

NATIONAL MINERAL DEVELOPMENT CORPORATION

**3.0 MT INTEGRATED STEEL PLANT
AT NAGARNAR, DIST. - BASTAR, CHATTISHGARH**

**TECHNICAL SPECIFICATION FOR
CAST-IN-SITU BORED PILING**



**MECON LIMITED
RANCHI - 834002**

NATIONAL MINERAL DEVELOPMENT CORPORATION LIMITED
3.0 MT INTERGRATED STEEL PLANT AT NAGARNAR, CHATTISHGARH
TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU R.C.C. PILING



01 General

This specification covers the Piling work, if required, for the construction for the proposed steel plant of National Mineral Development Corporation (NMDC) at Nagarnar, Dist- Bastar, Chattishgarh.

The bidder shall visit & carefully examine the site & surrounding, before submission of bid, to acquaint himself about general site condition, terrain, accessibility, existing features and all other conditions & matters affecting the work and build up his rates accordingly. Claims and objections due to ignorance of site condition shall not be considered after submission of bid.

The Termination criteria & Capacity of different diameter piles are stipulated in the Geotechnical Recommendation of the package. However, the length of pile at a particular location will depend on depth of specified rock stratum, at that location. To get tentative & qualitative idea of sub-surface stratification for the area, the enclosed borelogs, may be studied. However, for any specific location, if the contractor needs more sub-surface details, he may like to conduct pilot boring, for assessment of depth & extent of different strata, for assessment of pile length only, at no extra time & cost to NMDC. The outcome of such pilot boring, if conducted by the successful bidder, shall neither have any implication on stipulated Capacities &/or Termination criteria of pile foundation, nor have any commercial implication, whatsoever.

Bored Cast-in-situ cylindrical RCC pile passing through top Fill layer (if any), virgin soil layer, decomposed rock layer & terminated within underlying specified rock layer shall be considered. Capacity of different diameter piles, as furnished in enclosed Geotechnical Recommendation of the package, shall be considered for Estimation & Design purpose & shall again be confirmed by the executing agency by Load Test on Initial Trial Piles & Routine Load test on working piles as per clause No. 9, IS : 14593 : 1998 - Indian Standard code on " Design & Construction of Bored Cast-in-situ Piles Founded on Rocks - Guidelines" to ascertain that the tested capacities are not less than the corresponding design capacities. Increase of stipulated pile capacities &/or decrease in stipulated termination depth, shall not be acceptable at any stage of the project.

02.01 Codes

Any Standards / Codes mentioned in this specification means the latest revision of it including its all amendments, if any.

IS:2911 (Part 1/Section 2)-1979 : 'Code of practice for design & construction of Bored Cast-in-Situ concrete piles', IS : 2911 (part 4) -1985 'Load Test on Piles & IS : 14593 : 1998 : 'Design And

NATIONAL MINERAL DEVELOPMENT CORPORATION LIMITED
3.0 MT INTERGRATED STEEL PLANT AT NAGARNAR, CHATTISHGARH
TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU R.C.C. PILING



Construction of Bored Cast-in-situ Piles founded on Rocks – Guidelines' shall be referred to in conjunction with this specification during the entire design, construction & Load Testing work. These codes form the integral part of this specification.

If for any material or workmanship, appropriate Indian Standards or Codes are not available or have not been adequately specified in the Technical Specification, such materials & workmanship shall conform to other suitable Standard & Codes as may be approved by NMDC.

In case of any conflict between the requirement of this specification & those of the referred codes / standards, the former shall govern.

Any special requirements as shown or noted on the approved project drawings shall govern over this specification.

02.02 Design

The piles shall be bored cast-in-situ cylindrical type RCC piles of 500 mm &/or 550 mm &/or 600 mm &/or 750 mm &/or 1000 mm dia terminated within underlying specified rock layer. Minimum center to center spacing between adjacent piles shall be 2.5 D.

The contractor shall submit the structural design of pile for approval of NMDC. Such structural design shall be based on pile capacities already stipulated in Geotechnical Recommendation of the package. The contractor need not submit any calculation for pile capacity.

02.03 Materials

All the materials proposed to be used, shall be free from any objectionable substances, shall conform the following stipulation & shall be approved by NMDC. Any testing required to prove the suitability of such materials shall be carried out by the contractor at his own cost & in presence of NMDC. Any material rejected by NMDC shall be immediately removed from the site.

