A CASE STUDY ON REHABILITATION OF SARDAR SAROVAR DAM WITH SIKA SYSTEM

by

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REHABILITATION OF SARDAR SAROVAR DAM

ABSTRACT

- This paper describes a complete approach for repair of honeycombed surface and sealing of joints in upstream surface for preventing leakage / seepage in downstream side. The complete dam repair work has been completed in accordance with CWC Guidelines.
- The Sardar Sarovar Dam is a concrete gravity dam built on the Narmada River in the state of Gujarat. The construction of 1210 meters long; 139 meters height, Sardar Sarovar Dam started in 1987 and completed in 2017 with 30 Chute spillways. The total installed capacity is 1450 MW, which is generated through 6 nos. of 200MW Francis Turbine and 5 nos. of Kaplan Turbine generator.
- The dam has been plagued by problems from the start, including leakage and seepage. The main challenge of leakage and seepage in the Sardar Sarovar Dam is that it can cause the dam to become unstable and collapse. Leakage can also lead to flooding downstream of the dam. Seepage in dam gallery leads to operation challenges and it can also damage the dam's foundation and erode the surrounding soil.

REHABILITATION OF SARDAR SAROVAR DAM

ABSTRACT

The SARDAR SAROVAR NARMADA NIGAM LTD. has taken several measures to address the problem of leakage and seepage in the Sardar Sarovar Dam, including:

- Sealing work of the Upstream face/Vertical block joint/Horizontal lift joint/Honeycomb area of upstream of dam to prevent seepage/leakage in the downstream face and in the galleries of Sardar Sarovar (N) Dam Project
- Sealing the vertical/horizontal joints and honeycomb patches at upstream of concrete surface (RL 115.0 m to 75.00 m) in under water condition of Sardar Sarovar dam.
- Repairing of erosion, pitting and sealing of opened block joint of downstream surface of Sardar Sarovar Dam

REHABILITATION OF SARDAR SAROVAR DAM
CHALLENGES AT UPSTREAM SURFACE

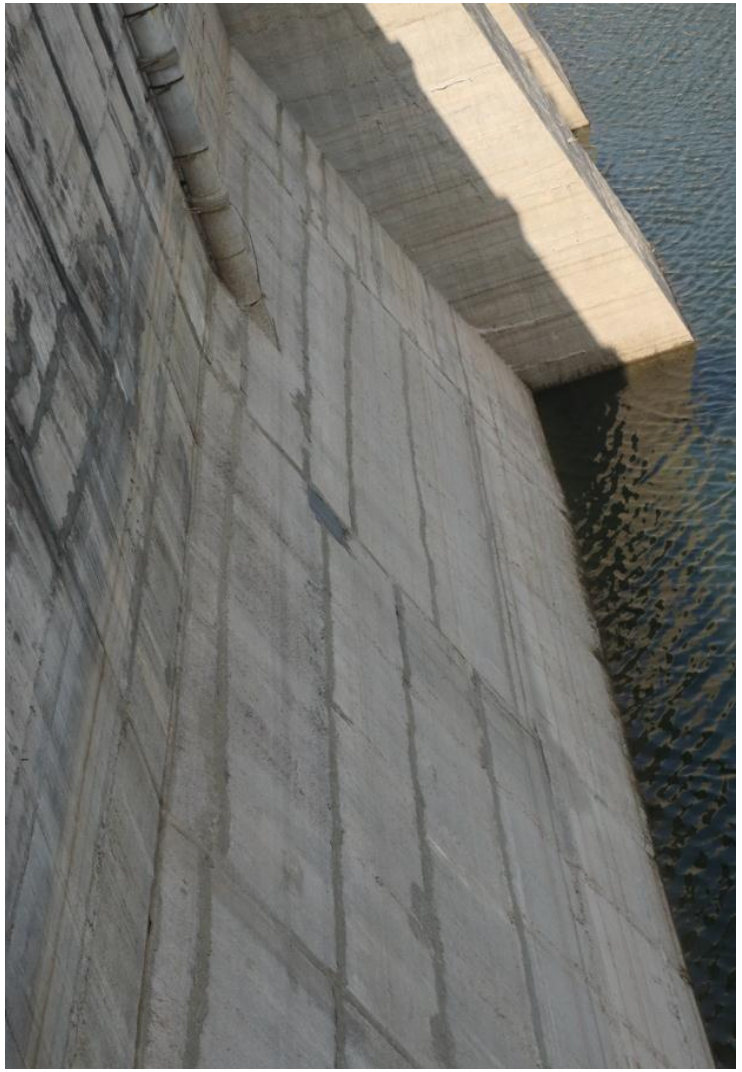
The challenges encountered at the Sardar Sarovar Dam include:

