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FEBSET 45

Pre-Mixed Magnesia-Phosphate Cement Mortar, for Rapid, High Early Strength Repair

Description of Product

FEBSET 45 is a specially formulated repair mortar, based on magnesia-phosphate cement pre-mixed with selected aggregates, which gives controlled, extremely high early strengths in temperatures ranging from -20°C (or lower) up to over 30°C.

FEBSET 45 provides a repair material for concrete slabs which reaches an adequate strength for trafficking, or other use, at a very early age. It is also suitable for use as a repair medium at low ambient temperatures.

When FEBSET 45 is added to the gauging water and mixed, an exothermic chemical reaction commences and a chemical setting process takes place within approximately 15 minutes (at 20°C). The material hardens to give sufficiently high early strength to receive heavy traffic within a period of less than one hour at 15 - 20°C.

Application depth:

20mm to 75mm unfilled
>75mm to 150mm filled with 10 mm aggregate.

Fields of Application

For use in concrete repair situation where the minimum delay and work disruption is of the utmost importance.

- Cold store floor areas.
- Concrete roads and nosings.
- Bridge decks.
- Quays/crane rails.
- Industrial floor areas.
- Loading bays and warehouses.
- Around fixing bolts.
- Raising and levelling manhole covers, gratings, hydrants etc.

Features and Benefits

- High strength at a very early age (45 minutes).
- Minimum delay to traffic and production. When used to repair concrete pavings, it permits early re-opening to traffic - within 45 minutes at 20°C.
- Ready for use. Only requires the addition of water (see Mixing.)
- Excellent bond to concrete and steel reinforcement. No secondary bonding agents required.
- Highly durable. Excellent resistance to de-icing salts.
- High freeze/thaw resistance.
- No curing required.
- Can be placed in sub-zero temperatures.
- 'Non-shrink'.
- Modulus and Thermal properties similar to concrete
- Lower permeability than cementitious mortars.
- Chemically resistant to fuel, engine oils and urine.
- Inhibits corrosion in steel even in the presence of chlorides.

Typical Properties /Technical Data

Full performance properties and values can be found in tables 1 - 9 at the back of the data sheet.

Appearance	Grey granular powder
Plastic Density	2200 kg/m^2
Setting Time (materials at ambient temperature)	15 minutes at 20^{o}C 35 minutes at 8^{o}C
Non-Shrink	Unlike most fast-setting materials. FEBSET 45 can be considered as 'non-shrink' with average linear expansion of 0.02% $\pm$ 0.02%. (FEBSET 45 concrete averages 0.01% $\pm$ 0.01%). This expansion is usually completed in 3-7 hours.

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Application Procedure

Surface Preparation:

It is essential the surface of the concrete substrate to which the FEBSET 45 is to be applied, should be thoroughly sound and uncontaminated by dirt, oil or grease. The minimum thickness of repair should not be less than 20mm. The boundaries of the repair must be square cut. Under no circumstances should "feather edging" be used. It is also essential that the minimum thickness be measured from the peaks and not the troughs of any scabbled concrete. Scabbling should be to an even depth.
Where reinforcement is exposed, all scale should be removed and the bar thoroughly cleaned by wire brush, or sand blasting. Do not use bonding agents on the steel.

Priming:

Although secondary bonding agents are not required, the area to be repaired must be thoroughly pre-wetted with clean water. Care should be taken, however, to ensure that all standing water is removed.

Mix Proportions :

The following table gives the exact proportions to be used

Mortar mix (standard) (20mm up to 75mm)	FEBSET 45	25 kg
	Water	1.5 litre
Concrete mix (large areas >75mm to 150mm deep)	FEBSET 45	25 kg
	Coarse Aggregate (10mm)	10 kg (max)
	Water	1.5 litre
Small Batches	60ml Water per 1kg FEBSET 45	

NB. See Guide to Application, Thickness.

Batching:

Batching should always be carried out in 25kg units, (ie. one bag) of FEBSET 45 or multiples thereof.

Mixing:

The following sequence must be followed at all times when mixing FEBSET 45 :

1. A suitable mixer (ie. tilting drum) should be located as near as possible to the area of work.
2. The amount to be mixed should never exceed that which can be transported, placed, compacted and finished within ten minutes.
3. Wet down the mixer and drain off the free water.
4. Pour the correcting measured amount of clean water into the mixer first. Do not add the water to FEBSET 45 .
5. When adding coarse aggregates* (*refer to 'Thickness' overleaf). these must be added to the water before the addition of FEBSET 45 into the mixer.
6. Empty the full contents of the FEBSET 45 bag into the mixer.
7. Minimum mixing time is 1 minute.

Workability:

Although stiff at the outset, workability will improve as mixing continues, to give the desired flow characteristics. **On no account must further water be added. It is also essential that no admixtures are included**.