02.03.01

Reinforcement steel shall conform to High yield strength deformed bars of grade Fe 415 as per IS:1786-1985 and for stirrups/links mild steel reinforcement conforming to IS:432-1982 may be used. For marine / coastal / corrosive surroundings, corrosion resistant bars shall be used. Test certificate for reinforcement steel shall be obtained from recognised agency, before using. If the steel

NATIONAL MINERAL DEVELOPMENT CORPORATION LIMITED
3.0 MT INTERGRATED STEEL PLANT AT NAGARNAR, CHATTISHGARH
TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU R.C.C. PILING



is purchased by the contractor, NMDC may desire to check the testing of the same and the contractor shall arrange it in an approved laboratory at his own cost. Reinforcement shall be provided for full depth of pile as furnished in the approved drawing.

02.03.02

Reinforced Cement Concrete for Piles shall be of Grade M-25 with minimum Cement content of 400 Kg/m³ and using 20 mm & down graded stone aggregates. The slump of concrete shall range between 150 mm to 180 mm. The water-cement ratio shall not exceed 0.5. To achieve the specified slump using specified water cement ratio without compromising with strength, suitable plasticiser, if required, may be used at no extra cost, subject to approval of NMDC. If concentration of Sulphate (measured as SO₃) exceeds 0.5% in soil or 1200 ppm in ground water, sulphate resisting cement shall be used.

02.03.03

The cement shall be Ordinary Portland Cement conforming to IS:269-1989 or Portland Pozzolona Cement conforming to IS :1498-1991 or Blast Furnace Slag Cement conforming to IS:455-1989. Each batch of cement supply shall be accompanied by valid manufacturer's certificate.

02.03.04

The physical properties, mechanical properties & gradation of coarse & fine aggregate shall follow IS:383-1970. Testing of aggregate properties (if desired by NMDC) shall follow relevant parts of IS:2386:1963.

02.03.05

Water used for concrete shall be clean & free from injurious amount of harmful substances in such amounts that may impair the strength & durability of pile concrete. Generally potable water shall be considered satisfactory. In case of any doubt felt by NMDC about the quality of water, contractor has to prove that the concrete prepared with proposed water shall not have a compressive strength lower than 95% of the strength of similar concrete prepared with distilled water.

02.03.06

Preliminary mix design shall be done in accordance with IS:10262-1982 & SP:23 subject to approval of the customer. Cube tests, slump test & other relevant tests for preliminary mix design and Routine cube test, slump test for regular concreting shall be carried out at site / site laboratory at contractor's

own cost. Concrete cube tests shall be done as per IS:516-1959. The calibration certificate (not older than one year) of the testing machine shall be available at site. If NMDC feels any doubt about the calibration, the contractor has to check the same at an approved laboratory at his own cost. All such tests shall be conducted in presence of NMDC. At least one set (3 cubes for 7 days & 3 for 28 days strength) of cube shall be tested for every 10 piles or at any deterioration in concrete quality if felt by NMDC, whichever occurs earlier. Slump tests (apparatus conforming to IS:IS:7320-1974) shall be carried out at least once for each pile or more frequently, if desired by NMDC.

02.04 Equipment & Accessories

The equipment & accessories should be compatible with the type of deposit, method of installation, type of founding strata & required penetration in the founding strata.

The capacity of rig shall be adequate so as to bore upto required depth. Rig shall be equipped with suitable Chisel &/or Bailer &/or Cutter capable to penetrate through any Local Obstruction &/or Hard stratum.

The equipment shall be capable to do the required rock socketing at stipulated stratum.

No excuses, whatsoever, in relation to the inability of equipment shall be entertained during execution of work.

Contractor must furnish a detailed list of equipment & accessories (in sufficient quantities to complete the job within scheduled time frame & as per specification) to be deployed by him for this job indicating quantity, type, capacity/dimension & model/make of each along with his offer & reconfirm the same in writing immediately after mobilisation to site.

02.05 Construction

02.05.01

Piles shall be installed as accurately as possible as per approved drawing. Permissible positional deviation shall be as per clause 7.1. 2 , IS: 2911 (part 1/sec 2) –1979.

02.05.02 (A)

In areas, where heterogeneous Fill & other industrial wastes are encountered, Boring shall proceed by driving suitable Bailer - Chisel, extracting the bored material with the boring tools & simultaneously



advancing the casing (temporary or permanent, as the case may be). The hard pieces shall be broken by Chisel / Hard-face shoe of Bailer & shall be extracted by the Bailer. While boring in soft material liable to cavitation, boring tools shall not be operated at a level below the toe of the casing. The Care shall be taken to ensure that the volume of water added to the bore shall be no more than the minimum necessary for the operation of the boring tools. The temporary casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of boring tools until the approved bearing layer is reached.