- **JOINTS:** Leakage & Seepage from Horizontal Lift joints, Vertical Block Joint & Upstream face leading to water loss from reservoir.
- **Structural Deterioration:** Accelerated structural deterioration of dam body due to continuous leakage & seepage from joints.
- **Dam Galleries:** Operational challenges due to flooding in dam galleries from honeycombed surface in upstream face.
- **Environmental Impact:** The dam's rehabilitation should comply with environmental regulations and minimize disruption to the ecosystem and local communities.

REHABILITATION OF SARDAR SAROVAR DAM
CHALLENGES AT UPSTREAM SURFACE

- **Honeycombed Area**
- **Leakage in Dam Gallery**

- **JOINTS**
  - Horizontal Lift Joints
  - Vertical Block Joint
  - Leakage from Upstream face

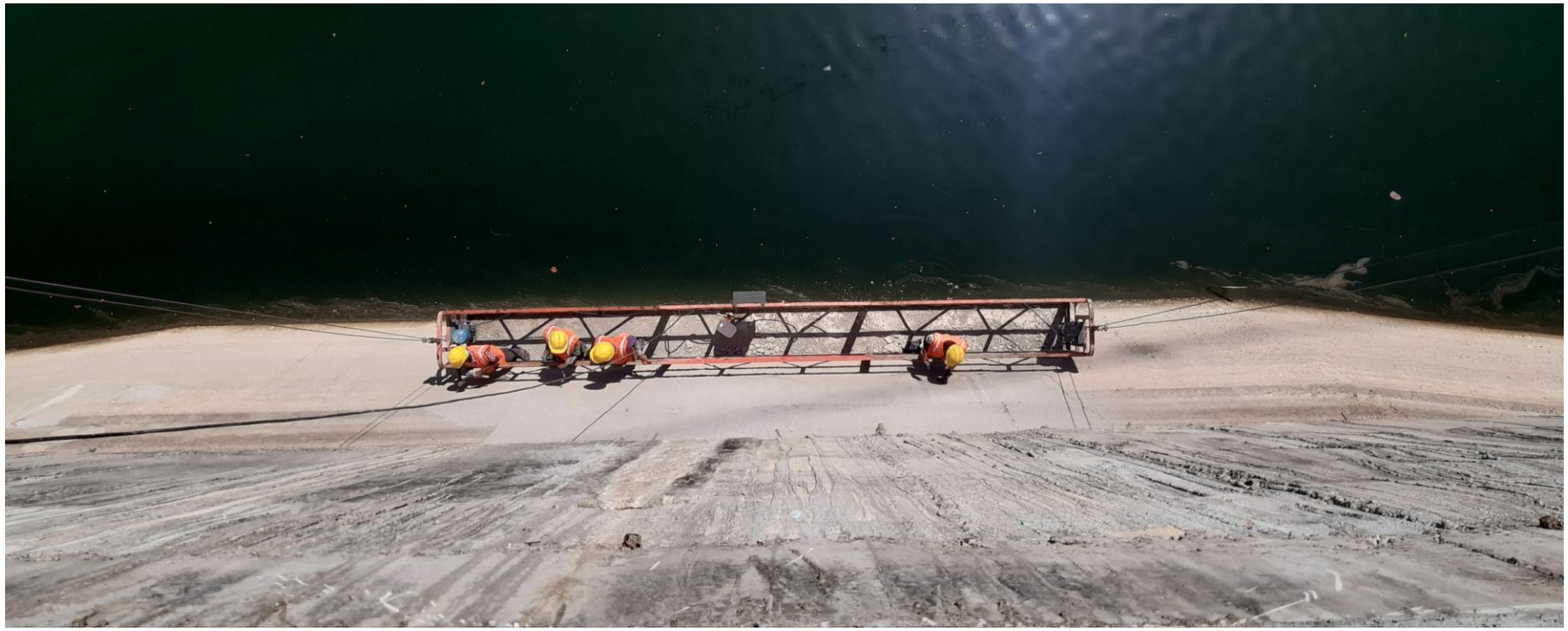


REHABILITATION OF SARDAR SAROVAR DAM

PRE-EXECUTION PLANNING

- Assessment of Project site with contractor
- Kick-off meeting with all stake holders
- Check points
- On-site training on Sika product application
- Site specific method statement provided
- Documentation & Record keeping

