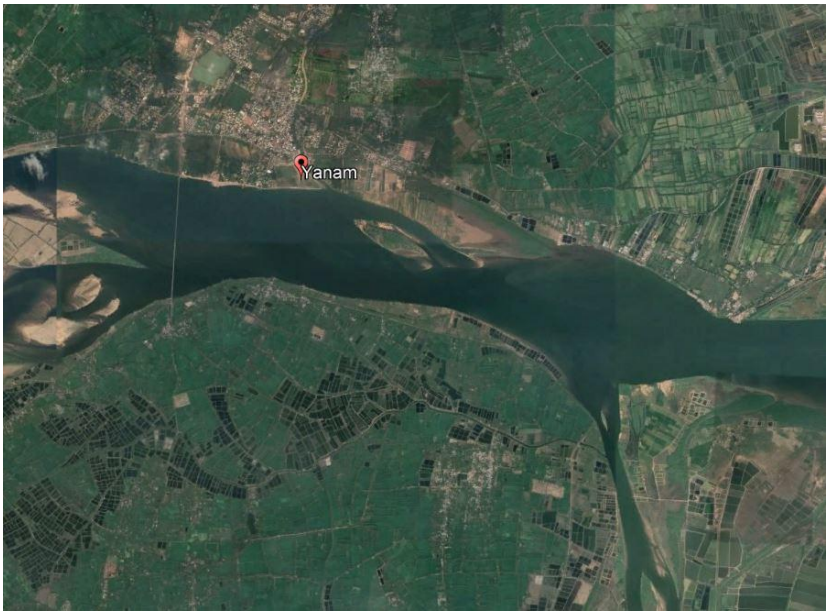
EXAMINATION AND TECHNICAL OPINION ON SAND BARS IN RIVER GODAVARI, YANAM



Client

OFFICE OF THE DEPUTY COLLECTOR (REVENUE), GOVERNMENT OF PUDUCHERRY, YANAM

Consultants

Prof. S.A.Sannasiraj

Department of Ocean Engineering

Indian Institute of Technology Madras

Chennai 600 036, India

August 2021

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1.0 INTRODUCTION

Yanam is one of the regions in the Union Territory of Puducherry, which is 870 kms away from it. It is situated on the East Coast of the Indian Peninsula at 16 degrees 42′ northern latitude, and between 82 degree 11′ Eastern longitude bounded on all sides by the East Godavari District of Andhra Pradesh State.

The bed and banks of lowland rivers are composed of loose sedimentary materials which erode, transport and deposit throughout the channels. Undue and rapid sedimentation from various causes such as huge sediment flux from upstream, less flow strength due to mild slope or slack water developing in a reverse eddy at the downstream of node points or some similar hydraulic factors bank erosion, and so on results large sandbars in the lowland rivers. These have significant roles in both engineering and ecological aspects in fluvial processes, pools cause successive side-bank erosion, while sandbars are habitats for various species in rivers. Large-scale alluvial structures greatly hamper the navigational routes at low flow time. Also the presence of these bars influences bank erosion, forms anabranches, and thus, makes the channels highly unstable. Thus these are to be moved from some regions. The location of study area is shown in **Fig. 1**.

Fig.1 Location of Study area

2.0 SCOPE OF WORK

The objectives of the present study are to examine and suggest the technical opinion on removal of sandbars and the suitability of the material for construction.

3.0 LOCATION OF SAND BARS

Locations of sandbars are identified by the client and the co-ordinates are presented in Table 1 and the locations are presented in Fig.2. These locations were identified based on the traditional custom of sand removal in the corresponding location.

Table 1. Coordinates of Sand bar location

S.No	Sand bar	Sand Bar co-ordinates	
		Latitude	Longitude
1	A	16 437.9691"N	82°12 20.8567"E
2	B	16°430.0473"N	82°13 22.92223"E
3	C	16°42'51.6728"N	82°14 17.5067"E
4	D	16 43 4.2029"N	82014'1.5228"E

