

**Centre for Industrial Consultancy and Sponsored Research (IC & SR)**

**IIT Madras**

**INVITATION FOR BID**

**SUPPLY, INSTALLATION AND INTEGRATION OF PORTABLE MULTI-AXIS SERVO SYSTEM FOR WAVEMAKER – LARGE SCALE SHALLOW WAVE BASIN AT NTCPWC**

For and on behalf of IC & SR, IIT Madras, sealed tenders under “**Three stage Bidding system**” as briefly described hereunder :-

|    |   |  |
|----|---|--|
| 1) | Description:                                    | Supply, Installation and Integration of portable multi-axis servo system for wavemaker – large scale shallow wave basin at NTCPWC.<br><br>(Detailed scope of work as mentioned under Section-III)  |
| 2) | Specification No.                               | OED/2019/20-SWB/NTCPWC/KMUR  |
|    | Tender Reference No.                            | OED/KMUR/010/2019  |
| 3) | Earnest Money Deposit:                          | <b>Rs. 4,00,000/-</b> in the form of DD drawn in favour of The Registrar IIT Madras Chennai issued by any Commercial or Nationalized bank. The DD shall be placed only in the technical bid failing which the tender shall be summarily rejected.  |
| 4) | Pre-Bid meeting(s)                              | Presentation by IITM to prospective vendors: 3 <sup>rd</sup> June 2019 at 4:00 PM IST<br><br>Pre bid Meeting: 7 <sup>th</sup> June 2019 at 10:30 AM IST<br><br><b>VENUE - NTCPWC, CONFERENCE ROOM</b>  |
| 5) | Last date for Submission of Bid:                | 1:00 PM IST on 3 <sup>rd</sup> July 2019   |
| 6) | Place of Opening of Tender (Technical bid only) | <b>NTCPWC, New Academic complex-6th Floor, IIT, Madras, Chennai-36.</b><br><br>If the due date fixed for submission / opening of the tender happens to be a holiday, the tender shall be opened at the same time on the next working day.<br><br>On the date and time fixed for opening of the tender the main cover and cover I alone will be opened in the presence of the tenderers who wish to participate.<br><br>Note 1: The financial Bid (Cover 3) of all the Bidders who participated in the tender shall be placed in a separate cover, unopened in the presence of the Bidders participated the Bid opening and sealed. |

|     |  |  |
|-----|--|--|
| 7)  | Date of opening of Tender                      | <ul style="list-style-type: none"> <li>• Cover 1: Fulfilment of the Eligibility criteria : 10<sup>th</sup> July 2019 at 2:30 PM IST</li> <li>• Cover 2: Technical bids of only those tenderer meet the eligibility criteria shall also be opened on the same day, 13<sup>th</sup> July 2019 at 3:30 PM IST</li> </ul>  |
| 8)  | Technical bid presentation by eligible bidders | Presentation on the technical content from individual bidder : 13 <sup>th</sup> July 2019 at 4:00  |
| 9)  | Date of opening of Financial bids (Cover 3)    | <p>The financial Bids (Cover-3) of only those Bidders who met the eligibility criteria and satisfy the technical requirements and prequalified technically based on the evaluation of technical Bid-Cover 2, opened at date and time intimated in due course of time. Such intimation shall be heard only in the website and by mails to the successful bidders.</p> <p>On the date and time fixed for the opening of financial bids (Cover-3) the sealed cover containing the price Bids of all the Bidders who participated in the tender and financial bids of only those technically qualified Bidders alone shall be opened in the presence of those Bidders who wish to participate.</p> |
| 10) | Validity of offer:                             | 90 days from the date of opening. Eligibility criteria   |
| 11) | Method of submission of tender:                | Three bid system (Technical and Financial bid)   |
| 12) | Technical Clarification to be obtained from:   | Email.: <a href="mailto:ntcpwc@iitm.ac.in">ntcpwc@iitm.ac.in</a><br>Dr.V.Sriram - 044 22574813   |
| 13) | Cost of Tender document                        | Nil  |
| 14) | Tender Inviting Authority:                     | Senior Manager, Project Purchase,<br>IC & SR building 2 <sup>nd</sup> floor,<br>IIT Madras,<br>Chennai- 600 036, Tamil Nadu  |
| 15) | <b>Important Instructions</b>                  | <b>Bidders shall note that their offer should be only quoted in the BoQ attached to the tender and should be without any alterations, additions or deletion. In case the BoQ is found to be altered , the tender will be considered as defective and is liable to be rejected.</b>   |

## SECTION -I

### INSTRUCTION TO BIDDERS

#### 1.1 General:

Sealed competitive bids under "Three stage system" are invited for the "Supply, Installation and Integration of portable multi-axis servo system wavemaker for the large scale shallow wave basin at NTCPWC".

