BASF
The Chemical Company

RHEOBUILD® TDS

A multi-component admixture containing microsilica and superplasticizers for concrete resistant to natural aggressive chemicals

Description of Product

RHEOBUILD® TDS (Total Durability System) is a multi-component admixture in powdered form containing super plasticizers and other compounds fixed on a base of amorphous silica of high specific surface area and pozzolanic activity.

The higher pozzolanic activity of RHEOBUILD® TDS, with respect to natural and artificial ordinary pozzolans, makes concrete resistant to the "natural" chemical aggressive action of sulphates, chlorides, carbon dioxide and alkalis.

Fields of Application

- High strength concrete, i.e. over 80 N/mm²
- Low permeability concrete
- Concrete to resist attack from sulphates, chlorides, carbon dioxide and alkalis.
- Rheobuild® TDS produces concrete with increased cohesion to resist segregation.

Features and Benefits

The presence of amorphous, high-specific-surface silica and superplasticizers imparts two basic characteristics to RHEOBUILD® TDS: the pozzolanic activity and the thixotropic activity, together with the ability to considerably reduce the water/cement ratio (w/c).

The pozzolanic activity is the ability to combine with the free lime from the cement hydration to produce calcium hydrosilicates. The higher pozzolanic activity of RHEOBUILD® TDS, with respect to natural and artificial ordinary pozzolans, makes concrete resistant the natural aggressive action of sulphates, chlorides, carbon dioxide and alkalis.

Technical Data/Typical Properties

Appearance	Lump free powder

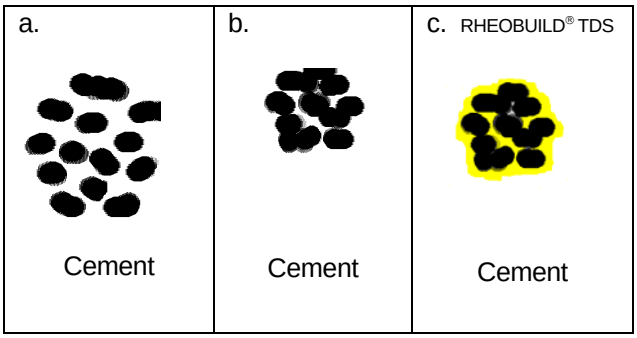


Fig. 1 - Schematic representation of cement paste in ordinary concrete (a), in concrete with superplasticizer (b) and in concrete with RHEOBUILD® TDS (c). Mix water is present among cement grains. Due to the superplasticizer, mix water is reduced, so that the distance among cement grains lowers. Consequently, the microstructure is denser and more compact (a → b). Besides the higher density deriving from the water reduction due to the presence of the superplasticizer, further increase in micro structural density occurs because of the filling of the interstitial voids among cement grains by amorphous silica particles, much smaller than cement grains (a → c).

The effect of the pozzolanic activity on durability is increased by the concurrent presence of the superplasticizer, that allows a marked reduction in mix water, and the very fine particles of amorphous silica, that fill the interstitial voids among cement grains (Fig. 1). Consequently, the extremely dense and compact microstructure obtained enables concrete to physically resist the penetration of very aggressive agents, and to improve the chemical resistance owing to the reduction in of calcium hydroxide.

The addition of RHEOBUILD® TDS provides increased durability whatever the severity of the natural chemical attack to which the concrete may be exposed. As the following headings are concerned with severe chemical attack, it is important to emphasise that the concrete is of superior quality and, in addition to RHEOBUILD® TDS, the content of cement must be such as to obtain a low water/cement ratio (0.35 to 0.45)

In particular, the use of RHEOBUILD® TDS provides concrete's resisting:

- The action of sulphates: under particular conditions, such as damp and cold environment, the aggressive action of sulphate can be severe. The presence of sulphates can be attributed to the environment, where the concrete structure is located (sea water, industrial environment selenitic grounds, etc). In other cases, sulphates are undesired impurities of aggregates, for instance, the aggregates obtained by rocks excavated for the construction of tunnels. The sulphate attack can lead to the thorough disintegration of even good quality concrete.

