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NEW PRACTICES IN CIVIL & INFRASTRUCTURE MAINTENANCE

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Abstract - *A Maintenance Planning and Execution is very different from planning of new infrastructure. The goal of maintenance is to sustain the life of a structure or provision of a service at the minimum possible costs. New practices, technologies and materials make the feasible, economic and faster way in maintenance work.*

Key Words: Forsoc Conbextra EP-75(Epoxy Grout), Nitrofill UR63 (Polyutherane injection resin system) Conbextra GP2 (cement grout), Hilti, Flowable, Cementitious, IS, BS.

1. INTRODUCTION

Now a day various products are available for maintenance (replacement, rectification and repairing) of structures. Cost is initially high while applying or purchase but when looking into criticality mainly in running industries like production, power, etc. each second of operation means a lot, hence time factor is always plays a vital role in every decision. Problems of foundation failure are the most critical, hence need to rectify as soon as possible. Replacement costs of any structure almost always exceed the sum of the maintenance costs and the interruption of the services associated with the assets causes all sorts of costs organization. The additional expenditures due to inappropriate planning of maintenance activities and insufficient allocation of maintenance funds could have been used to finance other projects addressing social, economic and environmental concerns, hence, here is the need of new technology, methodology & materials for fast and accurate result and give the quality by ensuring Cost & Time Concern. effectively this approach is not a comparison between a given maintenance project and a project addressing social, economic or environmental concerns, but is a comparison between the cost and benefits associated with discontinuing an existing asset and its services with projects creating new or improving asset. The cost-benefit analysis should be based on incremental life-cycle analysis by improving the life of structure.

Various new techniques are there, to be adopted and in different Construction & Maintenance activities, hence we have chosen the most important and critical repairing factor in major industrial as well as construction sector i.e., Grouting

Grouting- *(Conbextra- EP75, NitroFill UR63, & GP2 by Fosroc)*

Grout is a particularly fluid form of concrete used to fill gaps. It is used in construction to embed rebars in masonry walls, connect sections of pre-cast concrete, fill voids, and seal joints such as those between tiles. Grout is generally a mixture of water, cement, sand, often color tint, and sometimes fine gravel (if it is being used to fill large spaces such as the cores of concrete blocks). Unlike other structural pastes such as plaster or joint compound, correctly-mixed and -applied grout forms a waterproof seal although both are applied as a thick emulsion and harden over time, grout is distinguished from its close relative mortar by its viscosity; grout is thin so it flows readily into gaps, while mortar is thick enough to support not only its own weight, but also that of masonry placed on top of it.

A. Epoxy Resin Grout

Chemical Grouting provides a free flowing grout (application by injectors, pressurize gun, and other manual pour) , for use where physical properties and chemical resistance of the hardened grout are of utmost importance. It is suitable for a wide range of heavy duty applications including: „

- Under plate grouting to substantial structural elements. „
- Base plate grouting in dynamic load situations such as turbines and other reciprocating machinery. „
- Heavy industrial applications in steelworks, refineries chemical plants and electroplating works.
- Structural infill where very high strength is required. „
- Rail track applications, to support heavy cranes, or on transporter rails.

By using High strength, epoxy resin grout, Bolt can be re-fix in the concrete foundation by using a method called core cutter (*assembly by Hilti*), appropriate hole (greater than bolt diameter) is made bolt get embedded into foundation by filling up the gap.

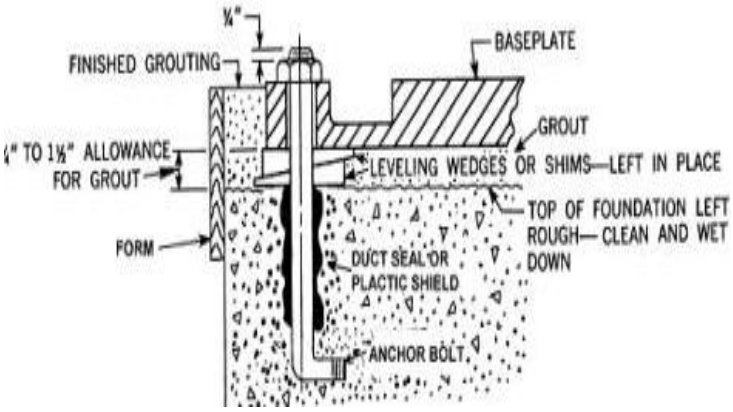
Advantages

- ✓ Excellent durability - high compressive, flexural and tensile strengths ensure a long working life. „
- ✓ Cost effective - high early strength gain promotes minimum downtime and early commissioning of plant. „ User friendly - simple, full pack mixing to ensure that the performance characteristics are achieved.
- ✓ Versatile - suitable for a wide range of loading situations including repetitive dynamic loads. „
- ✓ Excellent in service performance - non-shrink capability ensures full surface to surface contact.

