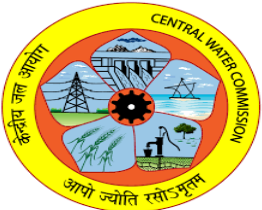




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## Dam Rehabilitation Case Studies

### Repair of Sardar Sarovar Dam by Sika

BY

PUSHPAM KUMAR

TARGET MARKET HEAD – REFURBISHMENT

SIKA INDIA PVT. LTD.

10-12 October 2022 at Jaipur, Rajasthan (India)

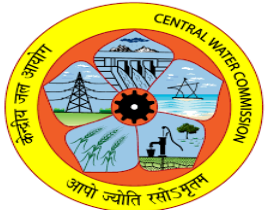


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## AN OVERVIEW OF SIKA SOLUTIONS FOR DAMS AND HYDROPOWER PLANTS

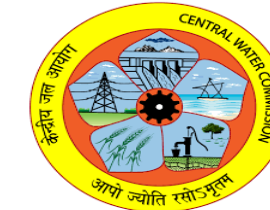


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## Tender - 1



**SARDAR SAROVAR NARMADA NIGAM LTD.  
(A WHOLLY OWNED GOVERNMENT OF GUJARAT UNDERTAKING)**

### TENDER DOCUMENTS FOR

**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.**

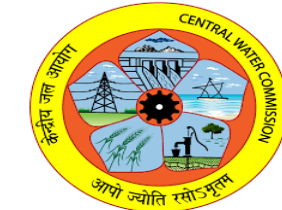
**Estimated Cost:- Rs. 1105.05 Lakhs**

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## Tender – 2



**SARDAR SAROVAR NARMADA NIGAM LTD.  
(A WHOLLY OWNED GOVERNMENT OF GUJARAT UNDERTAKING)**

### TENDER DOCUMENTS FOR

**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.**

**Estimated Cost:- Rs. 674.06 Lakhs**

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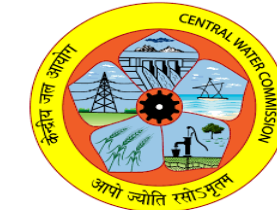


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## Tender – 3



**SARDAR SAROVAR NARMADA NIGAM LTD.  
(A WHOLLY OWNED GOVERNMENT OF GUJARAT UNDERTAKING)**

**TENDER DOCUMENTS**

**FOR**

**“REPAIRING OF EROSION, PITTING AND SEALING OF  
OPENED BLOCK JOINT OF DOWNSTREAM SURFACE OF  
SARDAR SAROVAR DAM ”.**

**Estimated Cost:- Rs. 37.95 Lakhs**

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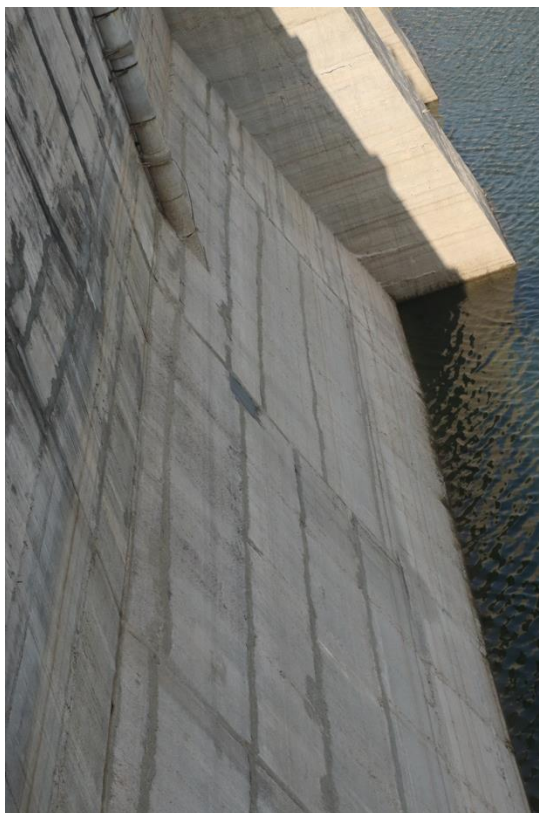
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## Sardar Sarovar dam Challenges at upstream surface