#### 1.2 Scope of work:

Detailed scope of work is elaborated under Section-III of this document

1.3 Cost of Tender document : Nil

1.4 EARNEST MONEY DEPOSIT (EMD) : 4,00,000/- (Rupees FOUR LAKH only) in the form of DD drawn in favour of "The Registrar, IIT Madras, Chennai" issued by any Nationalized / or commercial bank. The DD shall be submitted along with the technical bid only, failing which the tender shall be summarily rejected.

#### 1.5 Schedule date for Receipt and Opening of Bids:

- a) Last date and time for receipt of bids : 1.00 PM IST on 3<sup>rd</sup> July. 2019
- b) Date and time for opening of bids : 2:30 PM IST on 3<sup>rd</sup> July 2019

**Note: If the above due date falls on a holiday, the schedule times for (a) & (b) above shall be the same time on the subsequent working day.**

#### 1.6 Submission of Tender:

1.6.1 Tender should be furnished in sealed cover, super-scribed as "Portable Multi-axis servo wavemaker for the large-scale shallow wave basin at NTCPWC" and forwarded to

**Senior Manager, Project Purchase,  
IC & SR building 2<sup>nd</sup> floor,  
IIT Madras, Chennai- 600 036, Tamil Nadu**

1.6.2 The Bidders have the option of submitting the bid either by Registered post or by Courier or in person, and it shall be ensured that the bids are received at the office of the employer indicated above, on the date and time indicated in the Sl.No.1.5 above.

1.6.3 Bids submitted by Telex/ Fax/ Telegram/e-mail etc. will not be accepted.

#### 1.7 Opening of Tender

The tenders will be opened at 2:30 PM IST on 3<sup>RD</sup> JULY, 2019, at the address mentioned in sl.no 6- Invitation to bid on the due date and time mentioned in the pre paragraph, in the presence of the tenderers who wish to participate in the tender opening. If the due date for tender opening happens to be a holiday, the tenders will be opened on the next working day at the same time.

On the date and time fixed for opening of the tender the main cover and cover I alone will be opened in the presence of the tenderers who wish to participate. The financial Bid (Cover 3) of all the Bidders who participated in the tender shall be placed in a separate cover, unopened in the presence of the Bidders participated the Bid opening and sealed.

The financial bids of the bidders who fail to qualify in Technical evaluation will be returned unopened.

The representatives of the Bidders, attending the opening of tenders, should be duly authorized by the participating firm, whom they represent.

If any tenderer has doubt about the meaning of any portion of this tender and/or wish to seek any further clarifications on this Tender, they may address the Tender Inviting authority at least three days prior to the scheduled date of opening of the tender. Clarifications sought after this deadline will not be entertained.

### **1.8 Tender Inviting Authority**

Senior Manager, Project Purchase,  
IC & SR building 2<sup>nd</sup> floor,  
IIT Madras,  
Chennai- 600 036, Tamil Nadu

**SECTION – II**  
**COMMERCIAL AND TECHNICAL CONDITIONS**

**2.1 GENERAL**

The scope of services shall be as detailed in Section - III of this tender

**2.2 COMPLETENESS OF TENDER**

All information in the bid shall be in ENGLISH only. All corrections, over typing etc. in the tender should be attested.

Tenderers are advised to send their bids sufficiently early so as to ensure that the tenders reach this office in time. Tenders though posted in time but received after the due date and time will not be considered.

The Bids submitted by the Tenderers shall be complete in all respects. The tenderers are required to furnish all details called for, under various schedules along with relevant supporting documents, wherever required, for consideration by NTCPWC. The tenders not containing the complete details as required in this document are liable to be rejected.

**2.3. PRICE**

Tenderers shall quote a FIRM price only. They shall quote rates and amounts separately for each item in the respective schedule as prescribed in the Bill of Quantities.

**2.4 VALIDITY OF TENDER**

Tenders should be valid for a period of **Ninety (90) days** from the date of tender opening. In case any bidder who quotes only a shorter validity period than that called for, their offer will be liable for rejection. In exceptional circumstances, the authority may solicit the bidder's consent to extend the period of the validity. The request and response there to in such cases shall be made in writing (including mail).

**2.5 PERFORMANCE BANK GUARANTEE**

The successful bidder shall submit Performance Bank guarantee for an amount equivalent to 10% of the value of the contract. The performance Bank Guarantee shall be furnished as per the format attached.

In case the successful bidder wishes to submit Bank Guarantee (BG) towards performance obligations viz. Performance Bank Guarantee, the BG should be routed through Beneficiary bank to the end user bank. The Bank Guarantee should remain valid for a period of sixty days beyond the date of completion of all contractual obligations of the contractor.