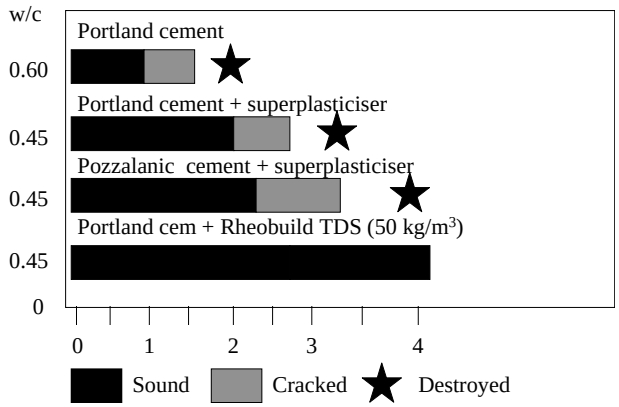


Fig. 2 - Sulphate attack at 5°C because of the presence of anhydrite ($CaSO_4$) in aggregates (10%). All the concretes used were manufactured with 350 kg/m^3 of cement; aggregate max. size; 20 mm; slump: 200mm; different water/cement ratios (w/c).

- **The action of chlorides:** it is known that chlorides penetrate the concrete cover and can reach reinforcement causing corrosion; to restrain the path chlorides must travel the concrete cover thickness must be increased and/or this path must be made more impervious by a denser and more impermeable structure.

ACI Committee 201 recommends that the concrete for works exposed to sea-water chlorides be manufactured with a water/cement ratio not higher than 0.45 and that concrete cover be at least 38 mm. In the case of bridge decks, exposed to de-icing salts based on chloride, because of the severe exposure conditions, the same Committee recommends even more protective measures, that is, water/cement ratio not higher than 0.40 and concrete cover of at least 50 mm.

By the use of RHEOBUILD® TDS, thanks to the more compact microstructure than with the superplasticizer alone (Fig. 1), the water/cement ratio of 0.40 for structures exposed to de-icing salts is a sufficiently protective measure even with concrete cover of 25 mm only. This assumes that the concrete is correctly placed, compacted and cured.

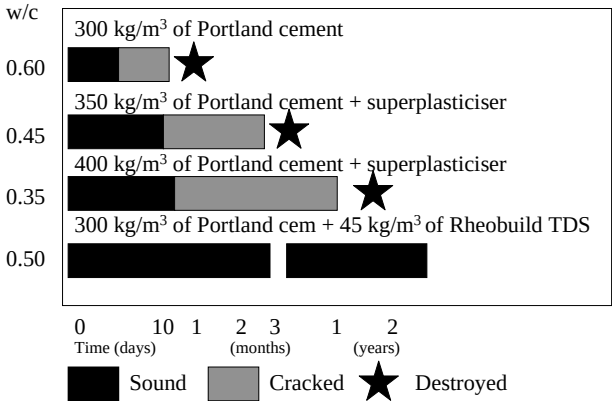


Fig 3 - The attack of 30% calcium chloride aqueous solution on concrete specimens kept at 5°C.

Calcium Chloride: concrete in contact with $CaCl_2$, in the form of aqueous solution deteriorates quite rapidly. The greater the concentration of chloride and the lower the temperature (down to 0°C), the more rapidly degradation of steel reinforcement will occur. Initially, deterioration occurs through the formation of cracks, mostly at the interface aggregate/mortar; subsequently, it occurs through the disintegration of the cement paste becoming less and less coherent.

RHEOBUILD® TDS develops a protective action against this disruptive force thanks to the pozzolanic activity of the amorphous silica among cement grains.