REHABILITATION OF SARDAR SAROVAR DAM
ACCESSIBILITY AT UPSTREAM SURFACE



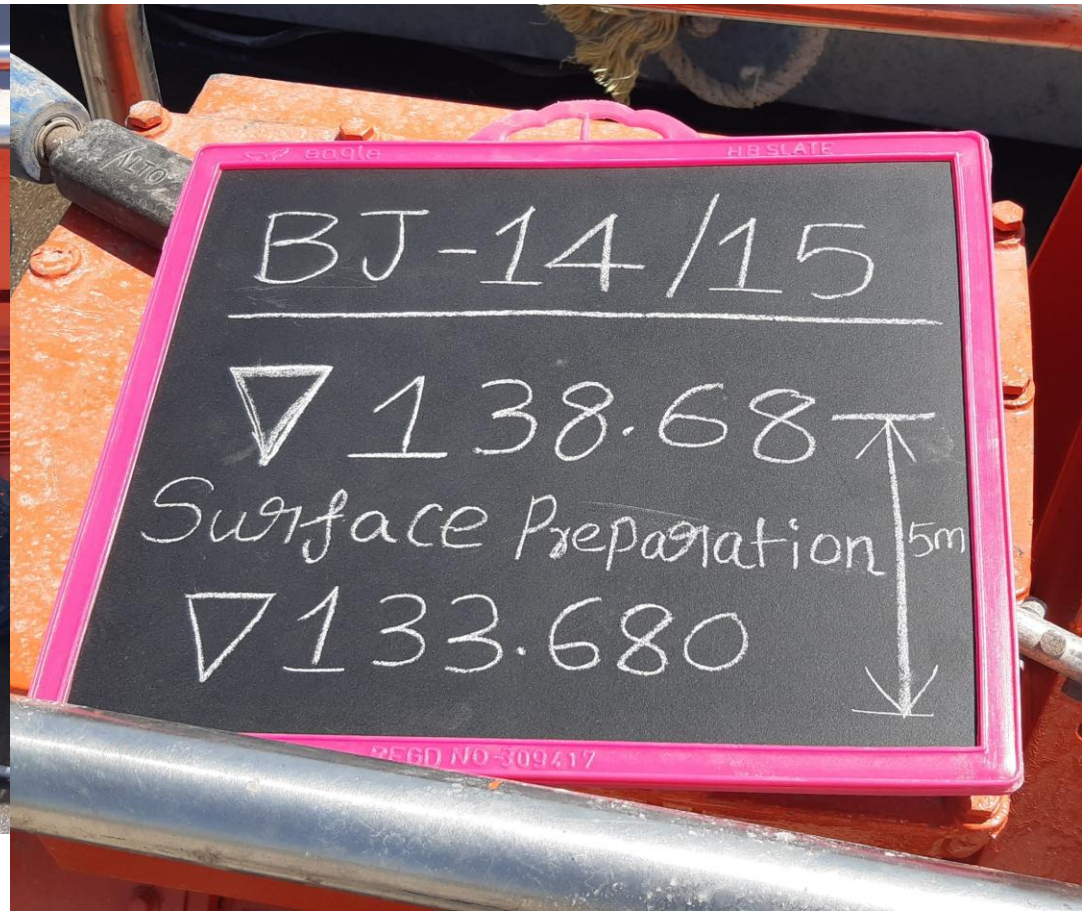
Special arrange were made to access the upstream side of work front.

Safety trainings were provided to workers & team members to ensure safe working.

