Corrigendum - 2 dated 25/08/2025 to CPC Tender No. BHEL/CPC/SGL/GPC/26/038

Name of Work: HIRING OF AGENCY FOR PRODUCTION OF REQUIRED GRADE OF GEOPOLYMER CONCRETE FOR ROAD WORKS AT 2X800MW SINGRUALI STPP STAGE-III, SONEBHADRA, UTTAR PRADESH, INDIA.

A) Technical Conditions of Contract (TCC): The Following clauses of TCC are revised as below**:**

<table>
<tr><th>Sl. No.</th><th>Clause No.</th><th>Existing in Tender</th><th>Revised As</th></tr>
<tr><td>1</td><td>Clause 7.2</td><td>PRICE VARIATION CLAUSE/ESCALATION

ESCALATION / PRICE VARIATION CLAUSE shall be applicable as detailed below: -
In order to take care of variation in cost of execution of work on either side, due to variation in the index of Aggregate, Labour & Diesel, Price Variation Formula as described herein shall be applicable

85% component of Contract Value shall be considered for PVC calculations and remaining 15% shall be treated as fixed component. The basis for calculation of price variation in each category, their component, Base Index, shall be as under:

<table>
<tr><th>Category</th><th>Index</th><th>Component (K)</th></tr>
<tr><td>Aggregates</td><td>Monthly index numbers for STONE, CHIP as per Office of the economic Adviser.
(website: http://eaindustry.nic.in/home.asp)</td><td>60</td></tr>
</table>
</td><td>PRICE VARIATION CLAUSE/ESCALATION

ESCALATION / PRICE VARIATION CLAUSE shall be applicable as detailed below: -
In order to take care of variation in cost of execution of work on either side, due to variation in the index of Aggregate, Labour, Sodium Hydroxide, Sodium Silicate & Diesel, Price Variation Formula as described herein shall be applicable

85% component of Contract Value shall be considered for PVC calculations and remaining 15% shall be treated as fixed component. The basis for calculation of price variation in each category, their component, Base Index, shall be as under:

<table>
<tr><th>Category</th><th>Index</th><th>Component (K)</th></tr>
<tr><td>Aggregates</td><td>Monthly index numbers for STONE, CHIP as per Office of the economic Adviser.
(website: http://eaindustry.nic.in/home.asp)</td><td>30</td></tr>
</table>
</td></tr>
</table>

		Labour (All Categories)	MONTHLY ALL-INDIA AVERAGE CONSUMER PRICE INDEX NUMBERS FOR INDUSTRIAL WORKERS' published by Labour Bureau, Ministry of Labour and Employment, Government of India. (Website: labourbureau.nic.in)	10
		Diesel	Monthly index numbers for HSD as per Office of the economic Adviser. (website: http://eaindustry.nic.in/home.asp)	15

Payment / recovery due to variation in index shall be determined on the basis of the following notional formula without any initial absorption, in respect of the identified components viz Aggregates, Labour & Diesel.

P = K x R x (Xn - Xo) / Xo
Where,

P = Amount to be paid / recovered due to variation in the Index for Aggregates, Labour & Diesel
K = Percentage component applicable for Aggregates, Labour & Diesel.
R = Value of work done for the billing month
Xn = Revised Index for Aggregates, Labour & Diesel for the billing month under consideration.

Labour (All Categories)	MONTHLY ALL-INDIA AVERAGE CONSUMER PRICE INDEX NUMBERS FOR INDUSTRIAL WORKERS' published by Labour Bureau, Ministry of Labour and Employment, Government of India. (Website: labourbureau.nic.in)	10
Sodium Hydroxide	Monthly index numbers for Caustic Soda (Sodium Hydroxide) as per Office of the economic Adviser. (website: http://eaindustry.nic.in/home.asp)	15
Sodium Silicate	Monthly index numbers for Sodium Silicate as per Office of the economic Adviser. (website: http://eaindustry.nic.in/home.asp)	25
Diesel	Monthly index numbers for HSD as per Office of the economic Adviser. (website: http://eaindustry.nic.in/home.asp)	5