Sodium Chloride: this salt does not cause the same type of deterioration than calcium chloride. However, it can start a more insidious degradation: the alkali-silica reaction (ASR). If aggregates contain a given amount of amorphous silica (opal, chalcedony, etc.), this silica may react with alkalis (sodium and potassium) generally present in the cement, and, if the concrete is moist and rich in calcium hydroxide, it can produce hydrated sodium silicate, which makes aggregates and concrete swell.

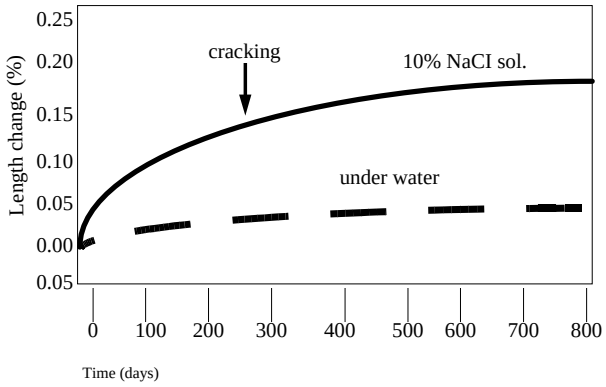


Fig. 4 - Swelling of concrete (kept in water or in 10% NaCi aqueous solution) having water/cement ratio (w/c) 0.60; 350 kg/m^3 Portland cement; 200 mm slump and potentially reactive aggregates (max. size: 20 mm).

The alkali-silica reaction may be very insidious. First of all, a preliminary diagnosis of the reactivity of aggregates is very difficult. Secondly, disruption due to the alkali-aggregate reaction is much slower than that caused by the other chemical attacks. It may occur even decades after the construction of the work. Nevertheless, there are examples of rapid deterioration that occurred in a few months' time.

However, the magnitude and degree of the deterioration of the alkali-silica reaction are not only bound to the amount and type of reactive silica into aggregates, but also to the concentration of sodium and potassium inside concrete. That is, the higher the concentration of alkalis inside the concrete, the greater the degree of reactivity may be.

Therefore, when sound concrete, without signs of deterioration due to the alkali-silica reaction, is put in contact with sodium chloride solutions, the reaction described above may be initiated, because the concrete absorbs sodium chloride, thus increasing the alkali concentration.

Due to the reduced permeability imparted on to concrete by the addition of RHEOBUILD® TDS the absorption of sodium chloride, and hence the potential for ASR is greatly reduced.

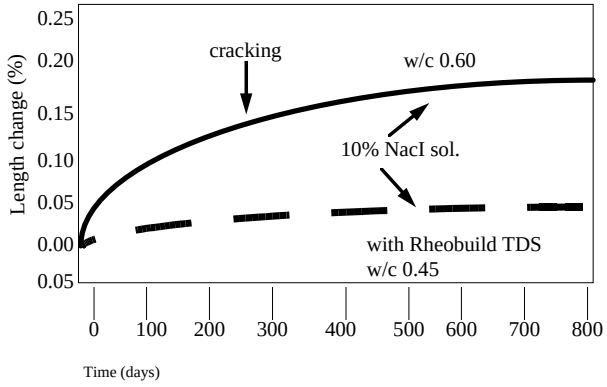


Fig. 5 - Effect of Rheobuild TDS on the alkali-aggregate reaction. Dosage of Portland cement: 350 kg/m^3; slump: 200 mm; potentially reactive aggregates (max. size: 20mm)

The action of carbon dioxide: when CO_2 in the atmosphere penetrates concrete and neutralises calcium hydroxide and the pH drops to below 10; under these conditions, iron (present in the steel reinforcement) is no longer protected. Corrosion of the steel, however, cannot start unless oxygen and moisture also penetrate concrete and make iron oxidise (rust).

This mechanism is known as carbonation.

