

भारत सरकार  
जल शक्ति मंत्रालय  
जल संसाधन नदी विकास एवं गंगा संरक्षण विभाग  
केंद्रीय मृदा एवं सामग्री अनुसंधानशाला  
ओलोफ पाल्मे मार्ग, हौज़ खास  
नई दिल्ली -110016



75  
Azadi Ka  
Amrit Mahotsav

Government of India  
Ministry of Jal Shakti  
Department of Water Resources, RD and GR  
Central Soil and Materials Research Station Olof  
Palme Marg, Hauz Khas,  
New Delhi- 110016

Q-14011/2/2021-DH(CSS),Part-II

**Dated: 13.04.2023**

To,  
Executive Engineer,  
Saraswati Heritage Division 1  
JAGADHRI, Haryana  
Mail id: Email: xenjdr1@gmail.com

Sub: FINAL REPORT ON CONSTRUCTION MATERIALS SURVEY AND LABORATORY INVESTIGATIONS ON TERRACE MATERIALS (NAGLI QUARRY, JAITPUR VILLAGE), AND RBM MATERIALS AT DAM AXIS SAMPLES FOR ASSESSING THEIR SUITABILITY FOR USE AS COARSE AND FINE AGGREGATE IN CONCRETE FOR REVIVAL OF SARASWATI PROJECT, HARYANA.- Reg.

Sir,

Please find enclosed herewith the final Report on construction materials survey and laboratory investigations on terrace materials (Nagli quarry, Jaitpur Village), and RBM materials at dam axis samples for assessing their suitability for use as coarse and fine aggregate in Concrete for Revival of Saraswati Project, Haryana

Encl: As Above

Yours faithfully

(U S Vidyarthi)

Scientist E

011 - 26581375



---

केंद्रीय मृदा एवं सामग्री अनुसंधानशाला, नई दिल्ली  
CENTRAL SOIL AND MATERIALS RESEARCH STATION, NEW DELHI

---

Report No: 1/C-II/CSMRS/E/4/2023

FINAL EPORT ON CONSTRUCTION MATERIALS SURVEY AND  
LABORATORY INVESTIGATIONS ON TERRACE MATERIALS (NAGLI  
QUARRY, JAIPUR VILLAGE), AND RBM MATERIALS AT DAM AXIS  
SAMPLES FOR ASSESSING THEIR SUITABILITY FOR USE AS COARSE AND  
FINE AGGREGATE IN CONCRETE FOR REVIVAL OF SARASWATI PROJECT,  
HARYANA

NEW DELHI

April, 2023

---

CSMRS

Director

*Not to be published in part or in full without prior permission of the Director, Central Soil & Materials Research Station (Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India) Olof Palme Marg, Hauz Khas, New Delhi — 110016*

**TEAM DEPUTED FOR FIELD INVESTIGATION**

U S Vidyarthi	Scientist - E
Manish Gupta	Scientist - E
B.K.Muzni	Scientist – D
Mandalozu Raja	Scientist – D
Shri Nisheeth Agnihotri	Scientist - C
U C Gupta	Scientist – B

**TEAM INVOLVED IN LABORATORY INVESTIGATIONS AND  
PREPARATION OF REPORT**

U S Vidyarthi	Scientist – E
Mandalozu Raja	Scientist – D
U C Gupta	Scientist – B
Rajendra Sharma	Lab. Assistant
Bhuwan Chand	Lab. Attendant

## CONTENTS

	<b>Details</b>	
1.0	Introduction	
2.0	Scope of the report	
3.0	Field investigation	
3.1	Coarse Aggregate	
3.2	Fine Aggregate	
4.0	Laboratory Investigation	
4.1	Coarse aggregate	
4.2	Fine aggregate	
5.0	Conclusions and Recommendations	

## **LIST OF ANNEXURES & APPENDIX**

Annexure I	Details of coarse and fine aggregate samples collected during the field visit
Annexure IIA	Test Results showing physical properties of coarse aggregate samples
Annexure IIB	Test Results of Potential Alkali Reactivity (Mortar-Bar Method, ASTM C1260) of coarse aggregate samples
Annexure IIIA	Test Results showing physical properties of fine aggregate samples
Annexure IIIB	Test Results of Potential Alkali Reactivity (Mortar-Bar Method, ASTM C1260) of fine aggregate samples
Annexure IIIC	Test Results showing physical properties of fine aggregate sample (Q2S1)
Annexure IIID	Test Results showing physical properties of fine aggregate sample (Q2S2)
Annexure IIIE	Test Results showing physical properties of fine aggregate sample (Q2S3)
Annexure-IV	Quarry Location & Quarry Photographs
Appendix I	Petrographic Analysis

**FINAL REPORT ON CONSTRUCTION MATERIALS SURVEY AND LABORATORY INVESTIGATIONS ON TERRACE MATERIALS (NAGLI QUARRY, JAITPUR VILLAGE), AND RBM MATERIALS AT DAM AXIS SAMPLES FOR ASSESSING THEIR SUITABILITY FOR USE AS COARSE AND FINE AGGREGATE IN CONCRETE FOR REVIVAL OF SARASWATI PROJECT, HARYANA**

**1.0 Introduction**

Executive Engineer, Sarasvati Heritage Division No.1, Jagadhri, vide his officer Letter No.2612/1E, dated 22/11/2021, requested to undertake the work of "construction materials survey and laboratory investigations on coarse and fine aggregate samples" to be used in the proposed Revival of Sarasvati Reservoir. In connection with the above, CSMRS submitted an estimate amounting to Rs. 25,26,642/- (Twenty Five Lakh Twenty Six Thousand Six hundred Forty Two Rupees only ) vide this office Letter No. 29/43/CSS/CSMRS/2012, dated 24th November 2021. The Office of Executive Engineer deposited an amounting Rs. 25,26,642/- through Demand Draft vide their office Letter No. 411/AF dated 4<sup>th</sup> February 2022.

The following CSMRS officers made a preliminary visit to the site on December 22<sup>nd</sup> and 23<sup>rd</sup>, 2021, to examine the proposed rock sources such as rock quarries/terrace/RBM by the project authorities for the production of aggregate (coarse and fine) for the construction of the project:

1. Shri U.S. Vidyarthi, Scientist E
2. Dr. Manish Gupta, Scientist E

That after the preliminary visit, a team of CSMRS officers went to the proposed rock/RBM sources to the collection of representative samples from those proposed quarries for testing to determine the suitability of aggregate for use in making concrete:

1. Shri B.K. Munzni, Scientist D
2. Shri Nisheeth Agnihotri, Scientist C

Six coarse aggregate samples and six fine aggregate samples were collected from the proposed sources by the CSMRS team. The details of the coarse and fine samples are as follows:

<b>Location</b>	<b>Details</b>
Somb River Terrace Material Quarry	<ul style="list-style-type: none"> <li>• No. of CA samples collected: 2 No (1. Nagli and 2. Bhattuwala)</li> <li>• No. of FA samples collected: 2 No (1. Nagli and 2. Bhattuwala)</li> </ul>
Yamuna Bank Terrace Material Quarry	<ul style="list-style-type: none"> <li>• No. of CA samples collected: 3 No (three different locations of the Belgarh Terrace Deposit )</li> <li>• No. of FA samples collected: 3 No (three different locations of the Belgarh Terrace Deposit )</li> </ul>

The Final report on the samples mentioned above was submitted to the Executive Engineer of the Sarasvati Project vide this office letter No. Q-14011/2/2021-DH (CSS) dated 25<sup>th</sup> March 2022.

Again, the Executive Engineer of the Sarasvati Project requested CSMRS to undertake aggregate testing to determine the suitability of aggregate from two reserved quarries (i.e., Terrace Material from Nagli Quarry at Jaitpur Village & RBM Materials at the dam axis). Subsequently CSMRS submitted an estimate of Rs. 23,91,398 /- (Twenty three Lakh Ninety One Thousand Three Hundred and Ninety Eight only) vide this office Letter No. Q-14011/2/2021-DH (CSS) dated 12<sup>th</sup> May 2022. Another team of following CSMRS officers visited the reserved quarries from 23<sup>rd</sup> May to 27<sup>th</sup> May 2022 to collect representative samples from reserved quarries.

