Confiber ®

Impact Resistance

Technical Information

Concrete is an intrinsically brittle material, prone to damage through the impact of heavy items and loads, particularly at exposed edges and arrises. In practice, this damage can come from forklift truck wheels on internal slabs and from dolly wheel legs on external hardstandings. The same is applicable in precast elements that are mishandled during production and transportation. In all cases, impact damage is a major cause of a reduction in the life span of any concrete construction; leading ultimately to early replacement due to premature failure.

Confiber® enhanced concrete will give greater protection from joint edge deterioration in floor slabs and helps to protect arrisses in precast concrete products. Its impact resistance properties mean that Confiber® should be considered for heavy industrial use, military installations for blast damage resistance and other applications where seismic activity could be a problem.

The inclusion of our patented fibres into concrete increases the impact resistance of the concrete by up to five times that of plain concrete.

The improved impact resistance of Confiber® enhanced concrete can be accredited to the high amount of energy absorbed in debonding, stretching, and pulling out of the fibres after the cement matrix has cracked.

Studies have been carried out by the BBA and ICBO to determine the impact resistance properties of concrete containing fibres. Tests include repeated impact drop weight tests as reported in The ACI Materials Journal of Nov. Dec. 1988 by ACI committee 544. This method uses a 4.54 kg drop weight hammer with a 457 mm drop, as described in ASTM D 1557 and British Standard 1377:Part1: 1990.

The hammer is repeatedly dropped onto a hardened steel ball held in position above the concrete sample and the number of blows to first crack are noted.

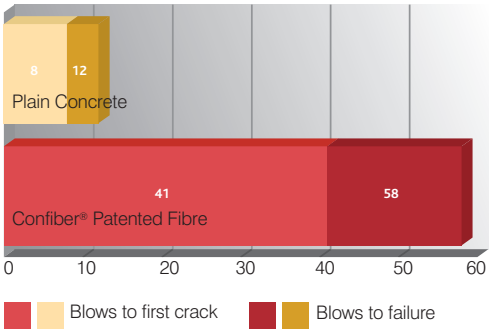
References

British Board Agrement Certificates ICBO AC 32 appendix 2

Abrasion Resistance of Fibre Reinforced Concrete Slabs - M. Sadegzadeh Aston Services.

Drop weight test

Impact damage to plain concrete



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Plastic Settlement Resistance

Technical Information

Plastic settlement cracks can occur where concrete segregates and bleeds excessively, outside of design parameters; this is particularly true in the case of thicker floor slabs. The inclusion of so-called crack control reinforcement will also exacerbate this problem, as concrete settles above the rebar, causing changes in height levels and voids beneath.

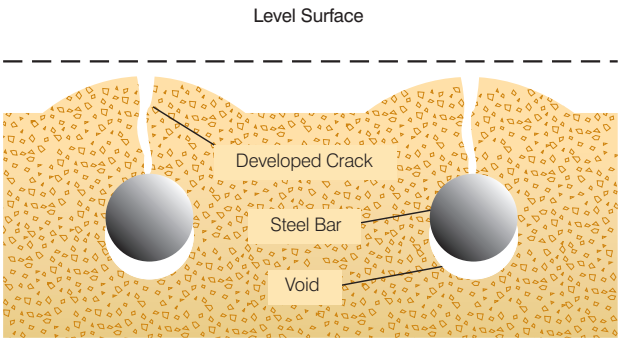
Therefore, as the concrete settles it will form a cracking pattern over steel mesh rebar or simply where there is a change in section depth. This type of cracking is often unsightly and will need repairing if durability of the concrete is to be maintained. In the worst case scenario, it is not unknown for significant amounts of concrete having to be replaced entirely for this reason.

In accordance with test results obtained following ASTM C 827-87 procedures, it has been demonstrated that Confiber® patented fibres significantly reduce the change of height of cylindrical specimens of fibre enhanced concrete. Fibres are able to do this by regulating the amount of settlement of fines within concrete through a more controlled rheology of the mix. This improved rheology, not only prevents the transmigration of fines settlement, but also controls bleed, which could, under certain circumstances, lead to loss of specified water content and a subsequent change of height due to reduced volume.

In accordance with results obtained by the BBA, it could be stated that the use of Confiber® fibres will reduce bleed by up to 40%, which will help reduce the incidence of settlement cracking.