		Xo = Index for Aggregates, Labour & Diesel as on the Base date.	Payment / recovery due to variation in index shall be determined on the basis of the following notional formula without any initial absorption, in respect of the identified components viz Aggregates, Labour, Sodium Hydroxide, Sodium Silicate & Diesel. P = K x R x (Xn - Xo) / Xo Where, P = Amount to be paid / recovered due to variation in the Index for Aggregates, Labour ,Sodium Hydroxide, Sodium Silicate & Diesel K = Percentage component applicable for Aggregates, Labour ,Sodium Hydroxide, Sodium Silicate & Diesel . R = Value of work done for the billing month Xn = Revised Index for Aggregates, Labour ,Sodium Hydroxide, Sodium Silicate & Diesel for the billing month under consideration. Xo = Index for Aggregates, Labour ,Sodium Hydroxide, Sodium Silicate & Diesel as on the Base date.
2	Clause 10.4	Void	Contractor to ensure requisition slip signed jointly by the laying agency along with BHEL before proceeding with production of GPC. Contractor shall supply Geopolymer concrete from the batching plants deployed by the contractor at site. Quantity produced shall be certified as per Batch Reports / weighment slips and same shall be received, signed and stamped by the BHEL's contractor responsible for laying of concrete as a proof for receiving of requisite quantity of concrete. Providing Geopolymer concrete in acceptable quality as per BHEL's / Customer's requirement is the prime responsibility of the Contractor. Contractor to ensure the quality/ quantity of Geopolymer concrete being produced and any

			doubt/issue raised during execution should be brought in the notice of BHEL's Quality-in-charge, whose decision in this regard shall be final and binding on the contractor. Acceptance / Rejection of freshly produced Geopolymer concrete will be the sole right of BHEL/it's Customer.
3	Clause 10.6	Void	Geo-polymer concrete work demands high precision and technical expertise in both production and laying processes due to its highly sensitive nature because of its quick initial setting time. Thus, these activities must be carried out with meticulous planning and seamless coordination between the production and laying teams. Hence proper coordination to be ensured between the bidder and the laying contractor. Responsibility for production of requisite quality geopolymer concrete (having required strength and workability) shall be of the contractor. After production of GPC, Joint recording of quantity and time of production shall be done at site along with BHEL & the Laying Agency. Wastages if any due to poor co-ordination b/w the laying and production teams and non-utilization of Geopolymer concrete after production, same is to be borne by the contractor.

B) Some of the Bidders sought clarifications in regard to the published tender specification. The clarifications/modifications issued by BHEL are as below:

Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
1	GCC	Security Deposit (GCC Clause 1.10)	5% of Contract Value and shall be furnished before Commencement of Work. SD to be released after completion of Guarantee Period.	Since the work is capital intensive, bidder request the reduction of the same to 2.5% on basic value of contract	Tender conditions prevail.

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Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
2	GCC	Retention amount (GCC Clause 2.22)	5% of contract value and shall be furnished before the first RA Bill becomes due for payment. On successful bidder's request, the Retention Amount can also be recovered at the rate of 10% of the gross amount, progressively, from each of the running bills of the contractor till the total amount of the required retention amount is collected. RA to be released along with Final Bill.	Since the work is capital intensive, the bidder requests the reduction of the same to 2.5% on basic value of contract. If Retention BG is not submitted the same to be recovered in percentage of retention to be deposited from each RA bill.	Tender conditions prevail.
3	TCC	Construction power (TCC Chapter - III Clause 3.3)	Construction power (three phase, 415 V/ 440 V) will be provided on a chargeable basis at one point near the site at a distance of approx. 500M.	Please specify the rate at which power will be charged as power will form a major component of cost. Charges include only Energy Charges?	Clause 2.18 (10) of the TCC may be referred for same. For further details the bidder may visit the site.
4	TCC	Scope of Work (TCC Chapter -II Clause 2.13)	Open spaces for material storage yard & construction of temporary site office shall be allocated as made available by the customer / BHEL free of cost.	Allotment of Store Area (Whether inside plant or outside) as this concrete has fast initial setting time, thus required to be nearest to the plant without any hindrance	The production of concrete shall be at project site near to the pouring location, so material storage may be nearer to the required pouring location. However, main storage may be within the project site.
5				Part payment for Mix design of Geopolymer Concrete, as this concrete is a special concrete and require RnD that will take upto 3 months , till finalisation of the proper mix design after field trials. So, when mix design is approved, some part payment to be released, as all the machinery and labour will be engaged without any production quantity.	Tender conditions prevail.
6	TCC	Scope of Work (TCC	The scope of work for above mentioned package shall include but not limited to following major works:	Request for Procurement of Sodium Hydroxide, Sodium Silicate, GGBFS in BHEL scope. As these materials have	Tender conditions prevail. Except Fly-ash all other ingredients required for the