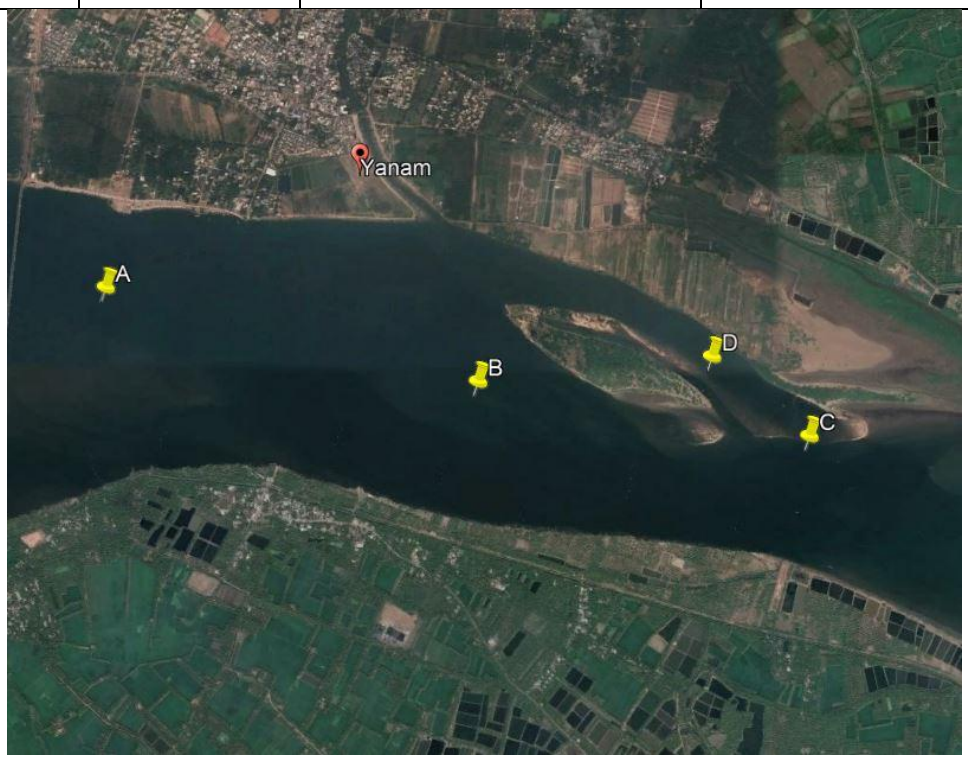

Fig.2 Location of Sand bars

4.0 AREA FOR THE REMOVAL OF SAND

The area for the removal of sand in the river is given by the client considering the location of sand bars. The area considered for the removal of sand is presented in **Fig.3**.