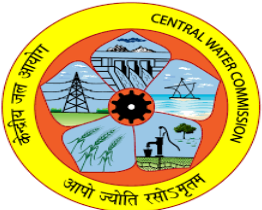
- **JOINTS**
  - Horizontal Lift Joints
  - Vertical Block Joint
- **Honeycombed Area**
- **Leakage in Dam Gallery**

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## Sardar Sarovar dam Pre-Execution Planning

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

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## 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.





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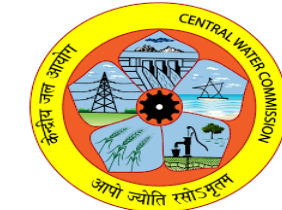


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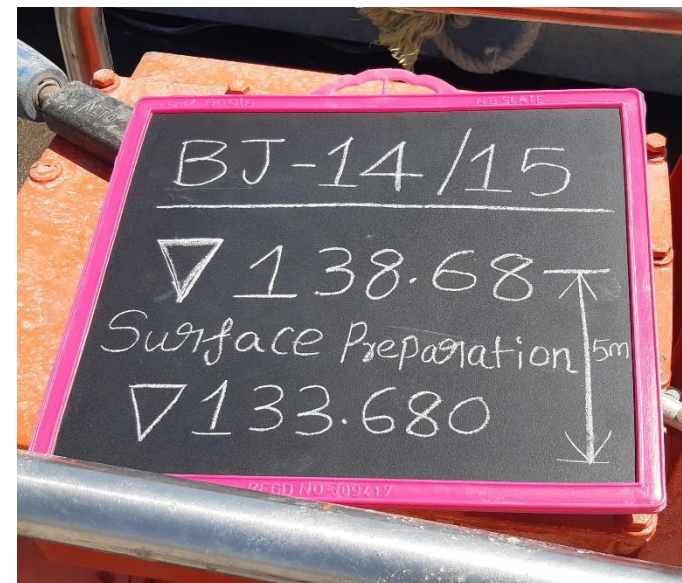
# INTERNATIONAL DAM SAFETY CONFERENCE



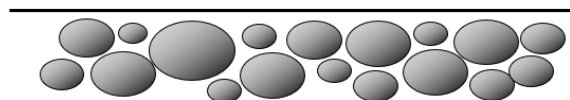
Central Water Commission

## Sardar Sarovar dam Surface Preparation

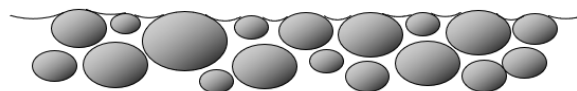
- Surface preparation is very important and key activity for durable repair system.
- High pressure water jetting with 100-450 bar for cleaning algae and loose material removal.



Original Surface



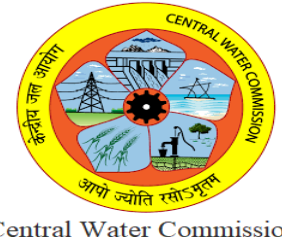
High water jet or sand blasting





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CSP 6  
Medium scarification

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## 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/mm<sup>2</sup> (1 day) according to IS 9162-1979 suitable for under water application.
  - Drilling & Fixing NRV Packers at 45-degree angle to intersect joints.
  - 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.