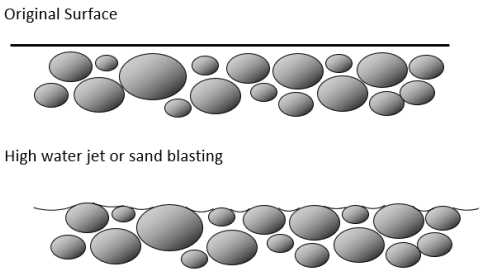
Complete mapping of upstream surface was done for repair work.

REHABILITATION OF SARDAR SAROVAR DAM
SURFACE PREPARATION

CSP 6
Medium scarification



- Surface preparation is very important and key activity for durable repair system.
- High pressure water jetting with 100-450 bar for cleaning algae and loose material removal.



REHABILITATION OF SARDAR SAROVAR DAM
CWC GUIDELINES – CEMENTITIOUS MATERIAL

- The repair materials/systems shall be **CE Certified meeting EN: 1504-3 Class R4** categories.
- The cementitious mortar complying with these properties are prepared using crystalline technology **OR** polymer-based additives in the cement.

Table 4-5: Performance Requirements as per EN: 1504-3 (R4)

Item No.	Performance Charac-teristic	Reference substrate (EN 1766)	Test Method	Requirement based on EN:1504-3 (R4)
1.	Compressive strength	None	EN:12190	≥ 45 MPa
2.	Chloride ion content	None	EN:1015-17	≤ 0.05%
3.	Adhesive bond	MC(0,40)	EN:1542	≥ 2.0 MPa
4.	Carbonation resistance	None	EN:13295	D_k ≤ control concrete MC(0,45)
5.	Elastic modulus	None	EN:13412	≥ 20 GPa

REHABILITATION OF SARDAR SAROVAR DAM
CWC GUIDELINES – EPOXY MATERIAL

Table 4-8: Mechanical properties of epoxy resin bonding system

Sl. No.	Performance Characteristic	Test Method	Requirement
1.	Viscosity of Neat Resin System	ASTM D 1084	< 20 Poise (2.0 Pa.s)
2.	Compressive strength (7days)	ASTM D695	≥70 MPa
3	Tensile strength (7days)	ASTM D638	≥50 MPa
4.	Bond strength (14days)	ASTM C882	≥10 MPa

- **Epoxy Grout:** The epoxy grout is a 2-components low viscous epoxy resin bonding system (Resin & Hardener) conforming to **ASTM C881 Type-IV Class C**.
- **Epoxy Mortar:** The epoxy mortar comprises of epoxy binders and aggregate/ filler. Epoxy binder is 2-component epoxy resin bonding system (Resin & Hardener) conforming to **ASTM C881 Type-IV Class C**.

REHABILITATION OF SARDAR SAROVAR DAM
SIKA SOLUTIONS – ABOVE WATER LEVEL

SUMMARY OF TREATMENT FOR RESPECTIVE APPLICATION AREA

Sr No	Application Area	Repair System (Above water level areas)
1	Joints – Horizontal & Vertical	▪ Sealing Joints with Moisture Insensitive Epoxy Putty – **Sikagard® 694 FI** ▪ Injection with Low Viscous, Epoxy Injection – **Sikadur® 52 LP (IN)**
2	Surface Patch Repairs / Honey Comb Repairs	▪ Repairs with Thixotropic, High Strength, Moisture Insensitive Epoxy Mortar – **Sikadur® 53 UF (Mortar)**
3	Protective Coating for Entire Area	▪ 2mm of Thixotropic, Epoxy Structural Adhesive / putty **Sikadur® 31 IN** ▪ 2 Coats of Polyurethane Coating – **Sikagard® PU UR.**

