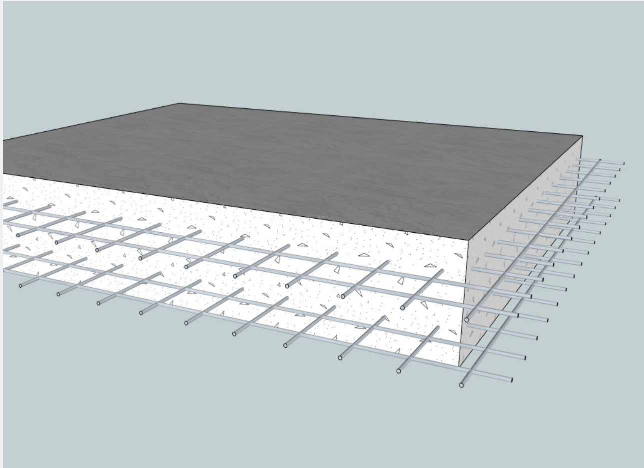
ADFIL Construction Fibres

Technical Note

Design of fibre reinforced concrete

Adfil® Durus



Structural concrete slab design

There are many methods to design ground supported concrete slabs. A structurally reinforced slab-on-ground can use a composite of concrete and structural steel to support the design load. Structural steel may be rebar or Welded Wire mesh.. The cross sectional area of the steel is inserted into engineering formulae to determine the load carrying capacity for a given slab design. In a structural concrete slab the thickness of the slab is not a factor in determining the load carrying capacity of that slab. The cross-sectional area of the steel, spacing of the steel and tensile properties of the steel are the key parameters for design calculations. To emphasize, the load carrying capacity of the structurally reinforced concrete slab is determined by the properties of the structural steel reinforcement specified and then typically Westergaard and/or Myerhof design methods are used to calculate the slab properties.

A structural slab design will accommodate (amongst other things) hogging moments above the primary and secondary supports, sagging moments between supports and shear at all supports. From this statement we can see that the flexural requirements at and between the supports will very likely exceed the flexural strength of the concrete and the reinforcement steel will be required to accommodate the stress generated throughout the design life of the slab.

One example of this are slabs supported on piles or fully supported on a framework of some description. These are generally deemed to be of a structural concrete design. A load is passed through a supporting framework of some description to the ground. The consequences of failure could be loss of life.

A plain structural concrete slab-on-ground

A plain structural concrete slab-on-ground uses the properties of the concrete to support the design loads. Here the thickness of the slab and the compression and flexural strength properties of the concrete based on 28 day tests are the controlling parameters. By definition, secondary/temperature-shrinkage reinforcement is used to control cracks after they have formed in the concrete cross-section. Secondary reinforcement is not considered in determining the load carrying capacity of the slab.
Typically, the majority of concrete car parks along with most industrial, warehouse and commercial floor slabs are designed with plain structural concrete. Plain concrete slabs will be thicker than structural slabs yet in most cases more cost effective .

These types of ground supported concrete slabs are generally not deemed to be of a structural concrete design as the load is passed directly through the slab to the ground. The consequences of failure are an inconvenience only. A ground supported slab may be required to accommodate the deflection stress associated with settlement. It will also be required to accommodate tension to the underside of the slab under load and tension to the top side of the slab between loads. From this statement we can see that a ground bearing slab is required to accommodate flexure and this is usually the limiting factor in a ground bearing slab design. A slab will never be designed to the limit of its compressive strength and is rarely deemed to be in tension only.

Macro Fibres

The use of Macro fibre Reinforced Concrete versus conventional steel as secondary reinforcement is in most cases very cost effective since there are no on site costs assignable to the fibres. The project time line can be reduced by eliminating the need to pre-place the wire mesh. We can also reduce costs by eliminating the need for a concrete pump when fibres are used in lieu of the wire mesh in slabs-on -ground. Here the use of fibres allow for the ready mix truck to discharge directly on the slab base at the point of use.

Macro Synthetic fibres are very useful for the design of ground bearing slabs for the following reasons:

- The Durus range of fibres improves the apparent flexural toughness of the composite concrete/fibre material. This provides an improved plastic limit which in turn improves the serviceability of the design if the stress condition designed for remains close to the elastic limit.
- The Durus range of fibres improves induced crack behavior which reduces the chances of the development of dominant joints and in turn helps maintain aggregate interlock and hence load transfer.

- The Durus range of fibres reduces the incidence of plastic shrinkage cracking.
- The Durus range of fibres reduces the amount of deformation due to plastic settlement experienced between casting the slab and achieving initial set.

From a design perspective we are interested in calculating the internal stress of the slab arising from the load, the concrete grade and depth and the ground reaction to the load.The stress calculation is considered at the center, edge and corner of a panel.

Flexural testing of a concrete beam to EN 14651 containing an different amounts of Durus fibre will provide a series of graphs of load versus deflection. We are interested in the section of the graphs between the elastic limit and 3mm deflection. This provides an indication of the slabs ability to redistribute plastic stress under load and provides an Re3 ratio. This in turn helps to determine the apparent flexural strength of the composite material at 90 days.

To ensure we provide a design that will not fail under load for a given ground reaction under a given load we ensure that the calculated internal stress plus any deflection stress remains within 20% of the elastic limit of the composite material. This provides an economic slab design within the load/ground conditions that is unlikely to crack and will not fail.

In addition to including a macro fibre only solution we will also on occasions combine this with a micro fibres which will also enhance the concrete ability to with stand plastic shrinkage and settlement cracks ,improve resistance to freeze thaw and also enhance the concretes impact and abrasion resistance .

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