1. Mandalozu Raja, Scientist D
2. U C Gupta, Scientist B

The following are the details of the reserved quarries and the number of samples collected:

<b>Location</b>	<b>Details of samples collected</b>
Terrace Material from Nagli Quarry at Jaitpur Village [Q2]	<ul style="list-style-type: none"> <li>• 3 No of CA samples collected</li> <li>• 3 No of FA samples collected</li> </ul>
RBM Material from the dam axis [Q1]	<ul style="list-style-type: none"> <li>• 2 No of CA samples collected</li> </ul>

## **2.0 Scope of the report**

As requested by the project authorities, CSMRS has conducted laboratory investigations on collected samples from terrace materials (i.e., Nagli quarry, Jaitpur Village), and RBM materials at dam axis samples for assessing their suitability for use as coarse and fine aggregate in use for making concrete for proposed Revival of Saraswati Project, Haryana. This investigation report broadly covers the physical and mechanical properties of coarse and fine aggregate to assess its suitability for use as coarse and fine aggregate in making concrete. The mineralogy of aggregates is of greater importance in selecting durable aggregates. The same information is also necessary for ascertaining the potential reactivity of aggregate with the presence of alkalis in cement. Hence, these five coarse aggregate and three fine aggregate samples were proposed to send to the Geological Survey of India (GSI) for carrying out the petrographic examination. The potential alkali-silica reactivity (ASR) tests on five coarse aggregate and three fine aggregate samples were conducted in the CSMRS laboratory using the accelerated mortar bar method as per ASTM C1260.

## **3.0 Field investigation**

### **3.1 Coarse Aggregate**

Three coarse aggregate samples were collected from the following two reserve quarries along with the project authorities:

1. Terrace materials (Nagli quarry, Jaitpur Village), and
2. RBM materials at dam axis

CSMRS officers collected three representative samples from Terrace Materials (Nagli quarry, Jaitpur Village) and two RBM Materials at the dam axis to assess their suitability for use as coarse aggregate in concrete. The details of the coarse aggregate samples collected from the above-reserved quarries are given in Annexure-I. The physical and mechanical properties of all collected representative samples from both reserve sources are presented in Annexure-IIA. These coarse aggregate samples were sent to the Geological Survey of India (GSI) for a detailed petrographic analysis to determine the composition of various mineral constituents and identify potentially harmful minerals that could cause an alkali-aggregate reaction (AAR). The aggregate

samples are under testing to find the expansion due to the alkali-silica reaction as per ASTM C 1260 standards at CSMRS.

### 3.2 Fine Aggregate:

Three representative samples were collected from Terrace Materials (Nagli quarry) along with the project authorities, The details of the fine aggregate samples collected from the above-reserved quarries are given in Annexure-I. The physical properties of all collected representative samples are presented in Annexure-IIIA and IIIC to IIIE. These fine aggregate samples were sent to the Geological Survey of India (GSI) for a detailed petrographic examination to determine the composition of various mineral constituents and identify potentially harmful minerals that could cause an alkali-aggregate reaction (AAR). The aggregate samples are under testing to find the expansion due to the alkali-silica reaction as per ASTM C 1260 standards at CSMRS.

## 4.0 Laboratory investigations

### 4.1 Coarse aggregate

The following laboratory tests were carried out on all the five coarse aggregate samples collected at project for ascertaining their suitability for use as coarse aggregates in concrete:

S. No	Name of Test	Reference standard followed
1	Water Absorption	IS: 2386 (Part - 3)
2	Specific Gravity	IS: 2386 (Part - 3)
3	Aggregate Impact Value	IS: 2386 (Part - 4)
4	Aggregate Crushing Value	IS: 2386 (Part - 4)
5	Aggregate Abrasion Value	IS: 2386 (Part - 4)
6	Soundness (5 Cycles of Na <sub>2</sub> SO <sub>4</sub> )	IS: 2386 (Part - 5)
7	Petrographic Examination	GSI (Geological Survey of India)
8	Potential Alkali Silica Reactivity Test on aggregates (Mortar Bar Method)	ASTM C1260

The physical test results of coarse aggregate samples are presented in **Annexure IIA**. Potential alkali silica reactivity (ASR) test results of coarse aggregate samples are presented in **Annexure-IIB**. Petrographic analysis report of coarse aggregate samples tested at GSI are presented in **Appendix I**.

## 4.2 Fine aggregate

The following laboratory tests were carried out on all the three fine aggregate samples collected at project for ascertaining their suitability for use as fine aggregates in concrete:

S. No	Name of Test	Reference standard followed
1	Specific Gravity	IS: 2386 (Part - 3)
2	Fineness Modulus	IS: 2386 (Part - 1)
3	Sieve Analysis /Grading	IS: 2386 (Part – 1)
4	Organic Impurities	IS: 2386 (Part – 2)
4	Materials finer than 75 microns	IS: 2386 (Part - 2)
5	Petrographic Examination	GSI (Geological Survey of India)
6	Potential Alkali Silica Reactivity Test on Aggregates (Mortar Bar Method)	ASTM C1260

The physical test results of fine aggregate samples tested are presented in **Annexure IIIA & III C to III E**. Potential alkali silica reactivity (ASR) test results fine aggregate samples are presented in **Annexure-III B**. Petrographic analysis report of fine aggregate samples tested at GSI are presented in **Appendix I**.

## 5.0 Conclusions and Recommendations:

- Three samples (Q2S1, Q2S2 & Q2S3) were tested from terrace material (i.e., Nagli Quarry at Jaitpur village). The Q2S2 sample meeting the specification requirements for use in non-wearing surfaces as per IS 383. The other two samples (Q2S1 & Q2S3) meeting the requirements for use in both wearing and non-wearing surfaces. Hence, the project authorities are advised to adopt selective quarrying while mining the terrace material quarry. Further advised to conduct frequent testing and check the results with IS 383 before use as aggregate in the project. The mortar bar expansion of all three samples shows an ASR expansion of less than 0.1% at 14 days (16 days after casting). Hence, these samples mostly fall into the category of innocuous behavior.
- Two samples (Q1S1 & Q1S2) were tested from RBM material near to the dam axis and are meeting the specification requirements for use in non-wearing surfaces only as per IS 383. The mortar bar was made of Q1S2 aggregate samples showing ASR expansion falling between

0.10% - 0.20% at 14 days (16 days after casting). Hence, this aggregate falls in the category of innocuous & deleterious in the field performance. Hence, the project authorities are advised to carry out ASTM C 1567 to find the quantity of pozzolanic material required to bring the expansion to acceptable limits before use in the project.

- Three fine aggregate samples (Q2S1, Q2S2 & Q2S3) were tested from terrace material (i.e., Nagli Quarry at Jaitpur village). The materials finer than 75 microns results are higher than the total percentages of all deleterious materials (except mica) for uncrushed fine aggregate specified in the IS 383 (i.e., 3.0%). Hence, the fine aggregate shall be washed before use and also tested regularly as per relevant standards. Further, The mortar bar was made of Q2S1 aggregate samples showing ASR expansion falling between 0.10% - 0.20% at 14 days (16 days after casting). Hence, this aggregate falls in the category of innocuous & deleterious in the field performance. Hence, the project authorities are advised to carry out ASTM C 1567 to find the quantity of pozzolanic material required to bring the expansion to acceptable limits before use in the project.
- All the aggregates must be tested frequently as per the specification of IS codes before using aggregate in the project.