REHABILITATION OF SARDAR SAROVAR DAM
SIKA SOLUTIONS – UNDERWATER REPAIR

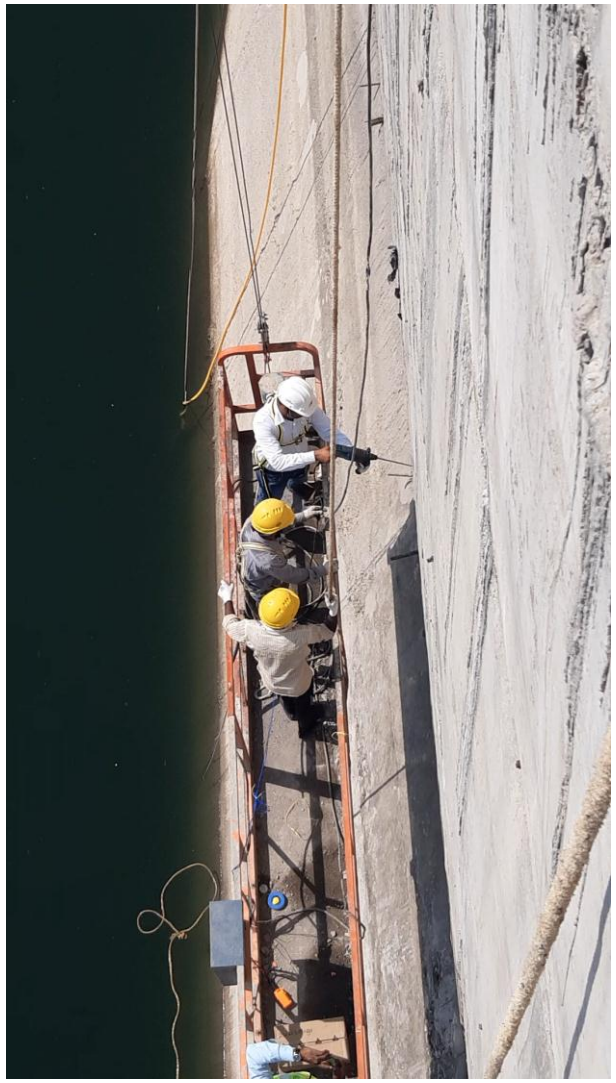
SUMMARY OF SYSTEM SOLUTION

Sr No	Under-water application area	Recommended Solution
1	Cracks	▪ Opening the cracks & sealing Joints with Moisture Insensitive Epoxy Putty – Sikagard® 694 FI ▪ Injection with Low Viscous, Moisture Insensitive, Epoxy Resin – Sikadur® 53UF
2	Surface Defects / localised Voids / Pot holes	▪ Moisture Insensitive Epoxy Putty – Sikagard® 694 FI
3	Lift & Block Joints	▪ Opening the Joints & sealing Joints with Moisture Insensitive Epoxy Putty – Sikagard® 694 FI ▪ Injection with Low Viscous, Moisture Insensitive, Epoxy Resin – Sikadur® 53UF
4	Honeycomb & large area cavities	▪ Pouring High Strength, Moisture Insensitive Epoxy Resin Grout – Sikadur® 53 UF (Grout); by providing shuttering.

REHABILITATION OF SARDAR SAROVAR DAM
SIKA SOLUTIONS

HORIZONTAL LIFT JOINT & VERTICAL BLOCK JOINT

- Opening of Joints by making V groove
- Sealing the joints with two component, solvent free, moisture insensitive epoxy resin-based putty **Sikagard 694 F (I)** having compressive strength of 40 N/mm2 (1 day) according to IS 9162-1979 suitable for under water application.
- Drilling & Fixing NRV Packers at 45 degree angle to intersect crack line.
- Injection of Low Viscous Epoxy Resin **Sikadur 52 LP (IN)** complying with ASTM C-881, Types II & IV, Grade-1, Class E+F; suitable for dry & damp substrate.