02.05.02 (B)

In areas, where piling is to be started right from virgin soil deposit, pile boring may be done either by Bailer - Chisel method or by rotary boring with mud circulation process. In rotary boring method, stabilisation of the side of borehole can be done by the use of bentonite slurry. Either, Direct Mud Circulation (DMC) or Reverse Mud Circulation (RMC) process shall be adopted depending on soil condition & pile dimension. In such cases, the bentonite slurry must be used at least from the level of sub-soil water, & the hole should then be always kept almost full with the fluid. The density of bentonite slurry shall be in the range of 1.05 to 1.12. During installation of Trial piles, the exact density of bentonite to be used, shall be made specific depending on site-condition. After standardization, the density of bentonite slurry shall be maintained although the project & checked regularly at an interval of 10 piles or at any change in its specified quality if felt by the purchaser, whichever occurs earlier. Pressure of slurry pump shall be sufficient enough to clear out all cuttings efficiently from the hole.

02.05.02 (C)

Hydraulic rotary Piling rig can be used, for any type of areas mentioned above, subject to its suitability.

02.05.03

At the last stage of boring or in intermediate hard layers chisel or chopper may be used. The necessary rock socketing shall be done by well designed chisel / suitable tool. The rate for piling work should be inclusive of any chiseling, chopping of hard strata, clearing of bottom of pile bore hole etc. complete as per specifications. The piles shall be installed with due consideration for safety of adjacent structures by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance.

NATIONAL MINERAL DEVELOPMENT CORPORATION LIMITED
3.0 MT INTERGRATED STEEL PLANT AT NAGARNAR, CHATTISHGARH
TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU R.C.C. PILING



Proper precaution shall be taken to prevent any collapse of overlying soil due to impact / vibration caused by chisel during penetration through rock strata. Irrespective of pile boring technique, broken rock pieces shall be completely cleared from pile hole by Bailer / Sludge pump or any other suitable tool. Such rock lump samples shall be carefully collected & preserved for identification of socketing stratum & for future reference.

02.05.04

Reinforcement as required shall be made into stiff cages sufficiently welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion. The clear cover to main reinforcement shall not be less than 50 mm.

02.05.05

Immediately before placing of reinforcement and concreting, the bored hole shall be cleaned of all the loose material, debris and all the water shall be removed. The pile tip zone shall be thoroughly cleaned by flushing the bore with fresh Bentonite slurry to completely replace the old Bentonite slurry used during the previous operations. This shall be carried out for 45 minutes in two stages. Cleaning for initial 30 minutes shall be done before lowering of reinforcement cage & final 15 minutes after lowering the reinforcement cage.

02.05.06

Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by the faulty consolidation or entrapped air. Proper care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete.

In case of bore holes stabilised by Bentonite slurry, concrete shall be placed by means of tremie pipe which will be suitably closed at bottom at the start of concreting. The tremie pipe must extend upto the bottom of the borehole at the start and may be withdrawn in sections as the level of concrete rises in the borehole; but its discharge end shall at all times be embedded in the concrete to a minimum depth of 500 mm. Placing of concrete should be continuous and the pile holes will be maintained full with the bentonite slurry, wherever used, throughout the concreting operation. Slurry displaced from the borehole by the concrete, shall be channeled away or pumped into suitable receptacles for re-use or disposal to waste.

NATIONAL MINERAL DEVELOPMENT CORPORATION LIMITED
3.0 MT INTERGRATED STEEL PLANT AT NAGARNAR, CHATTISHGARH
TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU R.C.C. PILING



In case of cased holes, after the required founding level is encountered, the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited in such a manner so as to avoid any segregation of concrete followed by gradual withdrawal of casings. If water is present in the borehole, it shall be bailed out by bailer. If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralised by the head of the concrete, excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top, as is done, if the borehole is dry.

02.05.07

Concreting of Pile shall continue until the Pile is fully formed upto a level of not less than 750 mm above cut-off level of piles. Extraction of casing wherever used, shall be done in such a way so that no necking or shearing of concrete in the shaft takes place. Pile length above cut-off level shall be trimmed. Trimming of Pile top shall not be permitted before 7 days of concreting in case of mechanical chipping & not before 3 days concreting in case of manual chipping.