**Annexure-I**

**Final Report on construction materials survey and laboratory investigations on terrace materials (Nagli quarry, Jaitpur Village), and RBM materials at dam axis samples for assessing their suitability for use as coarse and fine aggregate in Concrete for Revival of Sarasvati Project, Haryana**

**DETAILS OF COARSE AND FINE AGGREGATE SAMPLES COLLECTED DURING  
THE FIELD VISIT**

Sl. No .	Name of Construction Materials	Sample designation		
		Field location of samples/Brand	Field samples Designation	CSMRS Lab Designation
1	Coarse Aggregate	Terrace Material from Nagli Quarry at Jaitpur Village [Q2]	Q2S1	CA-01/22
			Q2S2	CA-02/22
			Q2S3	CA-03/22
		RBM Material from the dam axis [Q1]	Q1S1	CA-04/22
			Q1S2	CA-05/22
2	Fine Aggregate	Terrace Material from Nagli Quarry at Jaitpur Village [Q2]	Q2S1	FA-06/22
			Q2S2	FA-07/22
			Q2S3	FA-08/22

Quarry Location map and few Photographs are presented in annexure IV

**Annexure-IIA**

**Final Report on construction materials survey and laboratory investigations on terrace materials (Nagli quarry, Jaitpur Village), and RBM materials at dam axis samples for assessing their suitability for use as coarse and fine aggregate in Concrete for Revival of Saraswati Project, Haryana**

**TEST RESULTS SHOWING PHYSICAL PROPERTIES OF COARSE AGGREGATE SAMPLES**

Sl. No.	Location	Field Designation	Specific Gravity	Aggregate Impact Value (%)	Aggregate Crushing Value (%)	Aggregate Abrasion Value (%)	Soundness (loss of weight 5 Cycles of Na <sub>2</sub> SO <sub>4</sub> ) (%)	Water Absorption (%)	ASR Expansion at 16 days after casting	Remarks as per IS 383 – 2016
1.	Terrace Material from Nagli Quarry at Jaitpur Village [Q2]	Q2S1	2.62	24	22	30	8.00	0.81	0.087	use in both wearing non-wearing surfaces
2.		Q2S2	2.58	24	22	33	11.50	1.10	0.088	use in non-wearing surfaces only
3.		Q2S3	2.60	25	19	29	8.81	1.14	0.090	use in both wearing non-wearing surfaces
5	RBM Material from the dam axis [Q1]	Q1S1	2.60	35	33	41	11.04	1.94	0.094	use in non-wearing surfaces only
6		Q1S2	2.63	33	32	33	11.45	1.45	0.110	use in non-wearing surfaces only

***Specification requirements for coarse aggregate as per IS 383 – 2016:***

- *Aggregate Impact Value % :  $\leq 45\%$  for concrete for non-wearing surfaces  
 $\leq 30\%$  for concrete for wearing surfaces*
- *Aggregate Crushing Value %:  $30\%$  for concrete for wearing surfaces*

*Non-wearing surfaces: In case the aggregate crushing exceeds 30%, then the test for 'ten percent fines' should be conducted and the minimum load for the ten percent should be 50 kN.*

- *Aggregate Abrasion Value % :  $\leq 50\%$  for concrete for non-wearing surfaces  
 $\leq 30\%$  for concrete for wearing surfaces*
- *Soundness (loss of weight after 5 Cycles of  $\text{Na}_2\text{SO}_4$ ) % :  $\leq 12\%$*

***Specification requirements as per ASTM C1260:***

- *Expansion of less than 0.10% at 14 days (16 days after casting) is indicative of innocuous behavior in most cases*
- *Expansion of more than 0.20% at 14 days (16 days after casting) is indicative of potentially deleterious expansion.*
- *Expansion between 0.10% - 0.20% at 14 days (16 days after casting) include both aggregate that are known to be innocuous & Deleterious in field performance. In such a situation, it may be useful to take comparator reading until 28 days.*

**Potential Alkali Reactivity of Aggregate (Mortar – Bar) [ASTM C1260] test results of coarse aggregate samples collected from different locations for use in concrete for Revival of Saraswati Project, Haryana**

**TEST RESULTS OF POTENTIAL ALKALI REACTIVITY (MORTAR-BAR METHOD, ASTM C1260) OF COARSE AGGREGATE SAMPLES**

Test Regime: Accelerated Method under 80<sup>0</sup>C Temp. in 1N NaOH solution.

Type of Cement used for making: **OPC 43**

Equivalent Alkali Content of Cement (Na<sub>2</sub>O): 0.59%

Age in days	Terrace Material from Nagli Quarry at Jaitpur Village [Q2] OPC -43 (Equivalent Na <sub>2</sub> O: 0.59%)			RBM Material from the dam axis [Q1]		Remarks
	Q2S1	Q2S2	Q2S3	Q1S1	Q1S2	
	CA-01/22	CA-02/22	CA-03/22	CA-04/22	CA-05/22	
0	0.000	0.000	0.000	0.000	0.000	<b>Specification requirements as per ASTM C1260:</b> 1. Expansion of less than 0.10% at 14 days (16 days after casting) is indicative of innocuous behavior in most cases 2. Expansion of more than 0.20% at 14 days (16 days after casting) is indicative of potentially deleterious expansion. 3. Expansion between 0.10% & 0.20% at 14 days (16 days after casting) include both aggregate that are known to be innocuous & Deleterious in field performance. In such a situation, it may be useful to take comparator reading until 28 days.
4	0.015	0.010	0.016	0.020	0.021	
7	0.033	0.035	0.039	0.043	0.048	
10	0.060	0.055	0.060	0.061	0.066	
14	0.083	0.078	0.085	0.086	0.099	
16	0.087	0.088	0.090	0.094	0.110	
18					0.122	
23					0.142	
25					0.154	
28					0.160	

**Annexure-III A**

**Final Report on construction materials survey and laboratory investigations on terrace materials (Nagli quarry, Jaitpur Village), and RBM materials at dam axis samples for assessing their suitability for use as coarse and fine aggregate in Concrete for Revival of Saraswati Project, Haryana**

**TEST RESULTS SHOWING PHYSICAL PROPERTIES OF FINE AGGREGATE SAMPLES**

Sl. No	Location	Field Designation	Grading	Fineness Modulus	Specific Gravity	Materials finer than 75 microns (i.e., Silt and clay content)	Organic Impurities	Soundness (loss of weight 5 Cycles of Na <sub>2</sub> SO <sub>4</sub> ) (%)	Water Absorption (%)	ASR Expansion at 16 days after casting
1.	Terrace Material from Nagli	Q2S1	Zone - III	2.11	2.68	6.4%	Passed	9.7%	9.2%	0.113
2.	Quarry at Jaitpur Village [Q2]	Q2S2	Zone - II	2.58	2.65	13.6%	Passed	9.3%	11.2%	0.081
3.		Q2S3	Zone - II	2.24	2.67	3.3%	Passed	9.4%	13.0%	0.094

***Specification requirements for fine aggregate as per IS 383 – 2016:***

*1. Soundness (loss of weight after 5 Cycles of Na<sub>2</sub>SO<sub>4</sub>) % : ≤ 10%*

***Specification requirements as per ASTM C1260:***

- Expansion of less than 0.10% at 14 days (16 days after casting) is indicative of innocuous behavior in most cases*
- Expansion of more than 0.20% at 14 days (16 days after casting) is indicative of potentially deleterious expansion.*
- Expansion between 0.10% -0.20% at 14 days (16 days after casting) include both aggregate that are known to be innocuous & Deleterious in field performance. In such a situation, it may be useful to take comparator reading until 28 days.*

**Potential Alkali Reactivity of Aggregate (Mortar – Bar) [ASTM C1260] test results of fine aggregate samples collected from different locations for use in concrete for Revival of Saraswati Project, Haryana**

**TEST RESULTS OF POTENTIAL ALKALI REACTIVITY (MORTAR-BAR METHOD, ASTM C1260) OF FINE AGGREGATE SAMPLES**

Test Regime: Accelerated Method under 80<sup>0</sup>C Temp. in 1N NaOH solution.