Corrigendum - 2 dated 25/08/2025 to CPC Tender No. BHEL/CPC/SGL/GPC/26/038

Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
		Chapter -II Clause 2.1)	a. Procurement, Supply, Storage of Geopolymer concrete ingredients: • Approved quality fine & coarse aggregates, • Fly-ash (to be collected from location within existing operating plant/from existing fly ash silos near plant boundary). Fly ash produced by coal-based power stations of NTPC, will be issued free of cost for the production of Geo-polymer concrete on 'as is where is' basis. • Sodium Silicate. • Sodium Hydroxide. • Approved quality of GGBFS. The properties of GGBFS shall be as per IS 16714:2018. • Chemical admixtures like super-plasticizer, retarder, shrink-reducing compound, evaporation reducer etc	high investment. This can reduce the burden on the contractor and successfully complete the project without any financial constraints	production of Geopolymer concrete are in bidder's scope. However, transportation of fly-ash from its source is also in the bidder's scope.
7	NIT	Pre-Qualification Criteria (NIT Annexure-2 C-5 1a))	The bidder shall submit a certificate for any of the below mentioned instruments of value/limit not less than Rs. 190 Lakhs from any Scheduled Commercial Non-Cooperative Bank/Nationalised Bank/Indian Post Office, as on date not earlier than the date of NIT:	Reduction of BG amount, 1.9 crore BG for approx. 27000 cum concrete is very high for 34 months. Request you to kindly reduce it, this will reduce the burden on the bidder.	Tender conditions prevail.
8	TCC	Scope of Work (TCC Chapter -II Clause 2.1) a	Fly-ash (to be collected from location within existing operating plant/from existing fly ash silos near plant boundary). Fly ash produced by coal-based power stations of NTPC, will be issued free of cost for the production of Geo-polymer concrete on 'as is where is' basis.	Please define the Lead and Waiting time for transportation of Fly ash	Bidder should visit the site and assess the same before quoting.

Corrigendum - 2 dated 25/08/2025 to CPC Tender No. BHEL/CPC/SGL/GPC/26/038

Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
9	TCC	T&P and MMES to be Deployed by contractor (TCC Chapter -IV Clause 4.2.1)	Mobile Batching Plant /Ajax Fiori (01 no.)	Maximum Capacity and production rate of Ajax Fiori is 4cum per hour. If any concrete pour of 100 cum occurs then, it will take around 25 hours to complete the pour. Please clarify the number of fiori to be deployed	Bidder may plan the number of fiori to be deployed at site based on multiple front availability.
10	TCC	Terms of Payment (TCC Chapter -VII Clause 7.2)	Price escalation is only given for aggregate, labour In order to take care of variation in cost of execution of work on either side, due to variation in the index of Aggregate, Labour & Diesel, Price Variation Formula as described herein shall be applicable	Price escalation is only given for aggregate, labour and Diesel. As the Alkali Activator(Sodium Hydroxide and Sodium Silicate) is the main ingredient and major factor in cost. Any change in these chemical will have a large impact on the cost of the concrete.	Noted. Revised TCC chapter VII Clause 7.2 may be referred for same. **(Please Refer Sl. No. A) 1 above, of this corrigendum)**
11	TCC	Technical Specifications (TCC Chapter -X Clause 10.8)	The sampling of Geopolymer concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IRC 44:2017 & IRC 15:2011	Please define the IS Code for the Mix design of Geopolymer concrete	There is no IS code for mix design of Geopolymer Concrete. However, bidder may take the reference of ACI-PRC-242-22.
12				Estimated time when concreting of road will start. As we have visited the site and no work front is available	Bidder should visit site for such detailed information before quoting.
13				As per the tender, the scope of work is limited to the production of geopolymer concrete. Kindly confirm whether the laying of concrete is outside our scope.	Laying of concrete is not in the scope of current tender. Tender conditions prevail.
14				Please confirm how the measurement of supplied concrete will be considered—whether it will be based on the batch reports generated by the batching plant/Ajax flori or by any other method.	Tender conditions prevail. Refer revised Clause 10.4 of the TCC **(Please Refer Sl. No. A) 2 above, of this Corrigendum)** " Contractor to ensure requisition slip signed