Reference: Confiber® BBA certificates

Section 4.1.2 ICBO Acceptance Criteria for Synthetic Fibre Reinforced Concrete. (AC 32)



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Abrasion Resistance

Technical Information

Most concrete floors, both internal and external, are subject to abrasion through trafficking of vehicles such as, forklift trucks, cars and lorries. This problem also affects such constructions as bridges or sea defences, which are constantly subject to attack by abrasive agents such as: sand, shingle and boulders. Research has shown that the abrasion resistance of concrete is directly related to its strength, which is determined by a high cement content and low water /cement ratio as part of a properly designed mix. The most significant factor relating to abrasion resistance in concrete is the quality of the mortar and in fact, the hardness of coarse aggregates only becomes significant under exceptionally abrasive conditions when the surface matrix has worn away.

As part of our continuing effort to provide a cost-effective solution to this widespread problem, we suggest that our patented fibres be added to correctly designed mixes in order to provide significant abrasion resistance.

A Court Test

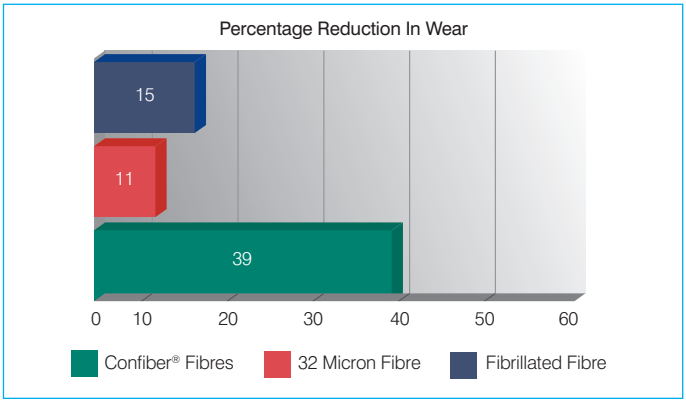
Confiber® patented fibres control the bleed water migration in a concrete mix, reducing the possibility of segregation of the fine cement and sand particles. This will give more efficient hydration of cement, and combined with the improved bonding of the cement matrix achieves a tougher more durable concrete surface. In addition, the surface will have a lower water/cement ratio than non-fibre concrete, thus increasing abrasion resistance.

Based upon BS, European and ASTM testing, independent bodies have constantly confirmed the need for fibres to be added to concrete if significant levels of resistance to abrasion are to be achieved.

Test reports show that the inclusion of fibres reduces the degradation of concrete through abrasion by up to 39%.

References

British Board Agrement Certificates. Abrasion Resistance of Fibre Reinforced Concrete Slabs - M. Sadegzadeh Aston Services. Abrasion resistance of fibre reinforced concrete floors - V. Vassou & R.J. Kettle, Aston University.



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Explosive Spalling Resistance

Technical Information

Although intrinsically fire resistant, concrete can under certain circumstances be subject to the violent phenomenon known as explosive spalling. Explosive spalling is most often encountered in the high-grade concrete mixes, employed in tunnels and high-rise structures. When high density concrete is subject to fire, moisture within the concrete attempts to escape from the heat source, but is unable to do so, given the lack of porosity of these types of concrete. Eventually, if the fire is allowed to develop over time, then internal stresses generated by the steam within the concrete surpasses the ability of the concrete to resist and large pieces of super heated concrete are violently exploded out of the structure.

Exploding concrete is a danger not only to fire fighters and other emergency services attempting to put out the fire but also to survivors attempting to flee either the tunnel or high rise structure. However, the main threat is to the integrity of the structure itself, as the irreversible spalling phenomenon continues to strip concrete away from any supporting steel structure, which could eventually be weakened by the excessive temperatures and subsequently collapse.

In initial testing carried out by SINTEF in Norway, it was found that the addition of very fine monofilament fibres to high density concrete provided a cost effective passive resistance to explosive spalling. The mechanism by which fibres provide this protection is relational to the amount of fibres in the concrete. In a fire scenario, polypropylene fibres melt at 160°c, creating voids and channels through which the vapour can escape. Therefore, because the pressure is alleviated, the internal stresses never reach the critical point and no concrete is explosively expelled from the structure.