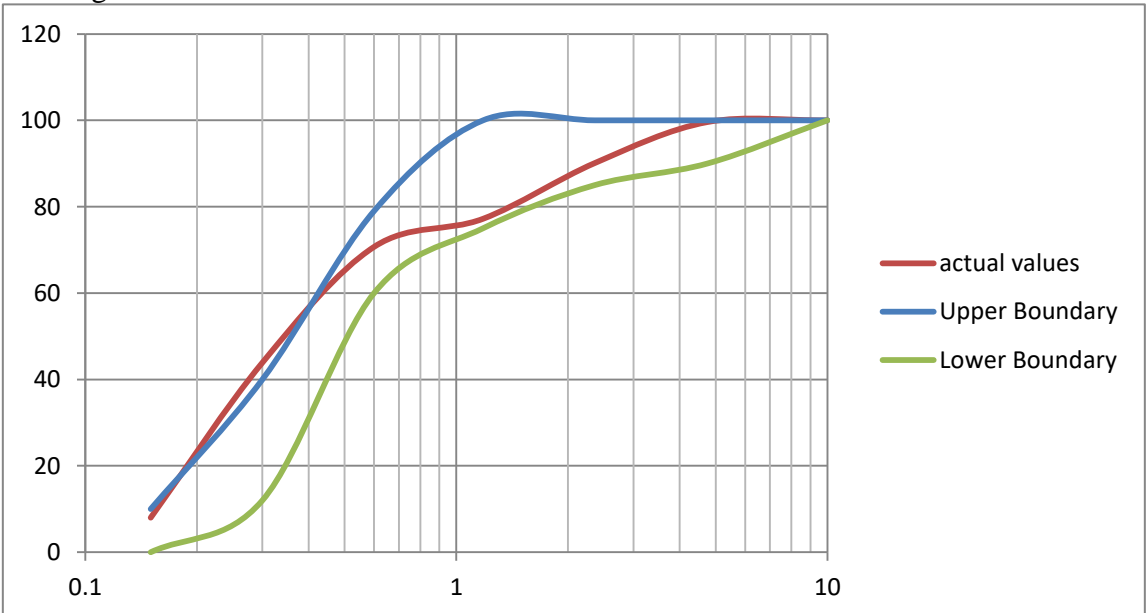
Type of Cement used for making: OPC 43

Equivalent Alkali Content of Cement (Na<sub>2</sub>O): 0.59%

Age in days	Terrace Material from Nagli Quarry at Jaitpur Village [Q2] OPC -43 (Equivalent Na <sub>2</sub> O: 0.59%)			Remarks
	Q2S1	Q2S2	Q2S3	
	FA-06/22	FA-07/22	FA-08/22	
0	0.000	0.000	0.000	<b>Specification requirements as per ASTM C1260:</b> <i>1. Expansion of less than 0.10% at 14 days (16 days after casting) is indicative of innocuous behavior in most cases</i> <i>2. Expansion of more than 0.20% at 14 days (16 days after casting) is indicative of potentially deleterious expansion.</i> <i>3. Expansion between 0.10% -0.20% at 14 days (16 days after casting) include both aggregate that are known to be innocuous &amp; Deleterious in field performance. In such a situation, it may be useful to take comparator reading until 28 days.</i>
4	0.024	0.023	0.024	
7	0.049	0.047	0.049	
10	0.080	0.056	0.068	
14	0.113	0.081	0.094	
16	0.125	0.085	0.104	
18	0.142		0.118	
23	0.168		0.139	
25	0.173		0.144	
28	0.182		0.157	

**Interim Report on construction materials survey and laboratory investigations on terrace materials (Nagli quarry, Jaitpur Village), and RBM materials at dam axis samples for assessing their suitability for use as coarse and fine aggregate in Concrete for Revival of Saraswati Project, Haryana**

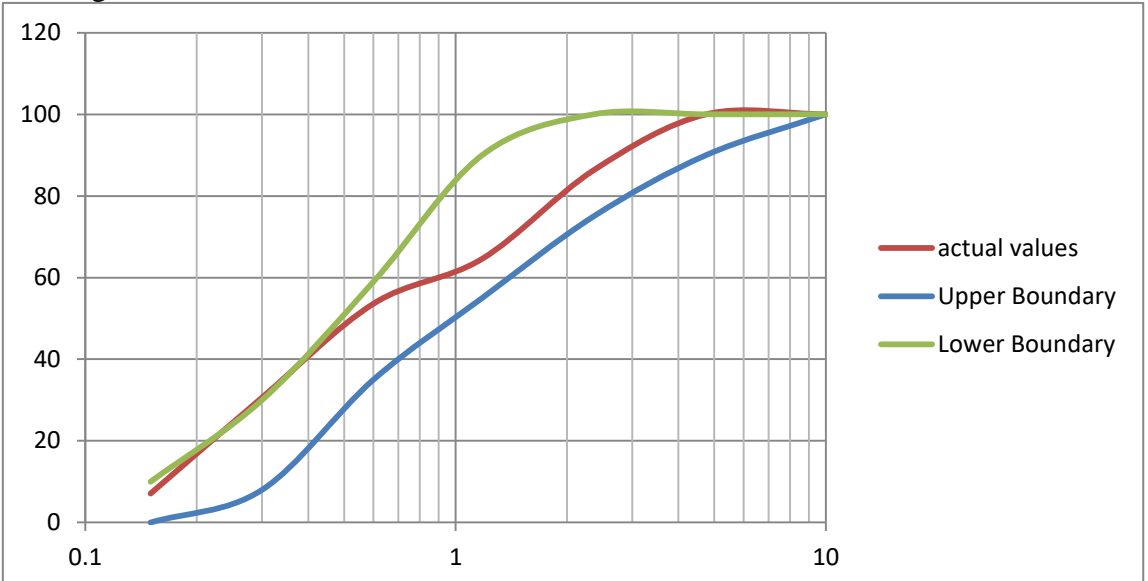
**TEST RESULTS SHOWING PHYSICAL PROPERTIES OF FINE AGGREGATE SAMPLE (Q2S1)**

Sl. No.	Properties	Terrace Material from Nagli Quarry at Jaitpur Village [Q2], Sample Designation: Q2S1	Requirements as per IS 383 - 2016		
1.	Grading	 <p>The graph plots cumulative percentage passing (0 to 120) against sieve size (0.1 to 10 mm) on a semi-logarithmic scale. Three curves are shown: 'actual values' (red), 'Upper Boundary' (blue), and 'Lower Boundary' (green). The actual values curve lies between the upper and lower boundaries, indicating compliance with the Zone III requirements.</p>	IS Sieve	Cumulative % Passing	Zone III
			10 mm	100	100
			4.75 mm	99.60	90 - 100
			2.36 mm	90.10	85 - 100
			1.18 mm	77.20	75 - 100
			<b>600 micron</b>	<b>70.70</b>	<b>60 - 79</b>
			300 micron	43.90	12 - 40
			150 micron	8.00	0 - 10
			Zone III		
2.	Fineness Modulus	2.11			
3.	Specific Gravity	2.68			
4.	Materials finer than 75 microns (i.e., Silt and clay content)	6.4%			
5.	Organic Impurities	Passed			
6.	Soundness	9.7%	<i>loss of weight after 5 Cycles of Na<sub>2</sub>SO<sub>4</sub>) % : ≤ 10%</i>		
7.	Water absorption	9.2%			

**Annexure-IIIID**

**Final Report on construction materials survey and laboratory investigations on terrace materials (Nagli quarry, Jaitpur Village), and RBM materials at dam axis samples for assessing their suitability for use as coarse and fine aggregate in Concrete for Revival of Saraswati Project, Haryana**

**TEST RESULTS SHOWING PHYSICAL PROPERTIES OF FINE AGGREGATE SAMPLE (Q2S2)**

Sl. No.	Properties	Terrace Material from Nagli Quarry at Jaitpur Village [Q2], Sample Designation: Q2S2	Requirements as per IS 383 - 2016		
1.	Grading	 <p>The graph plots cumulative percentage passing (0-120%) against sieve size (0.1-10 mm) on a semi-logarithmic scale. Three curves are shown: 'actual values' (red), 'Upper Boundary' (blue), and 'Lower Boundary' (green). The actual values curve stays between the upper and lower boundaries, indicating the sample meets the Zone II requirements.</p>	IS Sieve	Cumulative % Passing	Zone II
			10 mm	100	100
			4.75 mm	100	90 - 100
			2.36 mm	86.30	75 - 100
			1.18 mm	64.60	55 - 90
			<b>600 micron</b>	<b>53.60</b>	<b>35 - 59</b>
			300 micron	30.60	8 - 30
			150 micron	7.10	0 - 10
			Zone II		
2.	Fineness Modulus	2.58			
3.	Specific Gravity	2.65			
4.	Materials finer than 75 microns (i.e., Silt and clay content)	13.6			
5.	Organic Impurities	Passed			
6.	Soundness	9.3%	<i>loss of weight after 5 Cycles of Na<sub>2</sub>SO<sub>4</sub>) % : ≤ 10%</i>		
7.	Water absorption	11.2%			