Corrigendum - 2 dated 25/08/2025 to CPC Tender No. BHEL/CPC/SGL/GPC/26/038

Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
					jointly by the laying agency along with BHEL before proceeding with production of GPC. Contractor shall supply Geopolymer concrete from the batching plants deployed by the contractor at site. Quantity produced shall be certified as per Batch Reports / weighment slips and same shall be received, signed and stamped by the BHEL's contractor responsible for laying of concrete as a proof for receiving of requisite quantity of concrete. Providing Geopolymer concrete in acceptable quality as per BHEL's / Customer's requirement is the prime responsibility of the Contractor. Contractor to ensure the quality/ quantity of Geopolymer concrete being produced and any doubt/issue raised during execution should be brought in the notice of BHEL's Quality-in-charge, whose decision in this regard shall be final and

Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
					binding on the contractor. Acceptance / Rejection of freshly produced Geopolymer concrete will be the sole right of BHEL/it's Customer.
15				Geopolymer concrete is highly sensitive in nature. If not handled and laid quickly, it tends to set rapidly and becomes unusable. Kindly clarify how such issues will be addressed when laying is not in our scope. The concrete is also temperature- and water-sensitive. In case it is not laid within 4–7 minutes, the prepared material may get wasted. Kindly confirm how such wastage will be treated. If the alkali solution is prepared for the next day's concrete but production cannot be carried out due to the non-availability of the laying agency, the solution will set and cannot be used further. Please clarify how BHEL will compensate for such wasted material. In case work is delayed due to the non-availability of manpower from the laying agency, kindly clarify how idle charges will be dealt with.	Tender conditions prevail. Refer revised Clause 10.6 of the TCC. **(Please Refer Sl. No. A) 3 above, of this Corrigendum)** Geo-polymer concrete work demands high precision and technical expertise in both production and laying processes due to its highly sensitive nature because of its quick initial setting time. Thus, these activities must be carried out with meticulous planning and seamless coordination between the production and laying teams. Hence proper coordination to be ensured between the bidder and the laying contractor. Responsibility for production of requisite quality geopolymer

Corrigendum - 2 dated 25/08/2025 to CPC Tender No. BHEL/CPC/SGL/GPC/26/038

Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
					concrete (having required strength and workability) shall be of the contractor. After production of GPC, Joint recording of quantity and time of production shall be done at site along with BHEL & the Laying Agency. Wastages if any due to poor co-ordination b/w the laying and production teams and non-utilization of Geopolymer concrete after production, same is to be borne by the contractor.
16				As per BOQ, the supply of Alkali Activator (NaOH + Na_2SiO_3) and its relevant tests and the supply of GGBFS and its relevant tests are in the bidder's scope. Kindly specify the type of tests required. In our previous projects, only the manufacturer's MTC (Material Test Certificate) was submitted in line with the relevant IS code . Please confirm whether the same will be acceptable.	Refer TCC Clause No. 10.7" "The Contractor shall carry out testing in accordance with the relevant IS / standards/codes and in line with the requirements of the technical specifications/quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer. All testing shall be done in the presence of the