02.05.08

The concreted length of piles shall be measured from the toe of pile to cutoff level of pile.

02.05.09

Temporary stoppage of work may be permitted only during boring stage. Thereafter right from boring or chiseling of final portion of pile length through subsequent activities of flushing, lowering of reinforcement cage, lowering of tremie, pre-concrete flushing & upto concreting of full pile length, no halt whatsoever in the execution of work shall be permitted.

02.05.10

The rate of placing of concrete in the pile shaft shall not be less than 6 m (length of pile) per hour.

02.05.11

Boring of any pile shall not be carried out within a clear distance of three times of the pile diameter from the adjacent pile which has been freshly concreted within past 24 hours.

02.05.12

The contractor shall have to take all necessary actions to prevent side collapse (if any) of pile bore at his own cost.

02.05.13

The Contractor shall be responsible for the prompt removal from the site of all spoil due to the boring to places as indicated by NMDC. The cost of such disposal shall be deemed to have been included in the rate of piling.

02.06 Founding Strata

All the piles shall be socketed in specified rock stratum, with specified socket length subject to stipulated termination depth, as mentioned in Geotechnical Recommendation of the package.

For each pile, representative rock samples shall be collected from the top & bottom level of rock socket. Either rock lump samples collected by Bailer or rock core samples collected by rotary core drilling technique, shall be used for identification of specified rock stratum for socketing. All such samples shall be preserved for future reference.

The contractor shall engage a qualified & experienced geologist at site, for identification of specified rock stratum for pile socketing.

The contractor shall obtain approval from NMDC for finalization of founding stratum. However such approval does not leave the responsibility of the contractor for any underperformance of Pile capacity.

02.07 Pile Load Test

02.07.01

Immediately on mobilisation to site, the contractor shall arrange to construct Initial Test Piles (Trial Piles) with a view to establish suitability, installation criteria, safe load bearing capacity & guidelines for acceptance of routine tests. Initial tests shall separately be conducted for Vertical Compressive, Vertical Pull-out & Lateral load in separate non-working piles. Test load to be applied for such tests shall be 2.5 times of the corresponding safe design loads. For each package, at least 2 (Two) Nos. of Initial Pile Load Tests shall be conducted, for each mode of loading (Compressive, Pull-out, Lateral), for each pile diameter, proposed to be used in that package. Separate Trial piles shall be used for testing in each mode of loading.

All Initial Load tests in compressive mode of loading, shall be Cyclic in nature.

NATIONAL MINERAL DEVELOPMENT CORPORATION LIMITED
3.0 MT INTERGRATED STEEL PLANT AT NAGARNAR, CHATTISHGARH
TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU R.C.C. PILING



The contractor shall obtain necessary approval from NMDC for selection of location for such Trial piles.

Initial Test piles shall be constructed using the same equipment & technique & by same piling agency, as for working piles.

While executing the pile bore for Test Piles, a continuous record of borelog shall be maintained and Standard Penetration Test as per IS:2131-1981 at an depth interval of 1.5 m including one compulsory test at termination level, shall be conducted at no extra cost.

02.07.02

In each package, for Vertical mode of loading (Compressive or Pull-out - as per design requirement), 1% of actual number of working piles shall be tested, for each pile diameter, for Routine Load Test, subject to minimum 2 numbers, for each package.

For Routine Load Test in Lateral mode of loading, 0.5 % of actual number of working piles shall be tested, for each pile diameter, subject to minimum 2 numbers, for each package.

Separate working piles shall be used for testing in each mode of loading.

Exact location of the working pile to be tested for Routine Load Test, shall be indicated by NMDC at site.

Test load in such tests may be limited to 1.5 times of the corresponding safe design load.

02.07.03

For all types (Initial / Routine and Compressive / Pull-out / Lateral) of load tests, testing arrangement, test procedure shall follow relevant criteria set out in IS:2911(part 4) -1985 along with the following stipulations:

- i) All the tests shall be carried out in presence of NMDC.
- ii) Load test shall be carried out after 28 days from the date of casting.