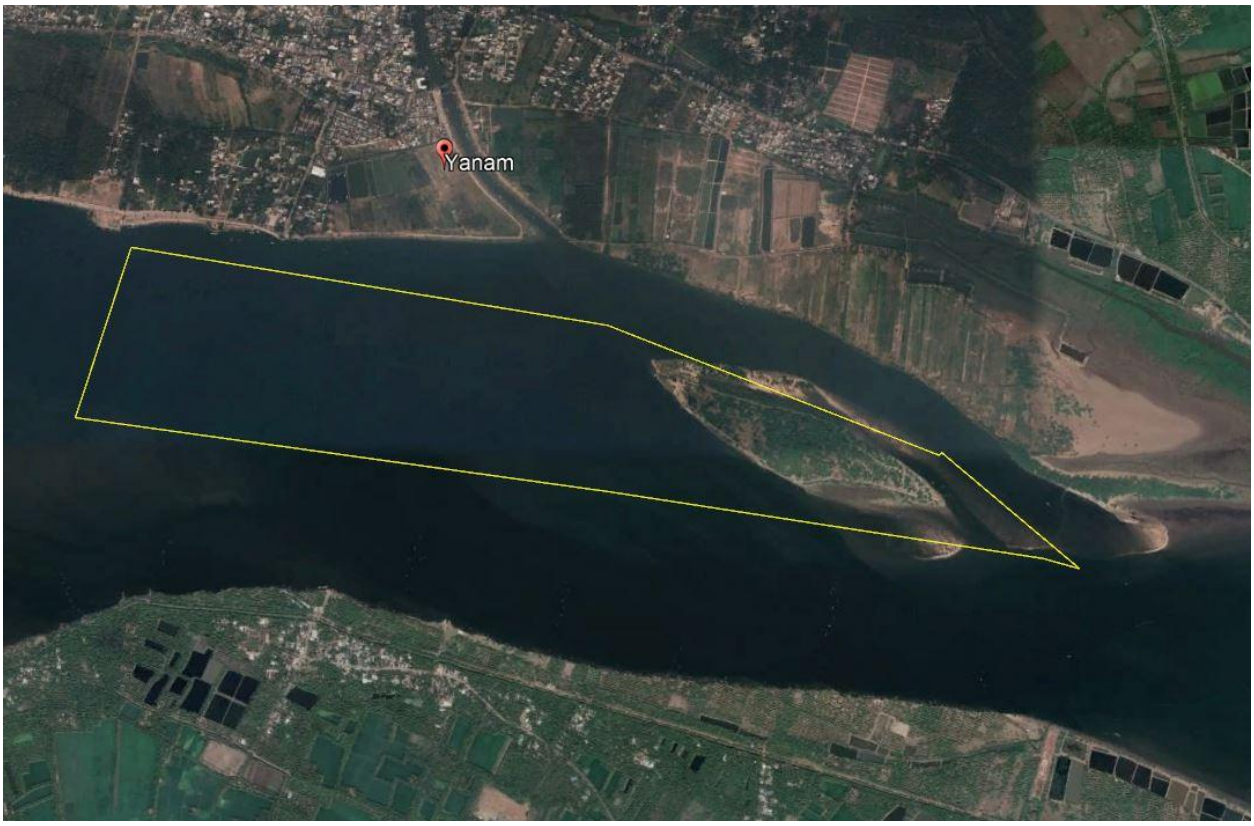

Fig.3 Area for the removal of sand

5.0 TYPES OF SAND AND TEST METHODS

Sand and gravel deposits are accumulations of the more durable rock fragments and mineral grains, which have been derived from the weathering and erosion of hard rocks mainly by glacial and river action, but also by wind. The term ‘gravel’ (“coarse aggregate”) is used to define particles between 4 and 80 mm and the term ‘sand’ (“fine aggregate”) for material that is finer than 4 mm, but coarser than 0.063 mm. The properties of gravel, and to a lesser extent sand, largely depend on the properties of the rocks from which they were derived. However, water action is an effective mechanism for wearing away weaker particles, as well as separating different size fractions. Most sand and gravel is composed of particles that are durable and rich

in silica (quartz, quartzite and flint). Other rock types, mainly limestone, may also occur in some land-won deposits including deleterious impurities such as lignite, mudstone, chalk and coal.

5.1 Standards and test methods

The key parameters for aggregates are particle size and shape, physical and mechanical properties and durability. The laboratory evaluation of construction aggregate ranges from simple and low cost to sophisticated and expensive testing.

5.1.1 Sieve Analysis

Particle Size Distribution (Grading) The particle-size distribution, or 'grading', is a fundamental property for all construction aggregates and often defines the product. Grading is usually carried out by sieve analysis. The sample is passed through a sieve stack (wet or dry) and the weight proportion retained on each sieve is determined. The cumulative percentage finer than each sieve size is plotted to produce 'grading curves'. Aggregate should be clean (free of clay, silt and dust) to ensure effective binding of cement or bitumen. Sedimentation methods may also be used to determine the grading of fines.

5.1.2 Density Testing

The bulk density of construction aggregate is expressed as the weight per unit volume for example kilograms per cubic meter (kg/m3). The bulk density can be calculated for loose and compacted aggregate, the latter simulates the density of aggregate after transportation. Measurements are carried out using calibrated containers of known volume. The density of fine aggregate can be determined using a pycnometer bottle.

6.0 SIEVE ANALYSIS - RESULTS AND OBSERVATIONS

6.1 Sieve Analysis

River sand is a type of fine sand formed by the corrosion from water current and is obtained from river streams and banks. It is generally white-grey. Unlike pit sand, the grains of river sand is smooth, rounded and of fine quality. Hence, it is used globally for a broad range of construction purposes such as plastering.

Results

Six samples were collected and the sieve analysis result for all the six samples are provided by the client which is attached in Annexure- I.

Observations

As per IS383 2016, percentage passing of sieve analysis is given below

Table 9 Fine Aggregates

(*Clause* 6.3)

Sl No.	IS Sieve Designation	Percentage Passing			
		Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
(1)	(2)	(3)	(4)	(5)	(6)
i)	10 mm	100	100	100	100
ii)	4.75 mm	90-100	90-100	90-100	95-100
iii)	2.36 mm	60-95	75-100	85-100	95-100
iv)	1.18 mm	30-70	55-90	75-100	90-100
v)	600 µm	15-34	35-59	60-79	80-100
vi)	300 µm	5-20	8-30	12-40	15-50
vii)	150 µm	0-10	0-10	0-10	0-15

NOTES

1 For crushed stone sands, the permissible limit on 150 µm IS Sieve is increased to 20 percent. This does not affect the 5 percent allowance permitted in **6.3** applying to other sieve sizes.