Corrigendum - 2 dated 25/08/2025 to CPC Tender No. BHEL/CPC/SGL/GPC/26/038

Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
					engineer or his authorized representative."
17				The referenced FQP (Field Quality Plan) is not enclosed in the tender documents. Kindly provide the FQP to clarify the specific testing requirements for geopolymer concrete.	Refer TCC Chapter-XI: Customer Specifications: "CUSTOMER TECHNICAL SPECIFICATIONS FOR QUALITY ASSURANCE OF CIVIL WORKS." Indicative Quality Plan is attached therewith. Further, Quality Plan shall be finalized during execution with the approval of BHEL and Customer.
18				As you know that Geopolymer concrete mix design, their production and effective use in work is under research and development phase. So the ratio of ingredients/compositions of material to be used in the design mix of Geopolymer concrete is not available anywhere. So, for competitive bidding design mix of M35 and M10 Geopolymer concrete is required from your end.	Tentative Design mix reports for Geopolymer DLC (M10) and Geopolymer PQC (M40) are **attached herewith along with this Corrigendum** for reference. These are tentative design mixes used in previous projects of NTPC. However, the molarity (M) of sodium hydroxide and proportions of slag may vary based on trials by third party while establishing the design mix. The proportion of ingredients may vary according to workability and strength requirements

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Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
					of specified grade of GPC (Geopolymer Concrete) as well as the properties of sand, aggregates and other ingredients of GPC. No extra payment shall be made due to any changes in ingredient proportions of Geopolymer Concrete. This design mix reports are provided only to give a preliminary idea about the proportions of ingredients of GPC. Bidder should not consider it as firm while quoting their price. It may vary according to the workability and strength requirement specified in approved drawings issued during work progress.
19				In BOQ/Scope of work only production of Geopolymer concrete is given, laying is not included in the item. It will be better if laying and production will be done by a single contractor. So, requesting you to incorporate laying also in the BOQ for hindrance free and smooth day to day working of contract/work.	Tender conditions prevail.
20	BOQ & TCC			In Preamble for BOQ cum rate schedule, Sr. No. 4, it is mentioned that item shall include taxes. However, in Chapter VIII	The total amount to be quoted in BOQ is exclusive of GST.

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Sl. No.	Reference Tender Document	Reference clause	Existing Provision	Bidder's query	BHEL's Clarification
				Taxes & Duties of TCC Clause 8.2.1 it is mentioned that Contractor's price/rates shall be exclusive of GST. Please clarify whether the total amount to be quoted in BOQ is inclusive or exclusive of GST.	

Note:

1) **All other terms and conditions against this NIT shall remain unchanged.**
2) **This corrigendum is to be submitted duly signed and stamped along with the Techno-commercial bid (Part- I).**

for BHARAT HEAVY ELECTRICALS LTD
Manager/ SCT- CPC

CONSULTANCY PROJECT FOR GEOPOLYMER CONCRETE MIX DESIGN (NTPC KAHALGAON) – DLC – M10 Grade

INTERIM REPORT – (1)

TEAM

Dr. C.ANTONY JEYASEHAR, Professor
Dr. S. THIRUGNANASAMBANDAM, Professor

DEPARTMENT OF CIVIL & STRUCTURAL ENGINEERING

ANNAMALAI UNIVERSITY

ANNAMALAINAGAR – 608 002 CHIDAMBARAM TAMILNADU

DESIGN OF MIX AT ROOM TEMPERATURE CURED FLY ASH BASED GEOPOLYMER CONCRETE ROAD TO BE CONSTRUCTED AT NTPC KAHALGAON

NTPC requested us to carry out Mix Design for the construction of Geopolymer concrete road at Kahalgaon (NTPC Kahalgaon Vide letter No. KhS/092/MGR/Geo-polymer dated 30.11.2019). Geopolymer concrete mix design has been carried out in our laboratory by using the materials supplied by NTPC Kahalgaon The interim report (Report No. 1) pertaining to M10 grade Geopolymer concrete is given in Annexure – I.