Placing and Finishing:

Pre-wet the area to be treated and remove surplus water.
The freshly mixed FEBSET 45 should be placed into the pre-wetted area without delay.
In view of the flow characteristics of FEBSET 45 , the use of vibrating pokers or vibrating screed board is not normally required. However, full compaction must be achieved.
Compact by hand in small areas and level the surface by ruling with a firm, straight-edged tamping bar.
The minimum of finishing with wooden floats leaves a better skid-resistant surface. However, particular care should be taken to achieve good compaction and bond at the edges and corners. On large areas, alternate narrow bay construction is desirable.
Do not re-tamper or over trowel, once the material has begun to stiffen.

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Special Circumstances:
Extremes of temperature affect the setting time of FEBSET 45 . However, providing pre-conditioning of the substrate and gauging water is carried out, normal properties can easily be achieved. Once the chemical reaction is started it cannot be stopped.

Cold Weather Working:
Below 5°C down to cold store temperature of -20°C or lower, pre-warm the mixer and equipment with warm water before batching. At temperatures below 0°C, or when ice is present, warm the substrate by infra-red or other suitable heating. The mixing water should be warmed to a temperature of 25°C to 30°C. The repaired area should be covered by insulating materials, such as loft insulation.

The area should be covered for not less than three hours, depending on the severity of the temperature. It is advisable to insulate in temperatures below 7°C.
For freezer floor repairs, refer to specific FEBSET 45 Specification Sheet.

Hot Weather Working:
Where the temperature is above 30°C, the use of chilled water in the mix will allow the open time to be extended, thereby allowing normal procedure to be carried out in areas such as those found in steel works, etc. The mixer drum, barrows and equipment must be kept cool by shading, use of cold water etc.

Wet Weather Working:
In wet conditions, care should be taken to ensure that both mixing and placing are carried out in protected environments, eg. tenting.
FEBSET 45 must be protected from the effects of inclement weather for a period of not less than 30 minutes after placing and finishing.

Thickness:
The miniumun thickness of FEBSET 45 shall be 20mm at all times.
FEBSET 45 can be applied from 20mm up to 75mm in thickness .For depths between 75mm to 150mm in thickness, FEBSET 45 can be bulked out with 10kg of a nominal 10mm graded, dust free, aggregate per 25 kg bag of product.
The workability of the bulked out material will depend upon the shape and absorption of the aggregate used. It is advisable to perform a trial to determine the correct aggregate loading to achieve the desired workability and physical properties.
Under no circumstances should either fine aggregates or cement be added.

Additional Information:
In conjunction with this leaflet, refer to the specific FEBSET 45 Specification Sheet.

Specification Sheet F1-02a:
Repair of concrete roads, motorways, airfields, pavement, industrial floors and slabs.
Specification Sheet F1-04:
Freezer floor repairs.

Specification Sheet F1-05:
Repairs to manhole cover surrounds and raising of manhole covers.

Coverage
25kg of FEBSET 45 combined with the correct amount of water (see Guide to Application, Mixing) will yield approximately 11.6 ltrs. Where coarse aggregates are added at the rate of 10kg per 25kg FEBSET 45 , an approximate increase in yield of 30% will be achieved.

Watchpoints
Joints:
All joints (and non-static cracks) in the substrate must be duplicated in the FEBSET 45 repair. As soon as the repair is hard, any joints that could be not pre-formed must be saw cut through the full depth of the repair and to at least the same width as the joints in the substrate. Clear out all debris from the formed joint and seal with a suitable sealant such as MASTERFLEX® 474

Overcoating:
Particular attention needs to be paid to preparation if FEBSET 45 is to be overcoated. For instructions contact BASF Construction Chemicals (UK) Ltd, Technical Services Department.

Proper Use:
FEBSET 45 is an advanced product and the above instructions should be meticulously followed, If in any doubt as to use, seek advice from BASF Construction Chemicals (UK) Ltd, Technical Services Department.

Odour
When using FEBSET 45 in large volumes or high temperatures, a slight smell of ammonia may be observed

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Table 1:
The effect of Ambient Temperature on Compressive Strength of FEBSET 45 .

Curing Temp.	Average Compressive Strength in N/mm²			
	1 hour	3 hours	24 hours	7 days
10°C	3	30	40	50
20°C	18	35	45	52
30°C	30	45	50	65

- All materials and equipment were conditioned to the curing temperature before mixing and casting. 70mm cubes were used.

Table 2:
Strength development of FEBSET 45 mortar and concrete. Strengths in N/mm² at 20°C and using 100mm cubes.

Properties	FEBSET 45	1 Hour	3 hours	24 hours	28 days
Compressive Strength BS.1881	Mortar Concrete	22 21	33 32	44 43	53 48
Flexural Strength BS.6319 Pt. 3. - BS.1881 -	 Mortar Concrete	 5 2	 7 5	 9 6	 10 8
Tensile Strength BS.6319 : Pt7	Mortar	3	2.5	3	3.5

Table 3:
Comparison of Slant Shear Bond between concrete and two different types of repair materials. The figures clearly illustrate the superior bond of FEBSET 45 to prepared and dampened concrete.