2 Fine aggregate complying with the requirements of any grading zone in this table is suitable for concrete but the quality of concrete produced will depend upon a number of factors including proportions.

3 As the fine aggregate grading becomes progressively finer, that is, from Grading Zones I to IV, the ratio of fine aggregate to coarse aggregate should be progressively reduced. The most suitable fine to coarse ratio to be used for any particular mix will, however, depend upon the actual grading, particle shape and surface texture of both fine and coarse aggregates.

4 It is recommended that fine aggregate conforming to Grading Zone IV should not be used in reinforced concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

From IS 383-2016, all the sand samples sieve results are under the grading zone -II. Hence the sand is suitable for construction.

6.2 Fineness Modulus of Sand

Fineness modulus of sand (fine aggregate) is an index number which represents the mean size of the particles in sand. It is calculated by performing sieve analysis with standard sieves. The cumulative percentage retained on each sieve is added and subtracted by 100 gives the value of fineness modulus. Fine aggregate means the aggregate which passes through 4.75mm sieve. To find the fineness modulus of fine aggregate we need sieve sizes of 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.15mm. Fineness modulus of finer aggregate is lower than fineness modulus of coarse aggregate.

Results

Six samples were collected and the sieve analysis result for all the six samples are provided by the client which is attached in Annexure- I.

Observations

As per IS1542 1992, The fineness modulus of sand shall be not less than 1.4 in case of crushed stone sands and crushed gravel sands and not less than 1.5 in case of naturally occurring sands.

From the above observation, the all-sand samples are having fineness modulus greater than 1.5. Hence it is suitable for the construction.

6.3 Silt Content

Silt content is a fine material which is less than 150 micron. It is unstable in the presence of water. If we use silty sand for bonding, it will reduce the strength and cause rework.

Results

Six samples were collected and the sieve analysis result for all the six samples are provided by the client which is attached in Annexure- I.

Observations

As per IS1542 1992, the limits of deleterious material is given below

4.3 Limits of Deleterious Materials

Unless found satisfactory as a result of further tests as may be specified by the engineer or architect, or unless evidence of such performance is offered which is satisfactory to him, the maximum quantities of clay, fine silt, fine dust and organic impurities in the sand shall not exceed the following limits:

a)	Clay, silt and dust [determined in accordance with IS 2386 (Part 2) : 1963]	Not more than 5 percent by weight
b)	Organic impurities [determined in accordance with IS 2386 (Part 2) : 1963]	Colour of liquid below that indicated by comparison with the standard solution specified in **6.2.2** of IS 2336 (Part 2) : 1963

NOTE — In particular cases crushed stone sand with even higher proportions of fine dust than specified above, may be satisfactory and the limit so permitted may be subject to the agreement between the supplier and the purchaser.

As per IS 1542 1992 the silt content in the tested sample is less than 5% of weight of the sample and hence it is suitable for the construction.

6.4 Bulking of Sand and moisture content

Bulking in sand occurs when dry sand interacts with the atmospheric moisture. Presence of moisture content forms a thin layer around sand particles. This layer generates the force which makes particles to move aside to each other. This results in the increase of the volume of sand.

Excessive presence of moisture content in the sand makes concrete to less durable and loses its strength. Remember, excessive presence of moisture content increase the workability of concrete but loses its strength.The extent of sand bulking depends on the grading of sand. Finer Sand possesses more bulking than the medium and coarse sand. Thus, Bulking in the sand is high for fine sand and low for coarse sand. An increase of bulking in sand effects concrete mix and results in harsh behaviour while placing.

Results

Six samples were collected and the sieve analysis result for all the six samples are provided by the client which is attached in Annexure- I.

Observations

As per IS2386-3, (Bulking in Sand) Presence of 4% of moisture content in sand increases 25% of its volume.