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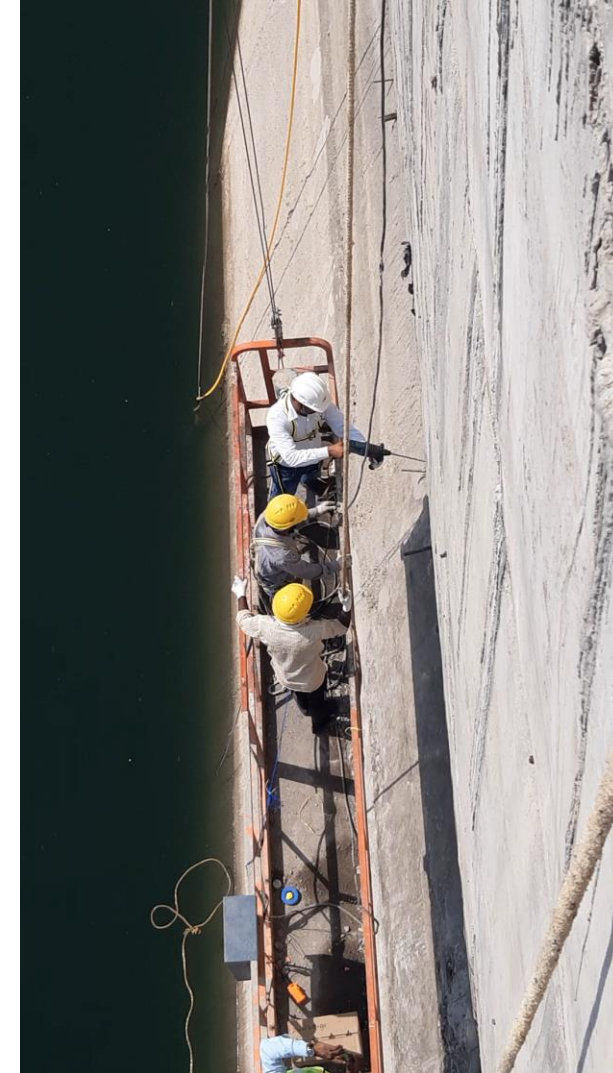


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## Sardar Sarovar dam

### 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.

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## Sardar Sarovar dam

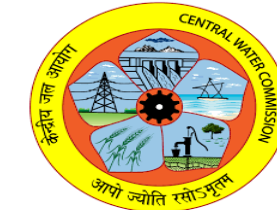
### Sika Solutions

- 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.