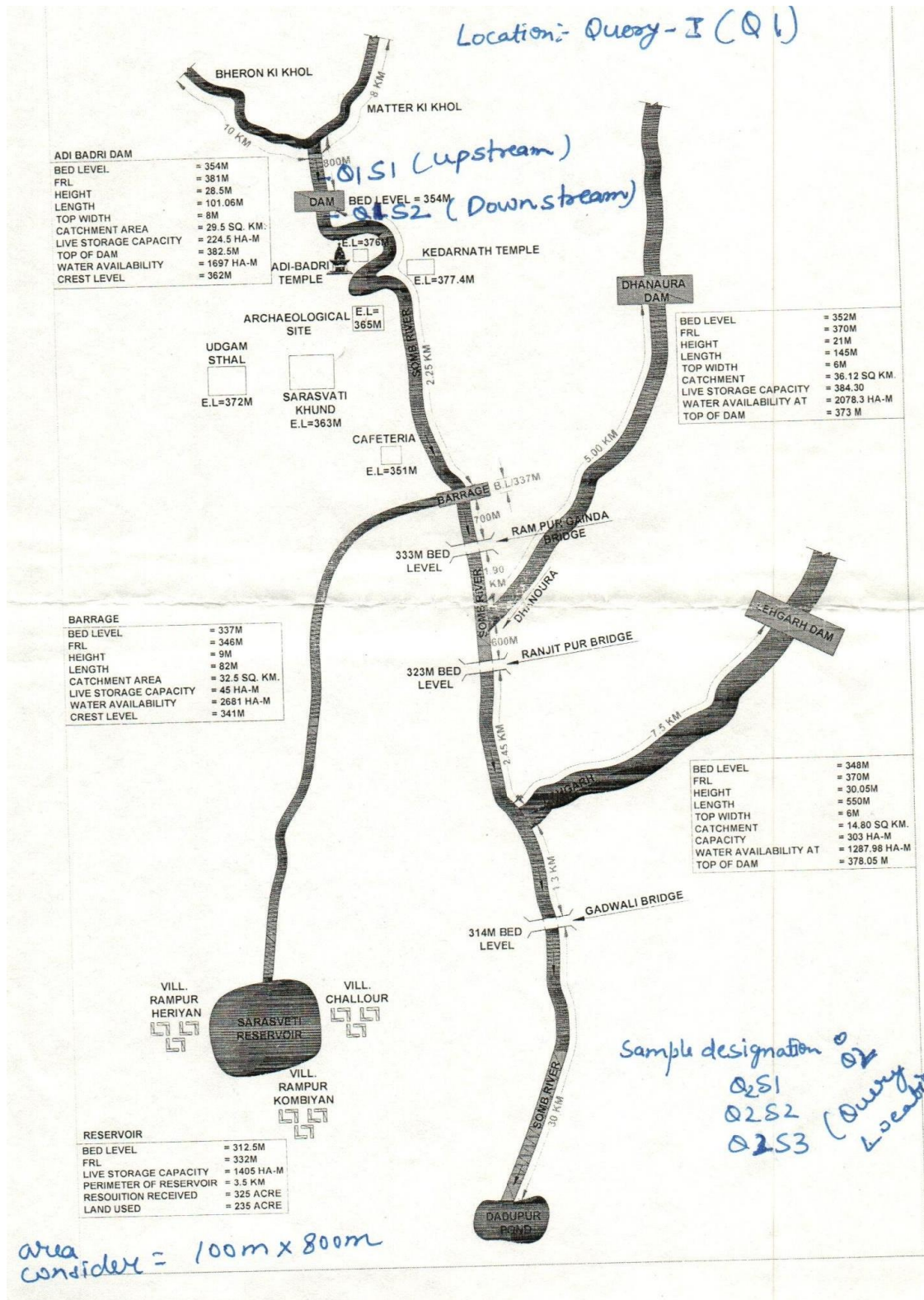
**Annexure-III**

**Final Report on construction materials survey and laboratory investigations on terrace materials (Nagli quarry, Jaitpur Village), and RBM materials at dam axis samples for assessing their suitability for use as coarse and fine aggregate in Concrete for Revival of Saraswati Project, Haryana**

**TEST RESULTS SHOWING PHYSICAL PROPERTIES OF FINE AGGREGATE SAMPLE (Q2S3)**

Sl. No	Properties	Terrace Material from Nagli Quarry at Jaitpur Village [Q2], Sample Designation: Q2S3	Requirements as per IS 383 – 2016		
			IS Sieve	Cumulative % Passing	Zone II
1.	Grading		IS Sieve	Cumulative % Passing	Zone II
			10 mm	100	100
			4.75 mm	100	90 – 100
			2.36 mm	88.40	75 – 100
			1.18 mm	71.70	55 – 90
			<b>600 micron</b>	<b>64.10</b>	<b>35 – 59</b>
			300 micron	43.40	8 – 30
			150 micron	8.10	0 – 10
			Zone II		
2.	Fineness Modulus	2.24			
3.	Specific Gravity	2.67			
4.	Materials finer than 75 microns (i.e., Silt and clay content)	3.3%			
5.	Organic Impurities	Passed			
6.	Soundness	9.4%	<i>loss of weight after 5 Cycles of Na<sub>2</sub>SO<sub>4</sub>) % : ≤ 10%</i>		
7.	Water absorption	13%			

# Annexure-IV: Quarry Location & Quarry Photographs



Location map of project



Picture 1 : Collection of samples from Dam Axis



Picture 2: Collection of samples from Dam Axis



Picture 3: Collection of samples from Terrace material (Nagli quarry)



Picture 4: Collection of samples from Terrace material (Nagli quarry)



Picture 3: Representative sample collection by quartering method at Terrace material (Nagli quarry)

**Appendix – I**  
**(Petrographic Analysis)**

## PETROGRAPHIC ANALYSIS

**Sample No. CA-1/22**

**Rock type: Sandstone**

The rock sample is white in color tinged with pink, medium grained, hard and compact in hand specimen, essentially composed of quartz mineral.

### Microscopic Description:

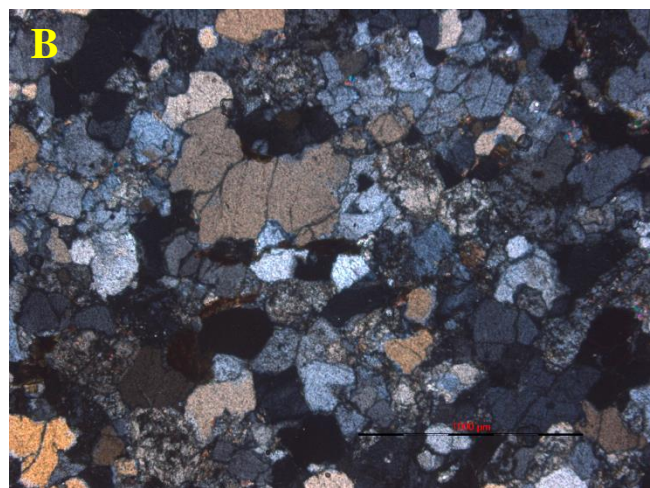
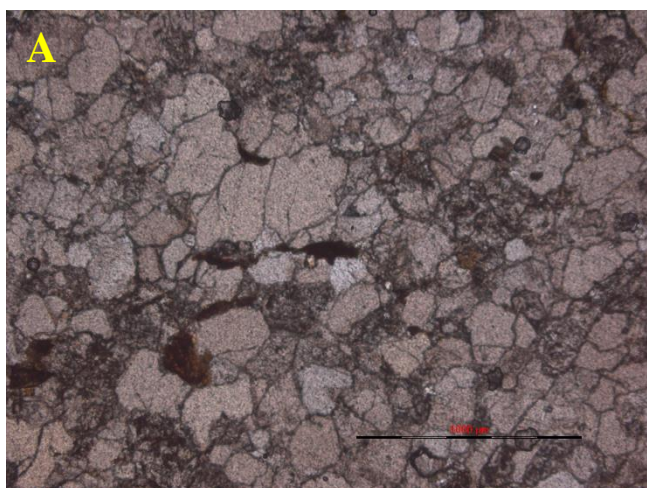
**Quartz:** The most abundant mineral phase in the thin section is quartz. In plane polarized light (PPL), quartz is colorless with low relief and no cleavage. These grains are subhedral to anhedral with uneven grain boundaries, exhibiting first order grey interference color. Quartz grains are not strained.

**Mica:** The second most abundant mineral phase in the sample is micaceous flakes having moderate relief occurring in the interstices between quartz grains consists of both muscovite and biotite. Muscovite is comparatively less abundant than biotite and are colorless to slightly pleochroic from green to pink and giving high order interference color in crossed polars. Biotites are mafic mineral, strongly pleochroic from brown to dark brown with straight extinction and high order interference color in crossed polars.

**Remark:** The rock is hard and compact but presence of mica may have deleterious effect on rock

**Mineralogy: V.E.**

Sl.No.	Quartz%	Mica% (Muscovite & Biotite)	Opaque %
Sample No. CA-1/22	80-85	5-10	1-5



**Sample No. CA-1/22**

a) PPL view showing association of transparent sub-angular to sub-rounded quartz and green to brown colored mica layers b) XPL view showing quartz grains exhibiting undulose extinction and mica exhibiting high order interference color.