REHABILITATION OF SARDAR SAROVAR DAM
SIKA SOLUTIONS

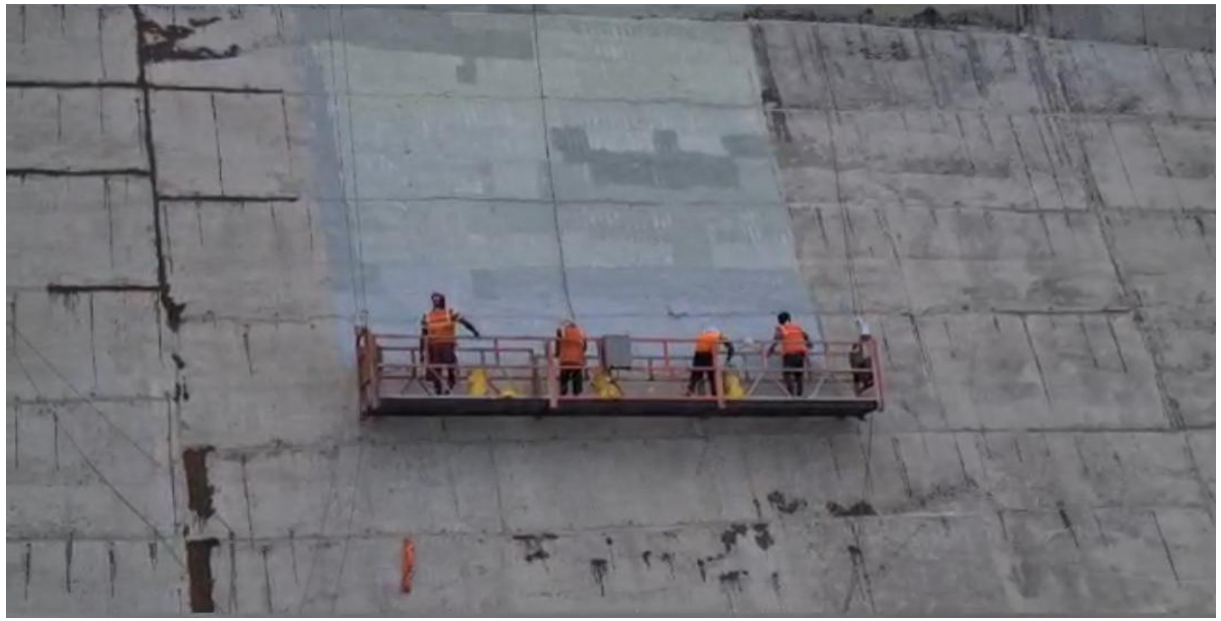
HONEYCOMB AREA REPAIR

- Surface Preparation & Cleaning.
- Application of Bonding Primer on prepared surface.
- Honeycombed area repaired with solvent free, three component moisture insensitive epoxy mortar **Sikadur 53 UF (Mortar)**, developed to meet special requirement of concrete repair particularly in damp, wet condition having excellent adhesion to cement substrate even under salt water and Cures without shrinkage.

REHABILITATION OF SARDAR SAROVAR DAM
SIKA SOLUTIONS

PROTECTIVE MORTAR & COATING AT ENTIRE UPSTREAM AREA

- Surface Cleaning with Mechanical Means.
- Application of epoxy resin-based thixotropic, structural grade levelling mortar, **Sikadur-31 IN** in layer of 2mm thickness on entire upstream side surface.
- Application of UV resistant, Polyurethane Resin based Protective Coating **Sikagard PU UR**, suitable for Saline Condition.



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SIKA SOLUTIONS

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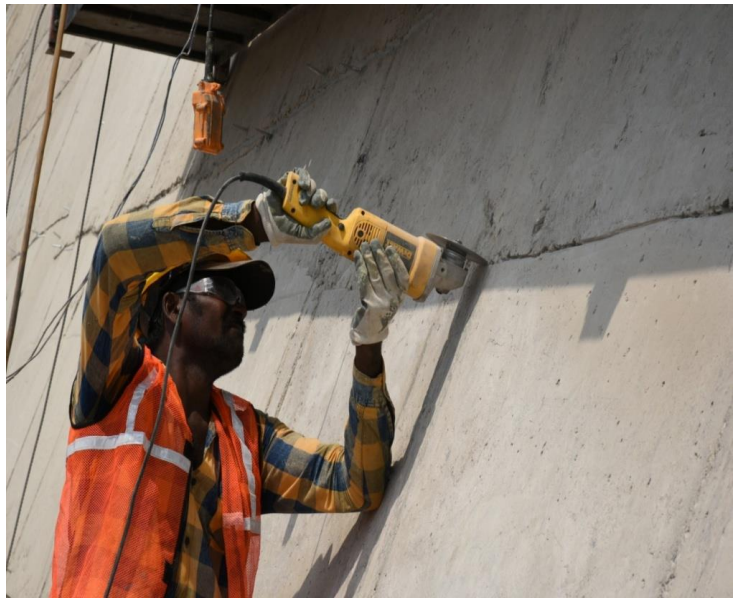

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SIKA SOLUTIONS

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Thank You