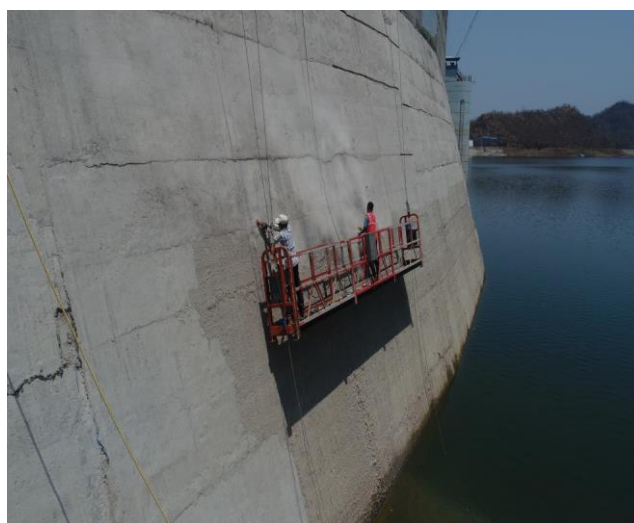
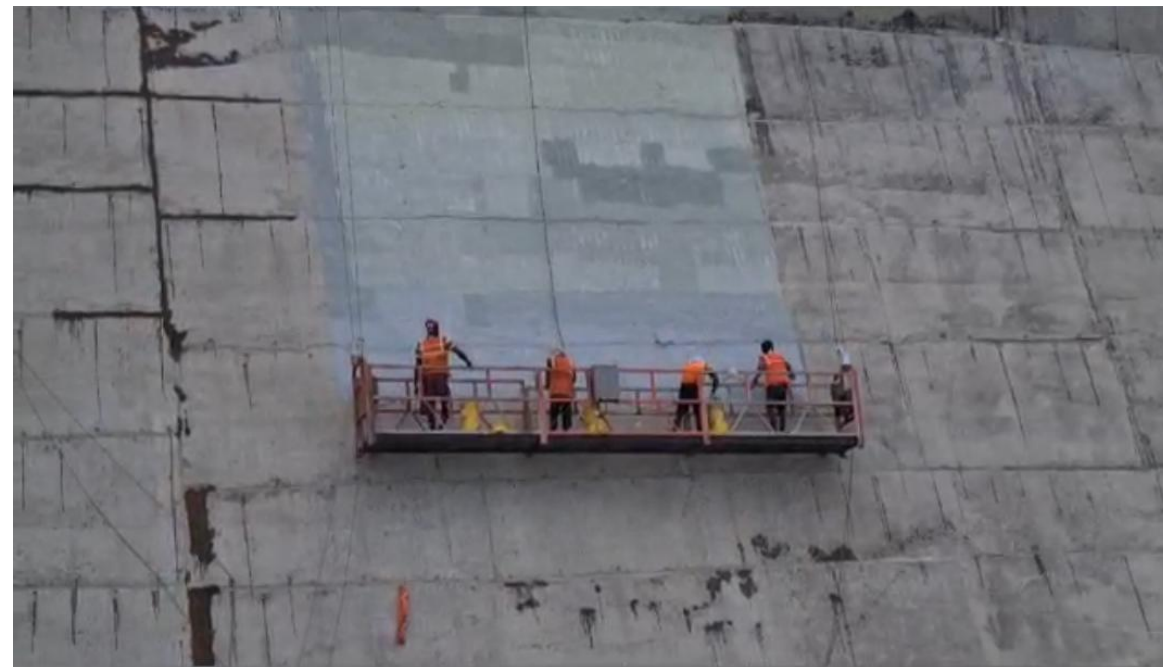


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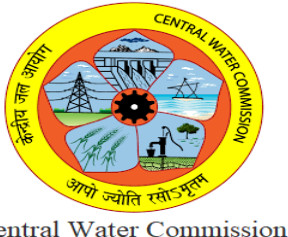


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## Sardar Sarovar dam – Finished Surface

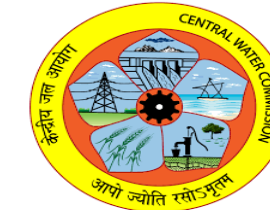


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## Sardar Sarovar dam Sika Solutions

### SUMMARY OF TREATMENT FOR RESPECTIVE APPLICATION AREA

Sr No	Application Area	Repair System ( Above water level areas )
1	Joints – Horizontal & Vertical	<ul style="list-style-type: none"> <li>Sealing Joints with Moisture Insensitive Epoxy Putty – <b>Sikagard® 694 FI</b></li> <li>Injection with Low Viscous, Epoxy Injection – <b>Sikadur® 52 LP (IN)</b></li> </ul>
2	Surface Patch Repairs / Honey Comb Repairs	<ul style="list-style-type: none"> <li>Repairs with Thixotropic, High Strength, Moisture Insensitive Epoxy Mortar – <b>Sikadur® 53 UF (Mortar)</b></li> </ul>
3	Protective Coating for Entire Area	<ul style="list-style-type: none"> <li>2mm of Thixotropic, Epoxy Structural Adhesive / putty <b>Sikadur® 31 IN</b></li> <li>2 Coats of Polyurethane Coating – <b>Sikagard® PU UR.</b></li> </ul>

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## TECHNICAL SPECIFICATION AS PER CWC GUIDELINES CEMENTITIOUS MORTAR

- 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.