**Sample No. CA-2/22**

**Rock type: Ferruginous Sandstone**

The rock sample is grey in color, medium grained, hard and compact in hand specimen, essentially composed of quartz mineral.

**Microscopic Description:**

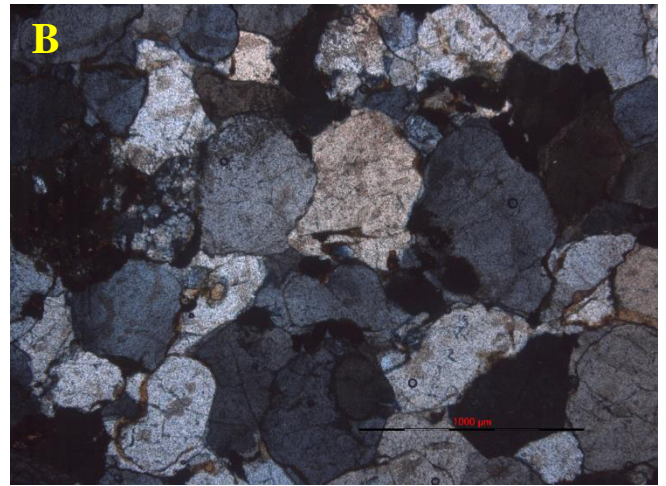
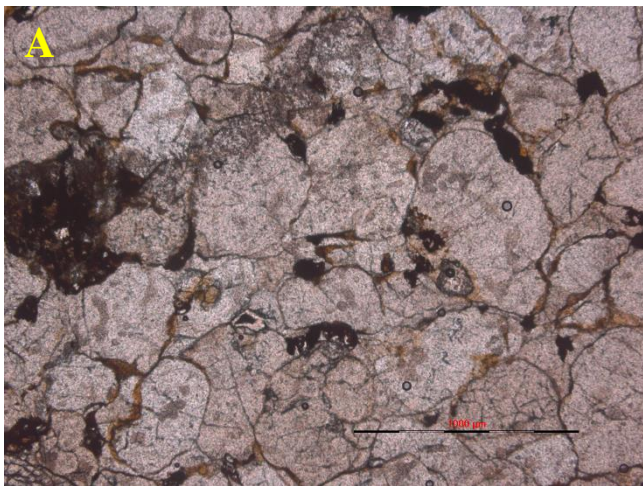
**Quartz:** The most abundant mineral phase is quartz. In plane polarized light (PPL), quartz is colorless with low relief and no cleavage. Mostly the grains are rounded to sub-rounded encircled by thin layer of ferruginous matrix. Under crossed polars, grains are exhibiting first order grey interference color and mostly all the grains are strained.

**Opagues:** Iron oxide phases are present mainly magnetites and also present as iron coatings around grains as cementing material.

**Remark:** The rock is hard and compact but presence of strained quartz may have deleterious effect on rock.

**Mineralogy: V.E.**

Sl.No.	Quartz%	Opaque %	Strained quartz %
Sample No. CA-2/22	80-85	15-20	75-80%



**Sample No. CA-2/22**

a)PPL view showing rounded to sub-rounded transparent quartz grains encircled by ferruginous matrix b) XPL view showing strained quartz grains exhibiting undulose extinction exhibiting first order interference color.

**Sample No. CA-3/22**

**Rock type: Ferruginous Sandstone**

The rock sample is pink in color, fine to medium grained, hard and compact in hand specimen.

**Microscopic Description:**

**Quartz:** The most abundant mineral phase is quartz. In plane polarized light (PPL), angular to sub-angular, colorless quartz grains are present with low relief and no cleavage. These grains are subhedral to anhedral with straight grain boundaries, exhibiting first order grey interference color. Larger quartz grains are strained with undulose extinction while smaller recrystallized grains are unstrained. A grain of Polycrystalline quartz is also observed.

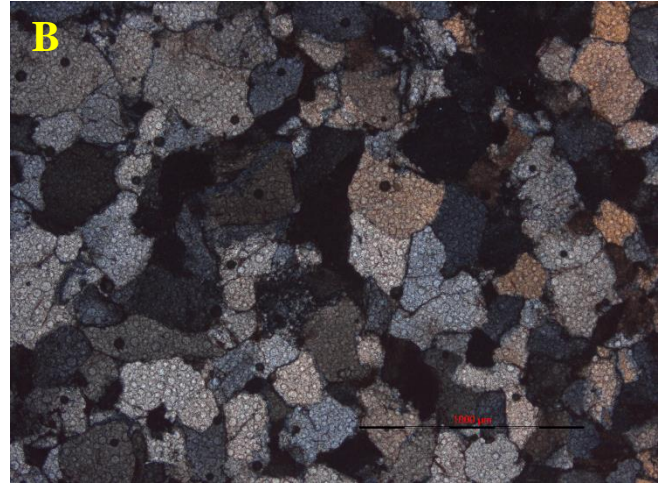
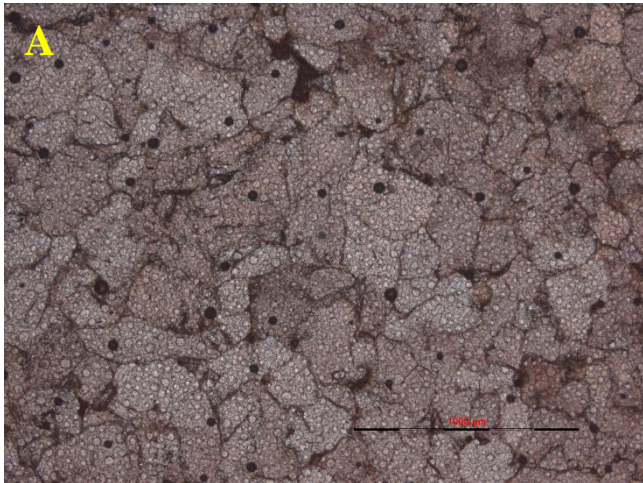
**Feldspar-** Few feldspar grains are also present having lamellar twinning with straight extinction exhibiting first order interference color under crossed polars.

**Opagues:** Iron oxide phases are present mainly magnetites.

**Remark:** The rock is hard and compact but presence of strained quartz may have deleterious effect on rock.

**Mineralogy: V.E.**

Sl.No.	Quartz%	Felspar %	Opaque %	Strained quartz %
Sample No. CA-3/22	80-85%	5-10%	4-5%	60-65%



**Sample No. CA-3/22**

a)PPL view showing angular to sub-angular, colorless quartz grains with low relief and no cleavage surrounded by ferruginous matrix b) XPL view showing larger quartz grains are strained with undulose extinction.

**Sample No. CA-4/22**

**Rock type: Ferruginous Sandstone**

The rock sample is pink in color, fine grained, hard and compact in hand specimen.

**Microscopic Description:**

**Quartz:** The most abundant mineral phase is quartz. In plane polarized light (PPL), angular to sub-angular, colorless quartz grains are present with low relief and no cleavage. These grains are subhedral to anhedral with straight grain boundaries, exhibiting first order grey interference color. Almost ~60% quartz grains are strained with undulose extinction while rest are the recrystallized grains and are unstrained.

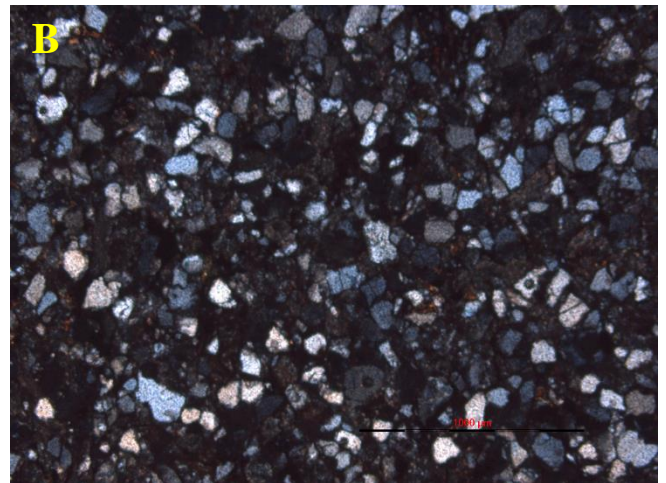
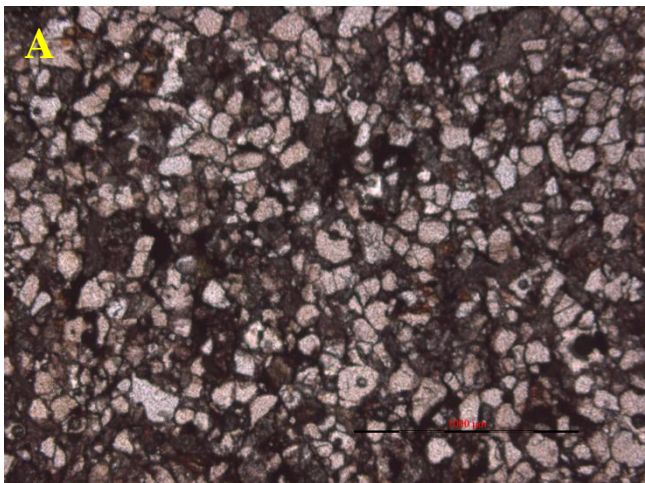
**Mica-** Few flakes of muscovite are also present with straight extinction exhibiting high order interference color under crossed polars.