17022020

C.ANTONY JEYASEHAR
PRINCIPAL CONSULTANT

METHODOLOGY OF PREPARING GEOPOLYMER POLYMER CONCRETE MIX OF M10 PER CU.M. **ANNEXURE I**

DAY 1:

1. Mix NaOH flakes (9.0 kg/cu.m) with the required water (36.0 kg/cu.m).
2. Allow this solution to cool down to room temperature.
3. Mix the NaOH solution with Na_2SiO_3 solution (112.5 kg/cu.m) Allow this solution to react for 24 hours.

DAY 2:

4. Keep all coarse and fine aggregate in saturated surface dry (SSD) condition.
5. After passing of 24 hours of time of mixing of alkaline solution (step no.3), mix fly ash (189 kg/cu.m) and GGBS (126 kg/cu.m) thoroughly in mixer machine.
6. Add sand (696 kg/cu.m) and coarse aggregate (20 mm – 836 kg/cu.m) & 10 mm – 557 kg/cu.m) and mix them thoroughly in dry condition.
7. During dry mixing, keep ready the mixture of SP – 0.6% of binder (1.89 kg/cu.m) and extra water 40% of binder (126 kg/cu.m).
8. **Pour SP + extra water solution into the mixture gradually and allow mixing for two minutes.**
9. Add alkaline solution to the mixture gradually.
10. Mix it for three minutes & GPC mix is ready for placement. The workability and strength details are given below:
11. Slump

    60 mins – 110 mm
12. Compressive Strength : 21.50 N/mm^2 (cube cast at 60 mins)

Geopolymer Concrete – M 10 Grade

Quantity of Materials required for one metre cube of concrete:

Fly ash – GGBS ratio --- 60:40

Fly ash : 189 kg/cu.m

GGBS* : 126 kg/cu.m

Sand : 696 kg/cu.m

Coarse aggregate : 20mm --- 836 kg/cu.m (60%)

10mm --- 557 kg/cu.m (40%)

Molarity of NaOH solution : 5M

NaOH : 9.0 kg/cu.m

Water : 36.0 kg/cu.m

Na_2SiO_3 : 112.5 kg/cu.m

Alkali activator solution NaOH : Na_2SiO_3 = 1: 2.5

Extra water [40%] : 126 kg/cu.m

S.P (Geotard360) [0.6 %] : 1.89 kg/cu.m

Compressive Strength : 21.50 N/mm^2

*** JSW / Jindal Panther GGBS**

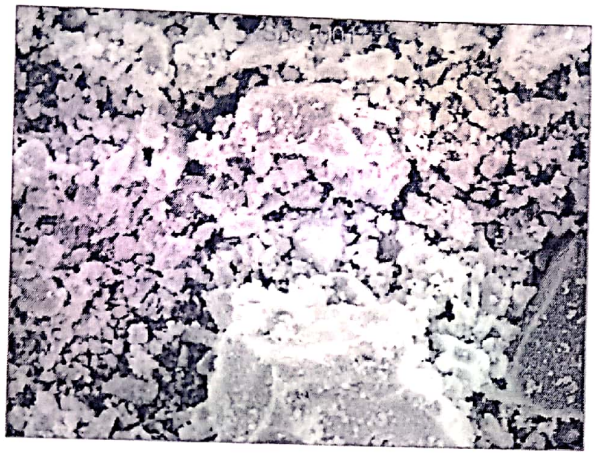
(Since, GGBS supplied by NTPC Kahalgaon contains the total quantity of Alumina & Silica less than 40% (Vide Annexure II), it is not suitable for strength gaining of Geopolymer Concrete. Hence, it is recommended to use JSW / Jindal Panther GGBS.)