The current weight of research testing has concluded that the greater the amount of individual fibres that are present in the concrete, the greater the number of channels and voids will be created; thereby reducing the likelihood of explosive spalling.

Subsequent testing has been carried out at several research institutions in Europe, such as BRE and TNO and it has been found that very fine monofilament fibres of 18 microns in diameter provide the most effective solution to this problem, when included at dosages of between 1 and 3 kg /m3. As a consequence of this and continuing research into the use of polypropylene fibres for passive fire resistance, many contracts around the world have used our technology.

Report References

British Research Establishment, SINTEF, TNO

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Plastic Shrinkage Resistance

Technical Information

Concrete is particularly prone to plastic shrinkage cracking when the rate of evaporation exceeds the rate of bleed from the concrete (Figure 1). This scenario can be exacerbated when there are either high cross winds, high temperatures, or in extreme circumstances, both. In such cases, tensile stresses form and when these exceed the tensile strength of the concrete, plastic shrinkage cracks can occur. These cracks, on occasion, penetrate the full depth of the concrete slab and if the durability of the concrete is to be maintained, often expensive remedial measures will have to be undertaken. However, if cracking is too severe, the slab might have to be replaced.

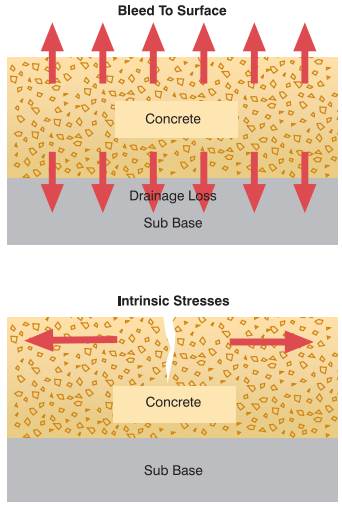

Figure 1

The use of our patented range of fibres has been shown in tests to reduce the incidence of plastic shrinkage cracks by increasing the early age tensile strength of concrete. Confiber® fibres, by forming a three dimensional network are able to arrest early stage micro-crack proliferation and hold the matrix together, thus preventing inevitable micro-cracks widening into serious, slab threatening cracking that would otherwise expand unchecked. Results for plastic shrinkage performance, as stated in the appropriate product BBA certificate were determined using the Trondheim ring test method (Figure 2).

The Confiber® BBA certificate confirms; "Plastic shrinkage tests conducted on both concrete rings and slab specimens show that the presence of fibres significantly reduced the amount of plastic shrinkage cracking when compared to concrete made from conventional (non-fibrous) mixes" The actual reduction of plastic shrinkage cracking is 100% (Figure 3).