**ONLY AFTER SUBMISSION OF PERFORMANCE SECURITY, THE CONTRACT AGREEMENT SHALL BE EXECUTED AND ANY PAYMENT UNDER THIS AGREEMENT SHALL BE RELEASED.**

### **2.6.1 BIDDER ELIGIBILITY CRITERIA (COVER-1)**

- Only Original Equipment Manufacturer (OEM) or their subsidiary of OEM of servo motors, drive and controller around the globe with five years of market existence in India are eligible to participate in the tender.
- The OEM should have an Indian support services/office in India with five years of its existence.
- The OEM products should have been supplied to Multi-Element Wave maker (MEWM) application. Proof either in the form of certificates from the end users and/or a confirmation by the OEM themselves along with printed literature. The purchaser may opt to check the genuine of the certificate through authorised sources. MEWM means individual servo axis control to generate multi-directional waves.
- OEM's application/support/service office in India should have the capability to establish the linear displacement control for the wave generation application for the proposed wave basin at NTCPWC, IITM-Thaiyur campus. Proof for having installed the linear displacement control in India for any other application should be provided.
- Dealers/Channel partners/System integrators/ Agents are not allowed to participate in the tender. The entire installation should be under the direct supervision of the OEM. NTCPWC will never entertain any other person apart from OEM persons.
- The bidder is required to submit a suitable documentation to substantiate that they are an authorised person of the equipment, having their registered office in India of the goods being procured.
- An organizational document, board resolution or its equivalent or power of attorney specifying the representative's authority to sign the bid on behalf of, and legally bind, the bidder.
- Important : To substantiate the claims for having satisfied the eligibility criteria the bidders shall produce all relevant documents, more particularly the documents mentioned above, either in "original" or duly "Notarized".

### **2.6.2 TENDER CONDITIONS**

Open tender with three stage bidding system viz., (i) Eligibility criteria (ii) Technical bid (iii) Financial bids are invited under this proposal. Individual closed and sealed cover for the above three stages should be placed in a main cover, stamped and sealed and be submitted as per check list/template in Form I-IV.

Based on the eligibility and technical scrutiny, the tender will be normally allotted to L1 bidder.

In order to evaluate the technical content, IIT Madras will call for the presentations to know or get clarified for their bidder architecture as per schedule provided in section 1.

Initially, in phase 1, the L1 bidder should demonstrate the working capability of one module for their proposed architecture. IIT Madras will procure only one (1) module initially. However the quote should be valid for the complete system.

Based on the outcome and satisfaction of the IIT Madras in Phase 1, remaining 18 modules with an additional 1 module as 'spare' (optional) will be ordered. The phase I should be completed within 3 months from the release of PO. The decision will be taken to order the remaining modules within 1 month from the completion of phase I.

IIT Madras reserves the right to cancel the entire tender after phase 1 or any time during the project tenure, without assigning any reason. The tenderers shall note that the payment will be made for the actual work done (in-site) upto the date of termination/cancellation of the order without entitlement of any additional claim for reasons what so ever.

### **2.6.3 SCOPE OF THE SUPPLY**

**The wave generator system consists of nineteen modules of Linear transmission (refer Fig AIV 1, 2&3) each module requires eight numbers of motors and their respective systems/sub systems. Each such module require an electrical panel with respect to this the broad scope of the work covered under this tender includes but not limited to:**

1. Selection and supply of Servo motor -152 nos with 8 spares as per the specification. (Total 160 nos)
2. Selection and supply of servo drive for 19 module (each having 8 axis servo motors) – single or dual drive based on the bidder architecture, with one additional spares (Total 20 nos).
3. Selection and supply of Controller – single or multiple as per the conceptual design of bidder architecture.
4. Supply of all required accessories from PC outlet to Motor end (Cables, Spares, Encoders, Cooling fan, electrical connections inside, wiring etc), except Laptop/PC.
5. Integration and installation of all the above items.
6. Overall architecture for communication/integration for servo motor, drive, controller and the electrical panel as per the specification.
7. PLC Programming/Driver programming/ configuration for communication between controller and the IITM-Wave gen v1.0 software (that generates wave paddle signal). Further, incorporation of active absorption in the controller/driver as per our requirements.

### **2.7. PAYMENT TERMS**

80% payment for the product (Servo motor, drive, controller and other accessories) after its delivery at IITM. 10% after installation and 10% after successful completion. This holds for both phase I and complete executions.