As per 383-2016 Moisture content less than 5% should be preferred for construction purposes which is shown below

Table 3 Additional Requirements for all Manufactured Aggregates
(*Clause* 5.7)

Sl No. (1)	Characteristic (2)	Requirement (3)
i)	Total alkali content as Na_2O equivalent, percent, *Max*	0.3
ii)	Total sulphate content as SO_3, percent, *Max*	0.5
iii)	Acid soluble chloride content, percent, *Max*	0.04
iv)	Water absorption, percent, *Max*	5 (*see* Note 1)
v)	Specific gravity	2.1 to 3.2 (*see* Notes 2 and 3)

NOTES
1 For recycled concrete aggregate and recycled aggregate, higher water absorption up to 10 percent may be permitted subject to pre-wetting (saturation) of aggregates before batching and mixing.
2 The limits are intended for use of aggregate in normal weight concrete.
3 Copper slag having higher specific gravity (up to 3.8) shall be permitted for part replacement of aggregates in accordance with **4.2.1**, such that the average specific gravity of the fine aggregate is not more than 3.2.

As per IS 383 2016, the water absorption percent in the tested samples is less than 5% and hence it is suitable for the construction.

7.0 CHEMICAL COMPONENT – RESULTS AND OBSERVATIONS

Results

Six samples were collected and the chemical component result for all the six samples are provided by the client which is attached in Annexure- II.

Observations

As per Specifications 91 - 92 CPWD MANNUAL (Volume II Mortars), the chemical requirements are stated as below

CHEMICAL REQUIREMENTS
(Clause 3.1.7 & 3.1.7.1)

Sl. No. (1)	CHARACTERISTIC (2)	REQUIREMENT (3)
i)	Silicon dioxide (Sio_2) plus aluminium oxide (Al_2O_3) plus iron oxide (Fe_2O_3) percent by mass, Min	70.0
ii)	Silicon dioxide (Sio_2) percent by mass, Min	35.0
iii)	Magnesium oxide (MGO), percent by mass, Max	5.0
iv)	Total sulphur as sulphur trioxide (So_3), percent by mass, Max	2.75
v)	Available alkalis as sodium oxide (Na_2O) percent by mass, Max (see Note 1)	1.50
vi)	Loss of ignition, percent by mass, Max	12.0

NOTE 1 Applicable only when reactive aggregates are used in concrete and are specially requested by the purchaser.

NOTE 2 For determination of available alkalis IS:4032-1985 'Method of chemical analysis of hydraulic cement' shall be referred to.

As per Specifications 91 - 92 CPWD Manual (Volume II Mortars) the above percentage of chemical components in the tested sample is ok and hence it is suitable for the construction.

8.0 REMOVABLE QUANTITY OF SAND

The area of the sand bar and assessment of removable sand from the sand bar as identified in the location is been given by the client which is presented in the **Table 2.**

Table 2 Removable quantity of sand

Sand bar No.	Length of the sand bar in meter	Width of the sand bar in meter	Area in Acres (Ac)	Area in Hectare (Ha)	Column Depth of Sand bar in meter	Approximate removable Quantity of sand in MT (M3 = 1.75 MT)
A	200	300	14.83	6.00	2.00+	2.10.000-00
B	200	500	24.71	10.00	2.00	3,50,000-00
C	600	150	22.24	9.00	2.00	3,15,000-00
D	100	100	2.47	1.00	2.00	35,000-00
					Total	9,10,000 -00 MT

It was noted that the proposal is to remove 15cm depth of sand bar to be dredged at a given time.

9.0 RECOMMENDATIONS

1. From the sieve analysis and chemical component results provided, the sand from the river is found to be suitable for the construction for concrete casting.

2. The proposal for sand removal with a maximum of 15cm depth at the specified sandbar location has been made based on the historical experience of reformation of sand bar seasonally. As hydrodynamic modeling study has not been carried out and river topography of the location is not available, it is difficult to predict the exact scenario. But considering the present condition and the request from the client, it is accepted to dredge the sand from the sand bars with the specified thickness. It is strongly recommended to monitor the river topography in the entire region of sand removal zone at a constant interval matching with the dredging frequency. Both pre- and post-dredging survey of river topography is required. With the continuous monitoring of the river bed, the natural retrieval of dredged spoil can be assessed after the first year. Based on the assessment of the retrieval rate, the sand removal on the second year onwards may be planned.