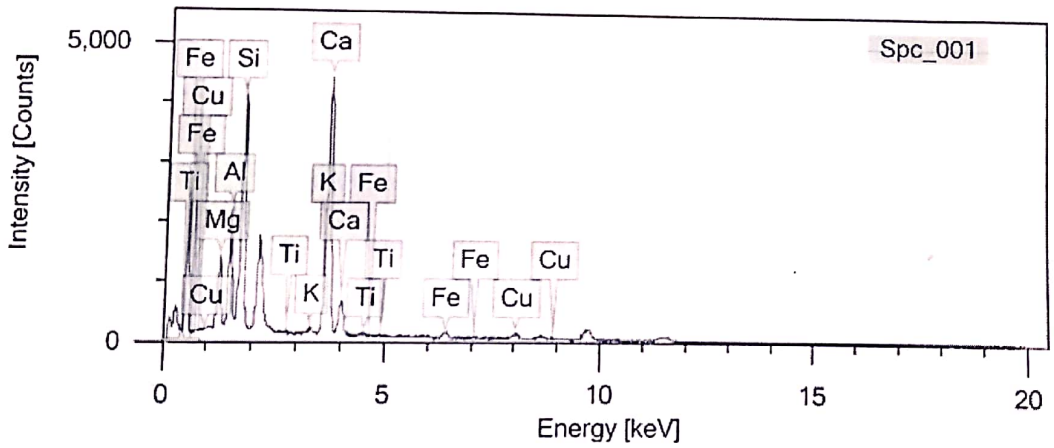
17.02.2020

C.ANTONY JEYASEHAR
PRINCIPAL CONSULTANT

ANNEXURE II

SEM ANALYSIS REPORT FOR GGBS SUPPLIED FROM KAHALGAON





Element	Line	Mas	Atom%
Mg	K	7.35±0.11	10.12±0.16
Al	K	12.65±0.15	15.71±0.19
Si	K	25.25±0.21	30.12±0.25
K	K	0.95±0.06	0.81±0.05
Ca	K	47.44±0.29	39.65±0.24
Ti	K	0.60±0.06	0.42±0.04
Fe	K	1.95±0.09	1.17±0.06
Cu	K	3.80±0.16	2.00±0.09
Total		100.00	100.00

Spc_001 Fitting ratio 0.3072

CONSULTANCY PROJECT FOR GEOPOLYMER CONCRETE MIX DESIGN (NTPC KAHALGAON) – PQC – M40 Grade

INTERIM REPORT – (2)

TEAM

Dr. C.ANTONY JEYASEHAR, Professor
Dr. S. THIRUGNANASAMBANDAM, Professor

DEPARTMENT OF CIVIL & STRUCTURAL ENGINEERING

ANNAMALAI UNIVERSITY

ANNAMALAINAGAR – 608 002 CHIDAMBARAM TAMILNADU

DESIGN OF MIX AT ROOM TEMPERATURE CURED FLY ASH BASED GEOPOLYMER CONCRETE ROAD TO BE CONSTRUCTED AT NTPC KAHALGAON

NTPC requested us to carry out Mix Design for the construction of Geopolymer concrete road at Kahalgaon (NTPC Kahalgaon Vide letter No. KhS/092/MGR/Geo-polymer dated 30.11.2019). Geopolymer concrete mix design has been carried out in our laboratory by using the materials supplied by NTPC Kahalgaon The interim report (Report No. 2) pertaining to M40 grade Geopolymer concrete is given in Annexure – I.

090320

C.ANTONY JEYASEHAR
PRINCIPAL CONSULTANT

ANNEXURE I

METHODOLOGY OF PREPARING GEOPOLYMER POLYMER CONCRETE MIX OF M4 0 PER CU.M.

DAY 1:

1. Mix NaOH flakes (30.4 kg/cu.m) with the required water (23.89 kg/cu.m).
2. Allow this solution to cool down to room temperature.
3. Mix the NaOH solution with Na_2SiO_3 solution (135.71 kg/cu.m) Allow this solution to react for 24 hours.