**Opagues:** Iron oxide phases are present mainly magnetites.

**Remark:** The rock is terrigenous clastic rock with matrix <15%. The rock is hard and compact but presence of strained quartz may have deleterious effect on rock.

**Mineralogy: V.E.**

Sl.No.	Quartz%	Opaque %	Mica %	Strained quartz %
Sample No. CA-4/22	80-85%	5-10%	1-5%	55-60%



**Sample No. CA-4/22**

a)PPL view showing angular to sub-angular, colorless quartz grains with low relief and no cleavage b) XPL view showing subhedral to anhedral quartz grains with straight grain boundaries, exhibiting first order grey interference color.

**Sample No. CA-5/22**

**Rock type: Ferruginous Sandstone**

The rock sample is pink in color, fine grained, hard and compact in hand specimen.

**Microscopic Description:**

**Quartz:** The most abundant mineral phase is quartz. In plane polarized light (PPL), angular to sub-angular, colorless quartz grains are present with low relief and no cleavage. These grains with straight grain boundaries, exhibiting first order grey interference color. Percentage of strained quartz is less around (~25%) with undulose extinction.

**Mica-** Flakes of muscovite present with straight extinction exhibiting high order interference color under crossed polars.

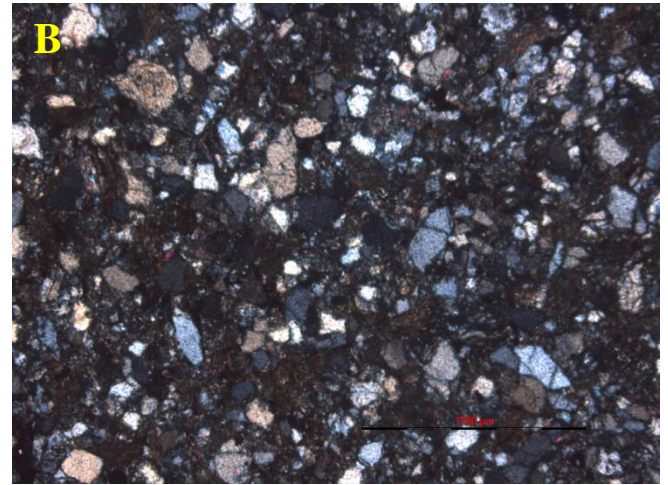
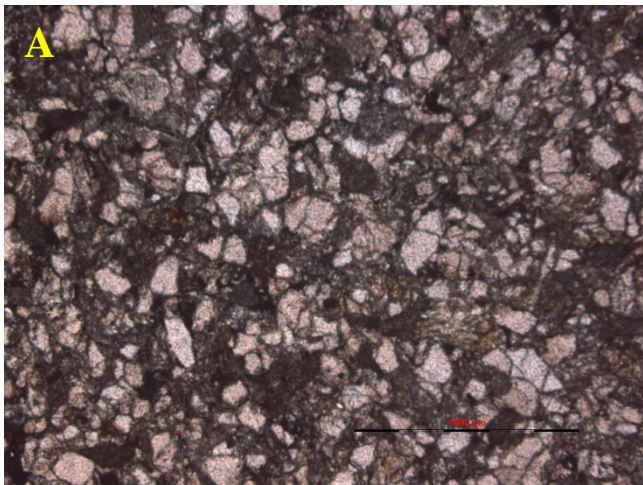
**Felspar:** Felspars are completely altered through sericitisation.

**Opagues:** Ferruginous coating is present around grains and in cementing material .

**Remark:** The rock is terrigenous clastic rock with matrix <15%. The rock is hard and compact.

**Mineralogy: V.E.**

Sl.No.	Quartz %	Mica %	Opaque %	Felspar%	Strained quartz %
Sample No. CA-4/22	65-70%	10-15%	5-10%	1-5%	25-30%



**Sample No. CA-5/22**

a)PPl view showing angular to sub-angular, colorless quartz grains with low relief and no cleavage, altered feldspar and mica flakes In matrix b) XPL view showing subhedral to anhedral quartz grains with straight grain boundaries, exhibiting first order grey interference color..

## Sample No. FA-6/22

### Megascopic Description:

The given fine aggregate sand sample is brownish grey in color. The fine aggregate consists of loose grains varying in size from medium to coarse grained sand. Most of the grains are sub angular to angular and some sub rounded grains are also present. The mineral constituents identified in the sample are quartz, feldspar, lithic fragments and opaques. Overall the sample is moderately sorted.

### Microscopic Description:

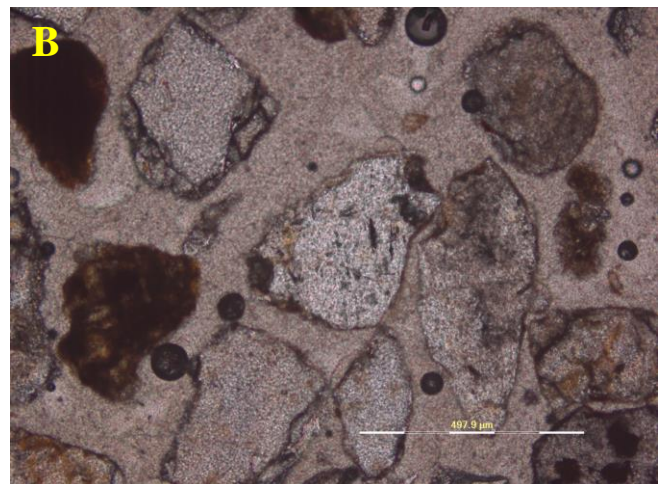
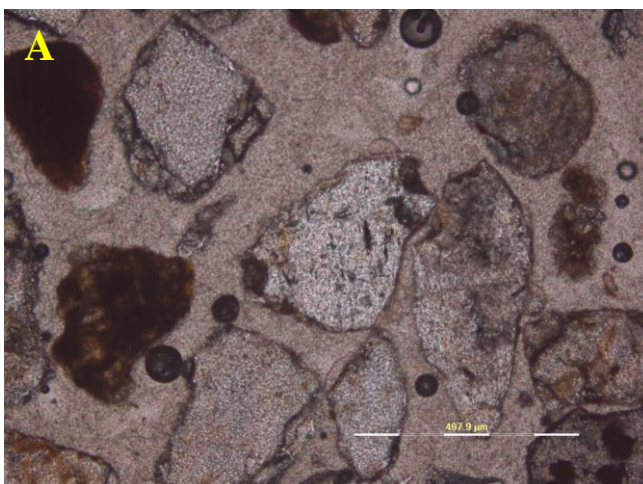
**Mineralogy: V.E. Mesh Size: -500 $\mu$**

**Mineralogical composition (in %) of sediments of suspended material**

Sample No.	Quartz % (H*=7) (Sp** 2.65 )	Lithic Fragment and opaques %	Feldspar% (H*=6-6.5) (Sp**2.57-2.76)	Mica (H*=2-2.5) (Sp** 2.76-3)
FA-6/22	55-60	15-20	10-15	1-5

**Abbreviations used: H\*: Hardness & Sp\*\* Specific gravity: given values are standard for the minerals, and not the measured ones.**

The grains in this fine aggregate sample are sub angular to angular and few sub rounded grains are also present. The quartz grains are mostly angular and many of these grains have grain overgrowth identified by optical discontinuity along the grain boundary. Larger quartz grains are mostly strained. Feldspar consists of microcline. The feldspar grains have tabular grain boundaries. Microcline exhibit cross hatched twinning. Few flakes of muscovite are also observed having straight extinction. The lithic fragments are also present, angular in shape suggesting small distance transport of these fragments. Iron oxide phases are also present.