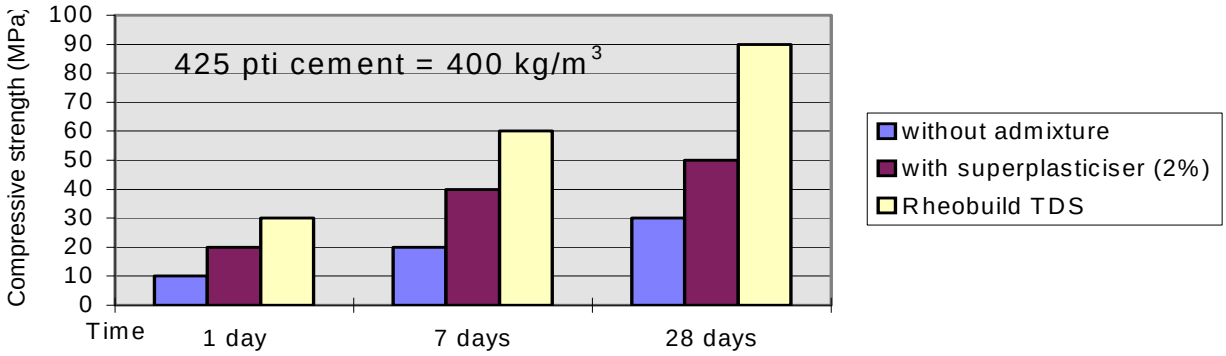
The use of RHEOBUILD® TDS, in concrete that is exposed to atmosphere carbon dioxide, reduces the rate of neutralisation of the sodium hydroxide and therefore steel corrosion due to carbonation is considerably delayed.

The thixotropic activity of RHEOBUILD® TDS imparts a high degree of cohesiveness to fresh concrete, even in high workability mixes.

This characteristic makes Rheobuild TDS particularly suitable for the production of concrete for underwater placements or into water-bearing ground.

Although RHEOBUILD® TDS is designed for use mostly in durable concrete works exposed to aggressive environments, it also provides high strength concrete.

Fig. 6 - Compressive strength of concrete without admixture with superplasticser (2%) and with Rheobuild TDS (50 kg/m^3).



Application Procedure
Rheobuild TDS should be dosed in the range 5 to 15% by weight of cement depending on the severity and type of aggressive attack to restrain.

Mixing
RHEOBUILD® TDS is introduced into the mixer after all the other solid components have been added (cement, aggregates). After mixing for about 30 seconds, add mix water at the rate of 25-30% by the weight of cement. Continue mixing until all the water has been added and the required workability is obtained.

Compatibility
RHEOBUILD® TDS is compatible with all Portland, pozzolanic and slag cements. However, enhanced performances of RHEOBUILD® TDS are obtained when Portland Cements are used.

RHEOBUILD® TDS should not be used with other water reducing admixtures without clarification from BASF Construction Chemicals.

RHEOBUILD® TDS may be used in conjunction with MICRO-AIR® 103 to produce air-entrained concrete.

The combined addition of RHEOBUILD® TDS with the following products or materials is also recommended:

- STABILMAC expansive agent to manufacture shrinkage-compensating concrete;
- steel fibre's to manufacture fibre-reinforced concrete;

Curing
As with all cementitious systems, curing of concrete produced using RHEOBUILD® TDS is recommended. This should be carried out using MASTERKURE® Curing Compounds.

Packaging
RHEOBUILD® TDS is available in 10 Kg bags.

Storage
Store in cool, dry conditions as for cement.

Shelf Life
Up to 12 months if stored according to manufacturer's instructions in unopened containers.

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Health and Safety
*For full information on Health and Safety matters regarding this product the relevant Health and Safety Data Sheet should be consulted.

The following general comments apply to all products.

As with all chemical products, care should be taken during use and storage to avoid contact with eyes, mouth, skin and foodstuffs, (which may also be tainted with vapour until the product is fully cured and dried). Treat splashes to eyes and skin immediately. If accidentally ingested, seek medical attention. Keep away from children and animals. Reseal containers after use.

Spillage
Chemical products can cause damage; clean spillage immediately.