating truss screeds to compact the concrete ensuring that a thin layer of paste is brought to the surface to assist in embedding the fibres.
3. Power floating should be conducted with “pan blades” to assist in embedding the fibres.

TECHNICAL SUPPORT

Firth Industries is able to provide and co-ordinate technical support for most aspects associated with the construction of floors using Firth Steelcrete™. This support may take the form of:-

1. Advise on the suitability of Steelcrete™ for your project.
2. Upon the supply of a summary of the design features, determine the appropriate pavement thickness and Steelcrete™ mix code. The mix code summarises the specified concrete strength, fibre type, and fibre dosage.
3. Provide guidance on the placing of Steelcrete™ to achieve the desired quality.

SUSTAINABILITY: THE FIRTH CONCRETE & CONCRETE MASONRY SUSTAINABILITY LIFECYCLE

- ✓ Environmentally compliant manufacturing plants
- ✓ Surplus water and some aggregates recycled
- ✓ Low transport impacts
- ✓ Leftover concrete returned from construction sites
- ✓ Passive solar heated thermal mass makes completed buildings more energy-efficient

- ✓ Most wash water returned from construction sites
- ✓ Highly durable, low maintenance buildings and no rot
- ✓ High degree of noise control
- ✓ Inherent fire resistance
- ✓ Overall longer effective building life
- ✓ Demolished concrete can be recycled as hard fill or aggregate

For more on Firth's contribution to building a sustainable tomorrow today, visit www.firth.co.nz or call us on 0800 800 576 for our free brochure.