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

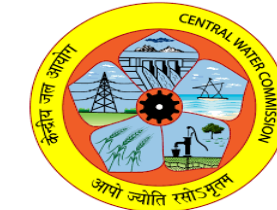
Item No.	Performance Characteristic	Reference substrate (EN 1766)	Test Method	Requirement based on EN:1504-3 (R4)
1.	Compressive strength	None	EN:12190	≥ 45 MPa
2.	Chloride ion content	None	EN:1015-17	≤ 0.05%
3.	Adhesive bond	MC(0,40)	EN:1542	≥ 2.0 MPa
4.	Carbonation resistance	None	EN:13295	$D_k \leq$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







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## SIKA MONOTOP®-412 IN EN 1504-3, CLASS R-4 STRUCTURAL REPAIR MORTAR

### DESCRIPTION

- Sika MonoTop®-412 IN is 1-component, fibre reinforced, shrinkage compensated, thixotropic cement-based structural grade repair mortar.
- Sulphate resistant, High Abrasion Resistant mortar for Dams & Spillway repair
- Suitable for hand or machine application
- CE certified meeting EN 1504-3 Class R4 categories for restoration work as per method principles 3.1, 3.3, 4.4, 7.1 & 7.2

### PRODUCT INFORMATION

- Density Powder : ~1.35 kg/L
- Consumption : ~2.1 kg of powder per mm thickness per m2
- Mixing ratio : 3.5–4.0 litres of water for 25 kg powder (0.14 ~ 0.16)
- Application : Manual or Wet Spray

### TECHNICAL DETAILS

- Compressive Strength (28 days) : ≥ 60 MPa (EN 12190)
- Chloride ion content : ≤ 0.05% (EN:1015-17)
- Tensile Adhesion Strength : ≥ 2.0 MPa (EN 1542)
- Carbonation resistance dk : ≤ control concrete [MC (0.45)] (EN 13295)
- Elastic modulus : ≥ 20.0 GPa (EN:13412)
- Flexural Strength (28 days) : ≥ 8 MPa (EN 196-1)



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## TECHNICAL SPECIFICATION AS PER CWC GUIDELINES

### EPOXY MATERIAL

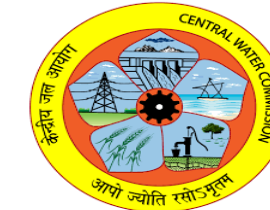
Table 4-8: Mechanical properties of epoxy resin bonding system

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**.



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## EPOXY MATERIAL AS PER CWC GUIDELINES

### SIKADUR – EPOXY INJECTION

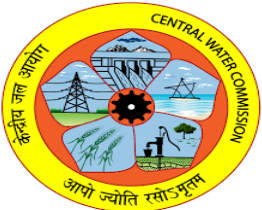
Properties	Test Method (Requirement)	Sikadur-55 LP (IN)	Sikadur – 53 UF	Sikadur®-55 SLV (IN)
Viscosity of Neat Resin System	ASTM D1084 (<20 Poise)	~ 2.5 Poise at +30°C	~ 5.0 Poise at +30°C	~ 7.0 Poise at +15°C ~ 3.5 Poise at +25°C
Compressive Strength (1 Day)	ASTM D695 (≥70 N/mm <sup>2</sup> )	65 N/mm <sup>2</sup>	40 N/mm <sup>2</sup>	≥70 N/mm <sup>2</sup>
Tensile strength (7days)	ASTM D638 (≥50 N/mm <sup>2</sup> )	50 N/mm <sup>2</sup>	≥30 N/mm <sup>2</sup>	≥50 N/mm <sup>2</sup>
Bond Strength	ASTM C882 (≥10 N/mm <sup>2</sup> )	10 N/mm <sup>2</sup>	10 N/mm <sup>2</sup>	≥11 N/mm <sup>2</sup>
Pot Life		50 min.	15 min.	75 min.
Compliance	ASTM	ASTM C-881, Types II & IV, Grade-1, Class E+F	ASTM C-881, Types I, Grade-1, Class C	ASTM C-881, Types I & IV, Grade-1, Class C



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## Thank You

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