NATIONAL MINERAL DEVELOPMENT CORPORATION LIMITED
3.0 MT INTERGRATED STEEL PLANT AT NAGARNAR, CHATTISHGARH
TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU R.C.C. PILING



iii) Test load shall be applied at cut-off level. If the test level is below the ground water table, suitable arrangement for dewatering shall be made by the contractor without any extra cost so as to conduct the test at dry condition.

iv) Loading shall be applied by reaction method consisting of a hydraulic jack placed centrally against a suitable loaded platform / anchorage system. Reaction system shall be well designed & capable of taking 1.25 times of the maximum load to be applied. It is the responsibility of the contractor to ensure the required capacity of the reaction system.

v) Test load shall be applied to pile in a static manner. Stage loading shall be applied in equal increments of 20% of estimated safe design load. Unloading may be done in higher decrements with at least 5 stages. For Cyclic Load test, each stage of loading shall correspond to unloading upto zero load. At each stage of loading & unloading, deflection of pile top shall be recorded accurate to 0.02 mm at an interval of 1, 2, 4, 8, 15, 30, 60 & 120 minutes upto a time when the deflection rate reduces to 0.1mm in 30 minutes or 0.2 mm in one hour or till two hours whichever occurs earlier.

vi) Increments of loads shall be continued upto Maximum Test Load (2.5 times of safe design load for Initial Test & 1.5 times of safe design load for Routine Test) or failure (soil-pile yielding or structural failure) whichever occurs earlier.

vii) Where failure does not occur, the final test load shall be maintained for 24 hours and deflection records shall be taken at every 6 hours interval, including initial 2 hours detailed records, as mentioned earlier.

viii) Assessment of Safe Load for different types of load test for pile socketed in rock, shall follow clause No. 9 of IS : 14593 : 1998.

ix) The contractor shall ensure that all the instrument / apparatus used by him shall be properly calibrated. The calibration certificates (not older than one year) of all the dial gauges & pressure gauges proposed to be used for load test shall be available at site. If NMDC desires to check any calibration, the contractor has to arrange the same in an approved laboratory at his own cost.

x) The Contractor shall maintain & submit NMDC immediately after completion of any load test, the following records / reports:

- a. Tabular & Graphical representation of Load vs. Settlement during loading and unloading.



- b. Tabular & Graphical representation of the Time vs. Settlement for each load.
- c. Graphical analysis of initial cyclic load test results (if any) to separate skin friction & end - bearing. as per Annexure A, IS 2911 (part 4).
- d. Remarks concerning any unusual occurrence (if any) during boring, installation or testing of piles.

02.07.04

In case of failure of piles, in load test, to achieve the specified safe design load, the contractor shall install extra piles at his own cost as per design requirement & as instructed by NMDC.

02.08 Standard of Acceptance

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification, IS Codes, and the Standards stated herein and instructions given by NMDC at site from time to time:

- a) The total volume of concrete shall not be less than actual shaft volume. The calculated volume for this purpose shall be the cross sectional area in side the bore multiplied by the length of the shaft. The concrete shall conform to the specified strength as indicated by the cube test results.
- b) The toe of pile shall be at approved bearing level in each case.
- c) Safe Load carrying capacity of pile as obtained from Load test shall not be less than corresponding Safe Design Load as mentioned.
- d) Tolerances specified in clause No. 02.05.01 shall be satisfied.

If an individual pile fails to meet the requirements specified in any of above clause/s, such pile shall be deemed to be defective.

When any pile is found defective, one or more pile shall be installed as a replacement of defective pile as necessary without any extra cost to NMDC. Defective piles shall be left in place or pulled out as directed by NMDC. Contractor shall not be paid any additional amount on this account. No payment shall be made for test piles found defective / unsatisfactory.



02.09 Record

The contractor shall maintain a record for each pile indicating the following data and shall be signed jointly with NMDC.

- a) The date and time of commencement and completion of each stage of piling operation.
- b) The particulars of the equipment and method of boring and concreting.
- c) The location and type of pile, Pile number, with a reference to approved drawings.
- d) The diameter of the pile and verticality.
- e) Bored depth, concreted depth, empty boring and nature of stratum at founding Level.
- f) The volume of concrete poured, quantity of cement, w/c ratio used and slump of poured concrete.
- g) Details of reinforcement provided.
- h) The sequence of installation of pile groups.
- i) During boring operation, a separate record for rate of advancement of borehole in terms of effective time vs. boring depth shall be maintained for each pile. The effective time implies the time required exclusively for boring operation barring the time for other activities such as temporary stoppage, cleaning of hole, in-situ tests, if taken etc.
- j) During chiseling through weathered rock strata, exact record for depth of penetration against time & number of blows for each 10 cm of chiseling shall be maintained. Weight & average height of fall of chisel shall also be recorded.