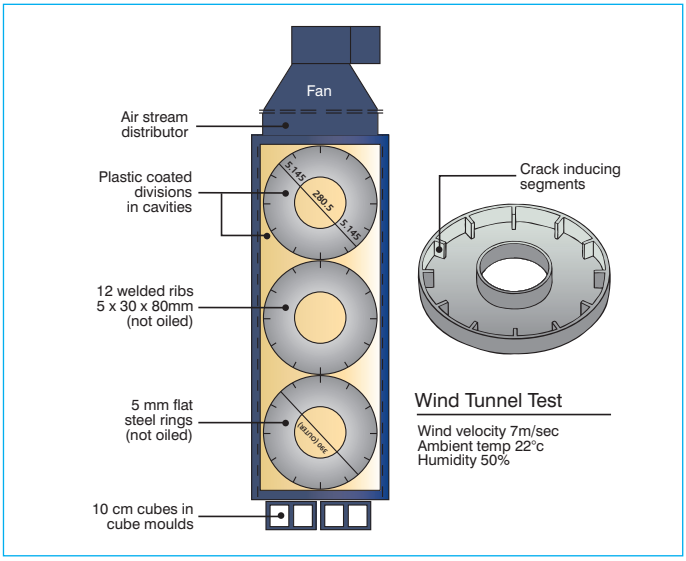

Figure 2

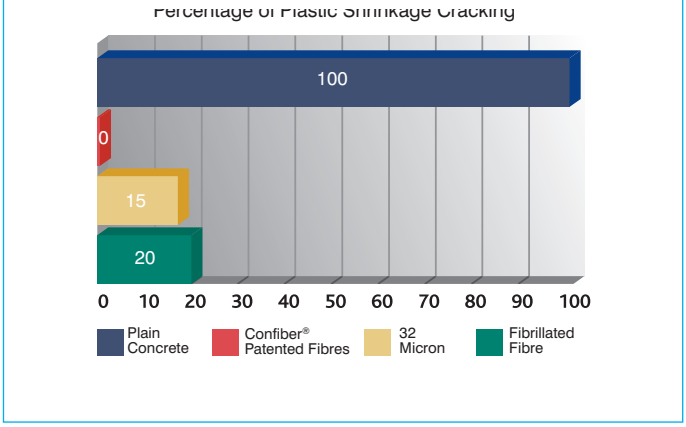

Figure 3

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Freeze Thaw Resistance

Technical Information

"*...freeze - thaw attack after chloride-induced corrosion is the most common cause of concrete deterioration.*"[1] This type of deterioration can take the guise of one of the following:

- Expansion, which leads to internal cracking and spalling
- Scaling of the surface, which usually occurs where salt is applied to the surface
- Aggregate pop outs caused by the use of freeze-thaw susceptible aggregates

One of the main methods of protecting concrete against freeze-thaw deterioration has been to use a good quality concrete, usually with a W/C ratio of less than 0.6 % and to use an air entraining agent (AEA). This method has proven, both in practice and in theory, to provide good concrete durability. However, the use of AEA in concrete can be variable due to one or a combination of the following:

- Cement type, source fineness
- Finer fines of the aggregate
- Admixture type
- Transportation
- Carbon content of PFA
- Mix proportioning
- Concrete workability
- Placing, compacting and finishing of the concrete

As part of our ongoing research, Confiber® has devised a simple and effective method of combating freeze-thaw attack, whilst taking away all the variabilities associated with the use of air entrainment agents. The addition of our uniquely developed construction fibre technology, has over the last 2 decades allowed hundreds of contracts to successfully replace AEA, notwithstanding changes in the appropriate construction norms, to ever harsher standards. Our fibres have passed two of the most exacting and rigorous test regimes for freeze-thaw attack and have in both cases, successfully been found to be an alternative and effective replacement to AEA. The tests in question are: BS 5075: part 2 1982- issue 2 January 1997 which measures the expansion of a concrete prism subjected to 100 cycles of freezing and thawing and the RILEM test, which measures the effect of 28 cycles of freezing and thawing in conjunction with a salt solution, whereby the the ability of concrete to withstand surface scaling is measured. Confiber® fibres reduce attack induced by freezing and thawing in the following ways:

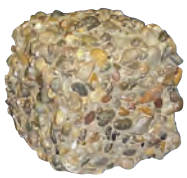
- The inclusion of Confiber® patented fibres reduces water absorption by the concrete and hence increases the penetration resistance to de-icing salts.
- The reduced water absorption is a function of the fibres' ability to reduce plastic shrinkage cracking, which, therefore, reduces the ability of water to permeate into the hardened state concrete.
- Concrete mixes enhanced with Confiber® patented fibre have reduced plastic settlement and bleed characteristics. This is achieved by making the mix more thixotropic and reducing the number of bleed channels, thus concrete less susceptible to the ingress of water.
- Confiber® fibres improve the toughness of the concrete through improvements in impact and abrasion resistance; making the concrete less susceptible to freeze - thaw damage.
- By intercepting cracks during their propagation, Confiber® enhanced concrete will import a high degree of ductility into an otherwise brittle matrix. This will, therefore, lead to the improved impact resistance of the concrete.

It is the combination of the above benefits, which ultimately will lead to a consistent way of reducing damage caused by freezing and thawing, whilst avoiding the uncertainties and potential problems associated with AEA.

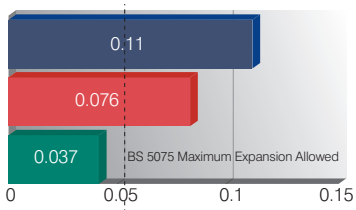
Reference: Confiber® BBA certificates

1. Dr. D.W. Hobbs-ICT Yearbook 2002-2003

Confiber® enhanced concrete



Plain concrete



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