Materials Bonded	Compressive Strength N/mm²	Substrate Surface Preparation	Shear Bond Strength (N/mm²)	Mode of Failure
OPC Concrete/ FEBSET 45 Mortar	56 47	Saw cut dry Surface	26.3	Bond interface
OPC Concrete/ FEBSET 45 Mortar	65 53	Roughened (*) and Dampened	44.8	Bond interface
OPC Concrete/ Mortar	49 50	Saw cut wet Surface	38.2	Bond interface
OPC Concrete/ FEBSET 45 Mortar	51 53	Roughened and Water Saturated (S.S.D.)	38.2	Monolithic
OPC Mortar/ Epoxy Mortar	65 77	Smooth and dry	42	Concrete substrate

*Surface roughened by acid etching. Test Method BS.6319 Part 4.

Table 4:
Bond of FEBSET 45 to Embedded Steel.
Core holes were drilled in 35 N/mm² concrete and steel bars were grouted into the holes using FEBSET 45 .

Age when tested	Reinforcement		Grout Core Hole Size (mm)		Pull (in KN) at curing temperature of	
	Diameter (mm)	Type of Steel Bar	Diameter	Depth	2°C	22°C
3 hours	2.7	Deformed	50	225	-	88
6 hours	12.7	Deformed	50	225	52	-
24 hours	12.7	Deformed	50	225	73	102 CF
7 days	12.7	Deformed	50	225	115 RB	108 CF
24 hours	19	Threaded	50	150	69	89 CF
7 days	19	Threaded	50	150	80	94 CR

Young's Modulus of Elasticity of FEBSET 45 and Pavement Quality OPC Concretes

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Table 5:

Material	Nominal Strength N/mm²	E-Value GPa
FEBSET 45 :		
Mortar	65	41
Concrete	60	43
OPC Concrete	40	31
	50	34
	60	36

Table 6:
Comparison of Thermal Coefficient of Expansion of different repair materials.

Type of Materials	Coefficient of Thermal Expansion (10^{-6} per °C)
FEBSET 45 Mortar	11.75
OPC Concrete	6 - 12
OPC Mortars	10.5 - 11.85
Epoxy Mortars	20 - 30

Table 7:
Freeze/Thaw Resistance Test on FEBSET 45 (in accordance with ASTM C666, Pro. A)

Number of Cycles	Relative Dynamic Modulus %
144	92.0
300	79.8

The results of relative dynamic modulus are well above the limit of 60 normally required for frost resistant air-entrained pavement quality concrete.

Table 8:
Scale Resistance of FEBSET 45 to de-icing chemicals (ASTM C672)

Number of Cycles	Rating	Surface Condition
5	0	No scaling
25	0	No scaling
50	1.5	Slight scaling

The above results are positively comparable with good quality air-entrained pavement concrete.

Table 9:
Corrosion inhibition properties of FEBSET 45 .
Tests carried out on standard mild steel reinforcing bars.

		Corrosion Scale (*) of Steel Bar after		
Type of Material	$CaCl_2$ add in (%)	14 days	30 days	90 days
OPC Concrete (W/c =0.4)	0	1	2	1
	0.5	1	2	2
	5.0	2	2	4
OPC Concrete (W/C = 0.6)	0	1	2	1
	0.5	1	1	2
	5.0	3	1	4
FEBSET 45 Mortar	0	0	0	0
	5.0	0	0	0
FEBSET 45 Concrete	0	0	0	0
	0.5	0	0	0

Addition of $CaCl_2$ is by weight of cement for OPC Concrete and by weight of the pre-packed mortar for FEBSET 45.
*** Corrosion scale is form**0 = no corrosion9 = total corrosion

Cleaning

Wash all tools and equipment with water immediately after use. Hardened FEBSET 45 must be removed mechanically.

Packaging

FEBSET 45 is supplied in 25kg sacks.

Storage

Store in cool, dry conditions.

Shelf Life

12 months minimum when stored in accordance with the manufacturer's instructions.

Specification Clause

Pavement Repairs:

All rapid repair of concrete slabs and pavements and raising road furniture etc. shall be carried out by using FEBSET 45, as manufactured by BASF Construction Chemicals (UK) or equal approved, to the following specification.

Mixing and use of the product and all related work shall be carried out strictly in accordance with the manufacturer's recommendations.

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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.

Powder Products
Should be handled to minimise dust formation; use light mask if excessive dust unavoidable. Cement powders when wet or moistened can cause burns to skin and eyes which should be protected during use.

Spillage
Chemical products can cause damage; clean spillage immediately.

Disclaimer:
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