Properties

Pot life	:	2 hours @ 23°C
Tensile strength	:	14 N/mm² at 7 days
Flexural strength	:	26 N/mm² at 7 days
Compressive strength	:	90 N/mm² at 1 day
		95 N/mm² at 3 days
		100 N/mm² at 7 days
Maximum flow distance for a head of 100 mm at 20°C :		
35 mm gap	-	2000 mm
70 mm gap	-	3500 mm
Coefficient of thermal expansion		
ASTM C531	:	28.1 x 10^{-6}
Compressive creep		
(ASTM C1181- 2.85N/mm²		
1 year, 60°C)	:	2.05 x 10^{-3} mm/mm

Strength analysis (faster than Conventional)



Typical section showing epoxy grouting

B. Polyurethane Resin Grout

Polyurethane resin is mainly used for sealing crack; it can be injected into cracks in concrete or masonry in dry or damp conditions to form an elastic seal. Caution must be exercised with cracks which are live or filled with dust, water or salts. Grouting with polyurethane [PU] resins represents an effective method, PU grouting technologies spread significantly from the mining.

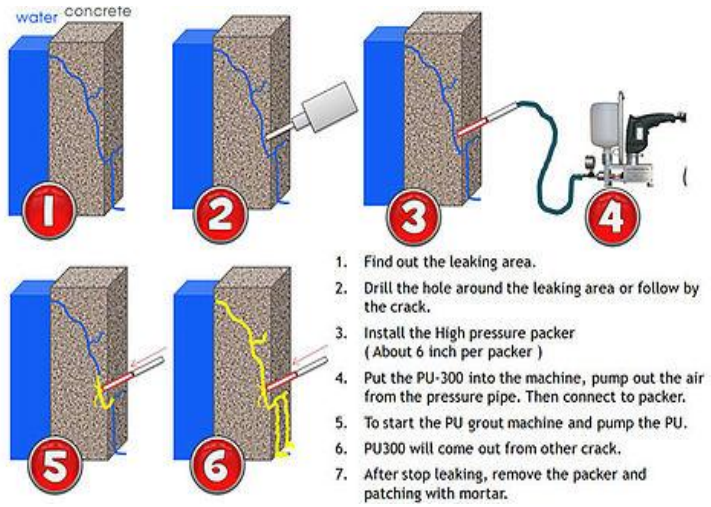
Advantages

- ✓ Low viscosity: Penetrates fine cracks and cavities.
- ✓ Good adhesion: Adheres strongly to dry or moist concrete „
- ✓ Flexible: Strong but flexible to withstand differential structural movement „
- ✓ Tough: Withstands high hydrostatic pressures
- ✓ Impermeable: On curing it forms a hard mass impermeable to water „ Suitable for use in high temperature conditions.

Typical properties

Specific gravity	1.0	
Viscosity at 20°C	3 poise	
Cure properties (Tropical grade)		
Temperature	**25°C**	**35°C**
Pot life	35 min	20 min
Reaction time	95 min	55 min

Secure foundation system by PU Grout



Procedural diagram for PU Grout

C. Cement Grout

Cement grouting, also known as slurry grouting or high mobility grouting, is a grouting technique that fills pores in granular soil or voids in rock or soil, with flowable particulate grouts.. Cement Grouting is a process by which cement is injected under pressure to fill fractures and voids in concrete structures.it is Free flow, high strength, non-shrink, cementitious precision grout. Cement grout *(Conbextra GP2)* is used for precision grouting where it is essential to withstand static and dynamic loads. Typical applications would be the grouting of base plates of turbines, compressors, boiler feed pumps etc., It can also be used for anchoring a wide range of fixings. These include masts, anchor bolts and fence posts.