Prof. S.A.SANNASIRAJ

ANNEXURE I

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INDUSTRIAL CONSULTANCY SERVICES

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA

Jawaharlal Nehru Technological University Kakinada

KAKINADA – 533 003 A.P. INDIA

Ref : : UCEK/JNTUK/CE/ICS/SM / 313 /2020-21 Date : 15.12.2020.

ICS

From :

Dr.B. Balakrishna,

B.Tech., M.Tech., FIE., MISTE., Ph.D.

Professor of Mechanical Engineering &,
Principal & Chief Co-ordinator, ICS.

To

Er. Dara SubbaRaju,
Executive Engineer,
Yanam Division

Sir,

Sub: Testing of Fine aggregate

Ref: Your Lr. No:795/PW/EE/DB/YNM/(Sand Mine)/2020-21 Dated . 11.12.2020.

Name of the Work: : PW –YNM – Submission of sand samples collected from Gowthami Godavari River bed in Yanam region for testing

With reference to your letter cited (Sand) the test results on the fine aggregate are herewith furnished.

TEST RESULTS

1. Seive Analysis: (FA (Sand) sample -1

Sl.No.	I.S. Seive No.	Cumulative Percentage Retained	Percentage Passing	FM
1.	10 mm	--	100	2.64
2.	No. 480 (4.75mm)	1.0	99.0	
3.	No. 240 (2.36mm)	9.5	90.5	
4.	No.120 (1.18mm)	25.5	74.5	
5.	No. 60 (600microns)	50.0	50.0	
6.	No. 30 (300microns)	82.0	18.0	
7.	No.15(150microns)	95.5	4.5	

2. Silt content : 0.7%
3. Bulking of sand : 17% @ 5% moisture content
4.Sand sample – 1 is suitable for construction

Principal & Chief Co-ordinator
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TEST RESULTS

1. Seive Analysis: (FA (Sand) sample -2

Sl.No.	I.S. Seive No.	Cumulative Percentage Retained	Percentage Passing	FM
1.	10 mm	--	100	2.57
2.	No. 480 (4.75mm)	0.5	99.5	
3.	No. 240 (2.36mm)	8.0	92.0	
4.	No.120 (1.18mm)	21.0	79.0	
5.	No. 60 (600microns)	47.0	53.0	
6.	No. 30 (300microns)	84.0	16.0	
7.	No.15(150microns)	97.0	3.0	

2. Silt content : 0.5%
3. Bulking of sand : 17% @ 5% moisture content
4. Sand sample – 2 is suitable for construction

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With reference to your letter cited (Sand) the test results on the fine aggregate are herewith furnished.

TEST RESULTS

1. Seive Analysis: (FA (Sand) sample -3

Sl.No.	I.S. Seive No.	Cumulative Percentage Retained	Percentage Passing	FM
1.	10 mm	--	100	2.60
2.	No. 480 (4.75mm)	1.0	99.0	
3.	No. 240 (2.36mm)	10.0	90.0	
4.	No.120 (1.18mm)	23.5	76.5	
5.	No. 60 (600microns)	46.5	53.5	
6.	No. 30 (300microns)	81.4	18.6	
7.	No.15(150microns)	98.0	2.0	

2. Silt content : 0.9%
3. Bulking of sand : 18% @ 5% moisture content
4.Sand sample – 3 is suitable for construction

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University College Engg.Kakinada
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With reference to your letter cited (Sand) the test results on the fine aggregate are herewith furnished.

TEST RESULTS

1. Seive Analysis: (FA (Sand) sample -4

Sl.No.	I.S. Seive No.	Cumulative Percentage Retained	Percentage Passing	FM
1.	10 mm	--	100	2.6
2.	No. 480 (4.75mm)	0.5	99.5	
3.	No. 240 (2.36mm)	10.0	90.0	
4.	No.120 (1.18mm)	24.5	75.5	
5.	No. 60 (600microns)	47.5	52.5	
6.	No. 30 (300microns)	83.0	17.0	
7.	No.15(150microns)	96.0	4.0	

2. Silt content : 0.5%
3. Bulking of sand : 18% @ 5% moisture content
4.Sand sample – 4 is suitable for construction

Principal & Chief Co-ordinator, ICS.

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With reference to your letter cited (Sand) the test results on the fine aggregate are herewith furnished.