### Sample No. FA-6/22

a) PPL view showing association of transparent quartz and green to brown colored mica layers b) XPL view showing stretched and strained quartz grains exhibiting undulose extinction and mica exhibiting high order interference color.

**Sample No. FA-7/22**

**Rock type: Fine Aggregate**

**Megascopic Description:**

The given fine aggregate sand sample is brownish grey in color. The fine aggregate consists of loose grains varying in size from medium to coarse grained sand. Most of the grains are sub angular to angular and some sub rounded grains are also present. The mineral constituents identified in the sample are quartz, feldspar, lithic fragments and opaques. Overall the sample is moderately sorted.

**Microscopic Description:**

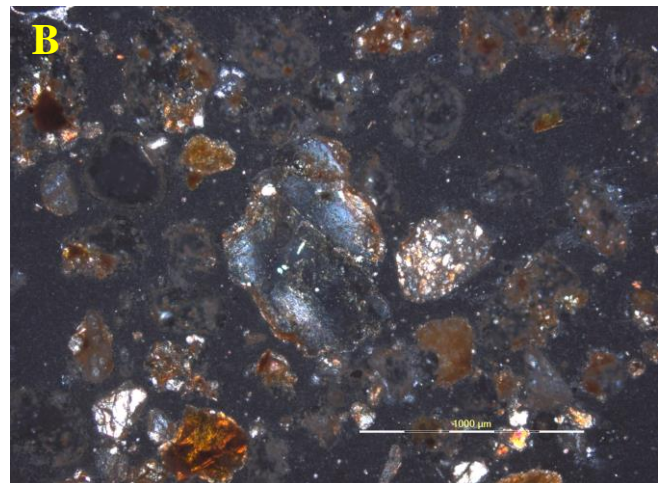
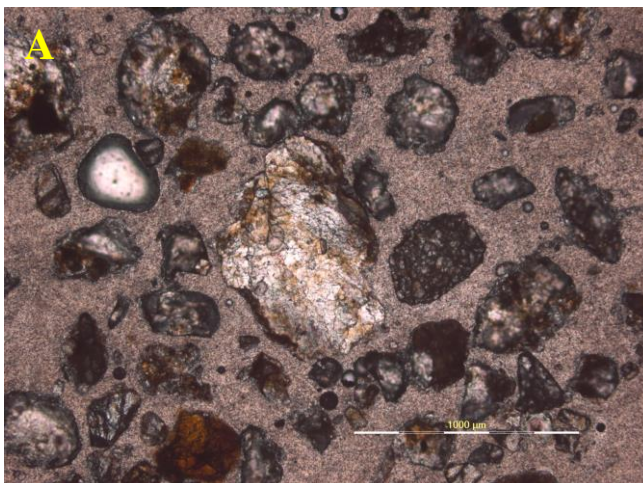
**Mineralogy: V.E. Mesh Size: -500 $\mu$**

**Mineralogical composition (in %) of sediments of suspended material**

Sample No.	Quartz % (H*=7) (Sp** 2.65 )	Lithic Fragment and opaques %	Feldspar% (H*=6-6.5) (Sp**2.57-2.76)	Mica (H*=2-2.5) (Sp** 2.76-3)
FA-7/22	55-60	15-20	10-15	1-5

**Abbreviations used: H\*: Hardness & Sp\*\* Specific gravity: given values are standard for the minerals, and not the measured ones.**

The grains in this fine aggregate sample are sub angular to angular and few sub rounded grains are also present. The quartz grains are mostly angular and many of these grains have grain overgrowth identified by optical discontinuity along the grain boundary. Quartz grains are mostly unstrained. Feldspar consists of plagioclase as well as microcline. The feldspar grains have sub angular to sub rounded grain boundaries. Microcline exhibit cross hatched twinning. Few flakes of muscovite are also observed having straight extinction. The lithic fragments are also present, angular in shape suggesting small distance transport of these fragments. Iron oxide phases are also present.



**Sample No. FA-7/22**

a)PPL view showing association of transparent quartz and green to brown colored mica layers b) XPL view showing stretched and strained quartz grains exhibiting undulose extinction and mica exhibiting high order interference color.

**Sample No. FA-8/22**

**Rock type: Fine Aggregate**

**Megascopic Description:**

The given fine aggregate sand sample is brownish grey in color. The fine aggregate consists of loose grains varying in size from medium to coarse grained sand. Most of the grains are sub angular to angular and some sub rounded grains are also present. The mineral constituents identified in the sample are quartz, feldspar, lithic fragments, mica flakes and opaques. Overall the sample is moderately sorted.

**Microscopic Description:**

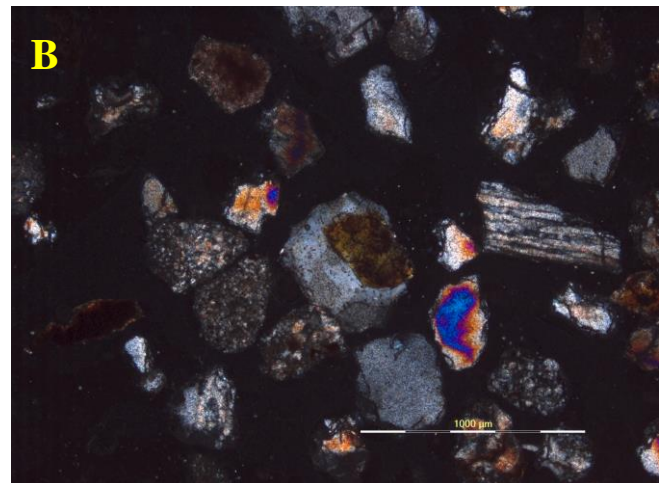
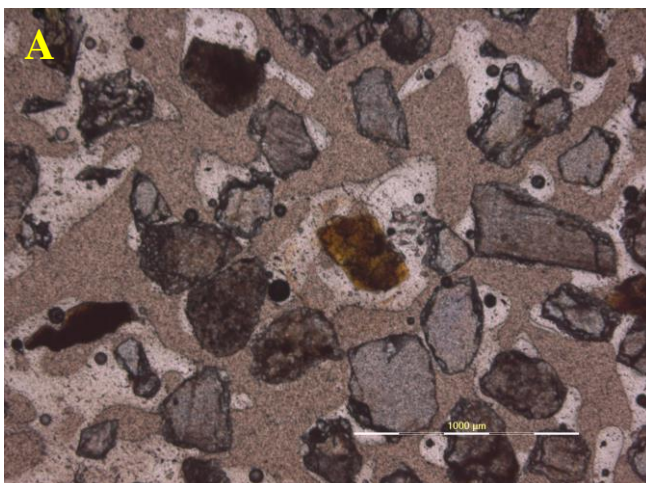
**Mineralogy: V.E. Mesh Size: -500 $\mu$**

**Mineralogical composition (in %) of sediments of suspended material**

Sample No.	Quartz % (H*=7) (Sp** 2.65 )	Lithic Fragment and opaques %	Feldspar% (H*=6-6.5) (Sp**2.57-2.76)	Mica (H*=2-2.5) (Sp** 2.76-3)
FA-8/22	55-60	15-20	10-15	1-5

**Abbreviations used: H\*: Hardness & Sp\*\* Specific gravity: given values are standard for the minerals, and not the measured ones.**

The grains in this fine aggregate sample are sub angular to angular and few sub rounded grains are also present. The quartz grains are mostly angular and many of these grains have grain overgrowth identified by optical discontinuity along the grain boundary. Quartz grains are mostly unstrained. Feldspar consists of plagioclase as well as microcline. The feldspar grains have sub angular to sub rounded grain boundaries. Microcline exhibit cross hatched twinning. Few flakes of muscovite are also observed having straight extinction. The lithic fragments are also present, angular in shape suggesting small distance transport of these fragments. Iron oxide phases are also present.



**Sample No. FA-8/22**

a)PPL view showing angular to angular and few sub rounded grains of quartz, iron oxide, feldspar and mica flakesb) XPL view showing grain overgrowth identified by optical discontinuity along the grain boundaries of quartz grains.