DAY 2:

4. Keep all coarse and fine aggregate in saturated surface dry (SSD) condition.
5. After passing of 24 hours of time of mixing of alkaline solution (step no.3), mix fly ash (300 kg/cu.m) and GGBS (200 kg/cu.m) thoroughly in mixer machine.
6. Add sand (725 kg/cu.m) and coarse aggregate (20 mm – 705 kg/cu.m) & 10 mm – 470 kg/cu.m) and mix them thoroughly in dry condition.
7. During dry mixing, keep ready the mixture of SP – 2.0% of binder (10 kg/cu.m) and extra water 25% of binder (125 kg/cu.m).
8. **Pour SP + extra water solution into the mixture gradually and allow mixing for two minutes.**
9. Add alkaline solution to the mixture gradually.
10. Mix it for three minutes & GPC mix is ready for placement. The workability and strength details are given below:
11. Slump

    50 mins – 80 mm
12. Compressive Strength : 49.30 N/mm^2

Geopolymer Concrete – M 40 Grade

Quantity of Materials required for one metre cube of concrete:

Fly ash – GGBS ratio --- 60:40

Fly ash	: 300 kg/cu.m
GGBS*	: 200 kg/cu.m
Sand	: 725 kg/cu.m
Coarse aggregate	: 20mm --- 705 kg/cu.m (60%)
	10mm --- 470 kg/cu.m (40%)

Molarity of NaOH solution : 14M

NaOH : 30.40 kg/cu.m

Water : 23.89 kg/cu.m

Na_2SiO_3 : 135.71 kg/cu.m

Alkali activator solution NaOH : Na_2SiO_3 = 1: 2.5

Extra water [25%] : 125 kg/cu.m

S.P (Geotard360) [2.0 %] : 10 kg/cu.m

Compressive Strength : 49.3 N/mm^2

*** JSW / Jindal Panther GGBS**

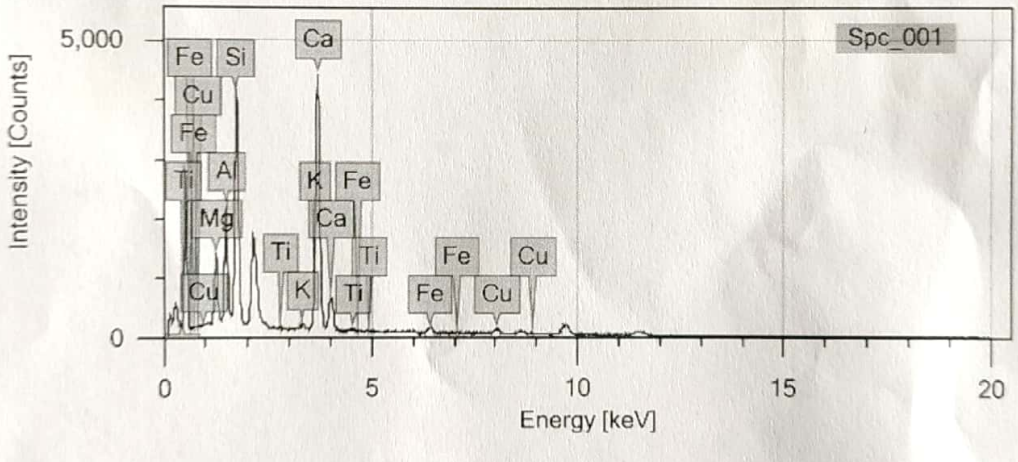
(Since, GGBS supplied by NTPC Kahalgaon contains the total quantity of Alumina & Silica is less than 40% (Vide Annexure II), it is not suitable for strength gaining of Geopolymer Concrete. Hence, it is recommended to use JSW / Jindal Panther GGBS.)

09032020

C.ANTONY JEYASEHAR
PRINCIPAL CONSULTANT

ANNEXURE II

SEM ANALYSIS REPORT FOR GGBS SUPPLIED FROM KAHALGAON



Element	Line	Mas	Atom%
Mg	K	7.35±0.11	10.12±0.16
Al	K	12.65±0.15	15.71±0.19
Si	K	25.25±0.21	30.12±0.25
K	K	0.95±0.06	0.81±0.05
Ca	K	47.44±0.29	39.65±0.24
Ti	K	0.60±0.06	0.42±0.04
Fe	K	1.95±0.09	1.17±0.06
Cu	K	3.80±0.16	2.00±0.09
Total		100.00	100.00
Spc_001			Fitting ratio 0.3072