TEST RESULTS

1. Seive Analysis: (FA (Sand) sample -5

Sl.No.	I.S. Seive No.	Cumulative Percentage Retained	Percentage Passing	FM
1.	10 mm	--	100	2.56
2.	No. 480 (4.75mm)	--	100	
3.	No. 240 (2.36mm)	0.7	99.3	
4.	No.120 (1.18mm)	24.8	75.2	
5.	No. 60 (600microns)	49.8	50.2	
6.	No. 30 (300microns)	83.3	16.7	
7.	No.15(150microns)	98.3	1.7	

2. Silt content : 0.8%
3. Bulking of sand : 17% @ 5% moisture content
4.Sand sample – 5 is suitable for construction

Principal & Chief Co-ordinator, ICS.

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KAKINADA – 533 003 A.P. INDIA

Ref : : UCEK/JNTUK/CE/ICS/SM / 313 /2020-21 Date : 15.12.2020.

ICS

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B.Tech., M.Tech., FIE., MISTE., Ph.D.

Professor of Mechanical Engineering &,
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To

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Yanam Division

Sir,

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Name of the Work: : PW –YNM – Submission of sand samples collected from Gowthami Godavari River bed in Yanam region for testing

With reference to your letter cited (Sand) the test results on the fine aggregate are herewith furnished.

TEST RESULTS

1. Seive Analysis: (FA (Sand) sample -6

Sl.No.	I.S. Seive No.	Cumulative Percentage Retained	Percentage Passing	FM
1.	10 mm	--	100	2.65
2.	No. 480 (4.75mm)	1.0	99.0	
3.	No. 240 (2.36mm)	9.0	91.0	
4.	No.120 (1.18mm)	22.5	77.5	
5.	No. 60 (600microns)	48.5	51.5	
6.	No. 30 (300microns)	85.5	14.5	
7.	No.15(150microns)	98.5	1.5	

2. Silt content : 0.6%
3. Bulking of sand : 20% @ 5% moisture content
4.Sand sample – 6 is suitable for construction

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ANNEXURE II

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INDUSTRIAL CONSULTANCY SERVICES

UNIVERSITY COLLEGE OFENGINEERING KAKINADA

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KAKINADA – 533 003 A.P., INDIA

Ref : Job No-: UCEK/JNTUK/CE/ICS/PH/ 130 /2020-21 Date : 10-02-2021

From

Dr. B. Balakrishna,
B.Tech.,M.Tech.,FIE.,MISTE.,Ph.D.
Professor of Mechanical Engineering &
Principal & Chief Co-ordinator, ICS

To

The Executive Engineer,
Yanam Division,
Yanam.

Sir,

Sub: JNTU College of Engineering, Kakinada – ICS – Analysis of Analysis of Sand Sample collected and supplied by PW - YNM - Submission of Sand Samples collected from Gowthami Godavari river bed in Yanam region for testing.

Ref:**YourletterNo:1068/PW/EE/DB/YNM/(Sand Mine)/2020-21., dated04.02.2021**

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Herewith are given the Test Results of Analysis of Sand Sample collected and supplied by you for analysis to the Environmental Engineering Laboratory of this College.

The bill for testing charges is also enclosed.

S.No.	Parameter	Sample -1	Sample – 2	Sample – 3
1.	Silica / Quartz as SiO_2	79.5	78.6	79.8
2.	Aluminate as Al_2O_3	13.8	12.5	12.8
3.	Ferrite as Fe_2O_3	1.85	1.70	1.50
4.	Cao	0.85	0.75	0.85
5.	Sodium Oxides as Na_2O	1.50	1.65	1.50
6.	Loss of Ignition (LOI)	0.31	0.25	0.30

S.No.	Parameter	Sample -4	Sample – 5	Sample – 6
1.	Silica / Quartz as SiO_2	79.0	79.5	79.0
2.	Aluminate as Al_2O_3	12.5	13.5	12.5
3.	Ferrite as Fe_2O_3	1.65	1.70	1.70
4.	Cao	0.80	0.75	0.80
5.	Sodium Oxides as Na_2O	1.50	1.40	1.65
6.	Loss of Ignition (LOI)	0.25	0.30	0.30

Thank You

Encl: 1) Test results
2) Bill

Yours faithfully,

Principal
Chief Coordinator ICS

Principal & Chief Coorinat...
Industrial Consultancy Serv...
University College Engg.Kaki...
JNTUK, KAKINADA.(AP)