Advantages

- ✓ Gaseous expansion system compensates for shrinkage and settlement in the plastic state
- ✓ No metallic iron content to cause staining
- ✓ Pre-packed material overcomes onsite batching variations
- ✓ Develops high early strength without the use of chlorides
- ✓ High ultimate strength ensure the durability of the hardened grout
- ✓ Free flow ensures high level of contact with load bearing area

Properties

Compressive strength : (BS 1881 - Part 116: 1983)

Age (days)	Compressive strength (Nmm²) Consistency Flowable (W/P 0.18)
1	24
3	45
7	55
28	65

Compressive strength with addition of aggregates

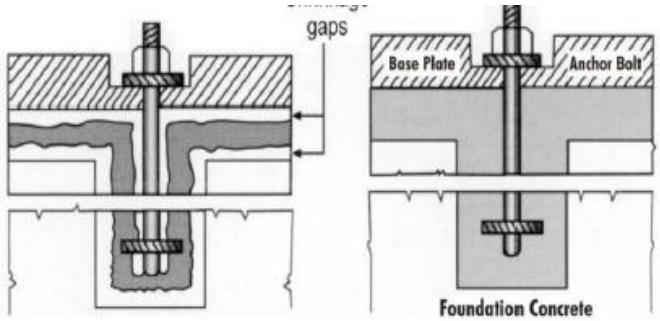
Age (days)	Compressive strength (N/mm²) W/P 0.18 % of aggregates (IS 516 - 1959)		
	50%	75%	100%
1	28	30	32
3	50	52	55
7	60	63	68
28	70	75	78

Flexural strength (BS 4551, 1998)

Age (days)	Flexural strength (N/mm²) W/P 0.18
1	2.0
3	7.0
7	9.0
28	10.0

Tensile strength (W/P - 0.18)	3.5N/mm² @ 28 days
Pullout bond strength (W/P - 0.18)	17 N/mm² @ 7 days 20 N/mm² @ 28 days
Time for expansion (after mixing)	Start : 20 minutes Finish : 120 minutes
Freshwet density	Approximately 2220kg/m³ depending on actual consistency used

Test Results for effective grouting



Typical diagram of Cement Grouting

Limitations

Low temperature working

When the air or contact surface temperatures are 100 C or below on a falling thermometer, warm water (30 - 400 C) is recommended to accelerate strength development.

For ambient temperature below 100 C the formwork should be kept in place for at least 36 hours.

Normal precautions for winter working with cementitious materials should then be adopted.

High temperature working

At ambient temperatures above 400 C, cool water (below 200 C) should be used for mixing the grout prior to placement.

PRECAUTION

- ✓ Material or Chemical used for grouting should identify before use by read all necessary information printed on the container/vessel.
- ✓ Gloves, goggles and dust mask should be worn. If contact with skin occurs, it shall be washed with water. Splashes to eyes should be washed immediately with plenty of clean water and medical advice sought.
- ✓ Specified job should be ensured, inspected and under the supervision and guidance of responsible person

COMPARISON

S.N	Conventional Method	New Techniques
1	Good strength (taking Nominal time)	High Strength (taking lesser time)
2	Durability depends upon the quality control and methodology adopted.	Ensured durability, hence enhance the life of structure.
3	Time Consuming & general procedural aspect	Fast & Feasible by defined special techniques
4	Less accuracy (depends upon quality control, hence need to be followed precisely)	More accurate as methods are specific for particular work condition.
5	If overall avg. time to dismantle (>70%) & construct new structure is around one month (including Curing) *(in case of foundation failure)*	Chemical grout (epoxy, PU etc.) will take 4-5 days max. Hence save around **80%** time, and is more significant in industrial sector.
6	Cost is normally estimated as per requirement with specifications, instructions & site condition.	Depends upon structure, sometimes, using new techniques results in cost reduction also **(30-40%)**
7	Not possible in several critical conditions (ex-running operational plants, tunnels, critical under water structures etc.	Made to utilize time, which is the most important factor for criticality.

CONCLUSIONS

- ✓ Conventional methods are not so beneficial & suitable for every conditions some places having time restrictions hence need to resolve problem as soon as possible, therefore it's a need to use effective materials & technology.

- ✓ Practical conditions & Criticality matters the most in industrial or production sectors, where minute to minute are related to money, hence to maintain and kept the system or channel as it is, use of fast & feasible, effective techniques shows a significant result & saves unnecessary time & cost, ultimately beneficial in overall business aspect.

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