### **2.8. FORCE MAJEURE**

**2.8.1** Neither the Contractor nor the Purchaser shall be considered in default in the performance of its obligations hereunder if such performance is prevented or delayed for any causes beyond the reasonable control of the party affected, such as war, hostilities, revolution, riot, civil commotion, epidemic, major fires, explosions, floods, earthquakes or because of any law, order, proclamatory regulations or ordinance of Government or because of any act of God, provided notice in writing of such cause with necessary evidence that the obligation under the Contract is thereby affected or prevented or delayed, is given within 14 days from the happening of the event and in any case it is not possible to serve the notice within 14 days period, then within the shortest possible period without delay. In case the Force

Majeure conditions extend beyond a continuous period of 6 months, the Employer shall be entitled to decide the further course of action including revisions to the terms of Contract, if any.

- As soon as the cause of Force Majeure has been removed, the party whose ability to perform its obligation has been affected shall notify the other party the actual delay occurred on account of such activities.

**2.8.2** Although the time for completion of work shall be suitably extended (not exceeding the period during which the work was stopped on account of Force Majeure clause), such extension shall not result in any financial claim by the Contractor against the Employer or any account of such a delay for any other reason whatsoever.

## **2.9 TAXES**

The price quoted for each item of work shall be firm and inclusive of all costs of mobilization, labour, Material, Fuel, Transportation, consumables, demobilization and other contingent and / or incidental works required for completion of any particular item of work in all respects. The tenderer, however, quote separately the duties and taxes and / or GST as applicable. The rate quoted shall be exclusive of all duties and taxes and or GST which shall be paid by NTCPWC directly or reimbursed to the contractor at actual if they are directed to pay. This work is eligible for concession of 5% GST under research facility.

## **2.10 LIQUIDATED DAMAGES:-**

If the supplier fails to complete the scope of the tender, within the period specified by the NTCPWC and / or the supplier deserted the work or delayed the work for reasons solely attributable to them, the NTCPWC shall levy the liquidated damage (not by way of penalty) at the rate of 0.5% of the total purchase value per week or part thereof subject to maximum of 10% of overall contract value. If the work has been abandoned or quality of the product supplied is not upto the satisfaction of the NTCPWC, the NTCPWC shall also reserve its rights to terminate the contract after giving 10 days notice , in addition of levying the Liquidated damage and forfeiting the performance Bank Guarantee. The decision of the NTCPWC in this regard is final and binding on the contractor.

## **2.11 JURISDICTION FOR LEGAL PROCEEDINGS**

No suit or any proceedings in regard to any matter arising in any respect under this contract shall be instituted in a Court Save in the City Civil Court of Chennai or the Courts of Small Causes at Chennai. It is agreed that no other courts shall have jurisdiction to entertain any suit or proceedings even though part of the cause of action might arise within their jurisdiction. In case any part of cause of action arises within the jurisdiction of any of the courts in Tamil Nadu and not in the courts in the Chennai City, it is agreed to between the parties that such suits or proceedings shall be instituted in a court within Tamil Nadu and no other court outside Tamil Nadu shall have jurisdiction, even though any part of the cause of action might arise within the jurisdiction of such courts.

**2.11.1** The tenderers should clearly indicate their acceptance or otherwise the terms and conditions of the tender in general and the following specific condition in particular.

- Specific acceptance of Board's terms of payment.



- Board's terms of Liquidated damages for delay in completion of work.
- Validity of tender.
- IIT Madras reserves the right to cancel/terminate the entire tender at any point in time.

If no indication is given by the tenderer in his offer, it is presumed that the tenderer is agreeable to the terms and conditions of IC & SR mentioned in the specification.

The bidders shall also furnish an undertaking, as per schedule furnished in Annexure-I, in a non-judicial stamp paper of value Rs.100/- confirming to their agreement to the conditions of this Tender.

## **2.12 ARBITRATION**

Arbitration is not applicable to this contract.

## **2.13 DEVIATIONS IN TENDER**

- Offers which conform to the specification without any deviation will be preferred. If the tenderer wishes to deviate from any of the terms and conditions, the same shall be mentioned clearly in cover 2 only and the acceptance or otherwise of the deviations shall be at the sole discretion of the Employer.
- Neither the content of BOQ can be altered nor any new conditions can be stipulated in the financial Bid (Cover 3)

## **2.14. NTCPWC, IIT MADRAS RESERVES THE RIGHT**

- Order the whole or any part of the tender or partition of the quantity after implementation of phase work and/or reject it in full without assigning any reason.
- To relax or waive any of the conditions stipulated in the tender specification as deemed necessary in the best interest of the project for good and sufficient reasons.
- To revise the quantum of works/completion period of work of any or all the items covered by this enquiry during the pendency of contract and to terminate the contract in between the agreed stipulated period.

## **2.15. EVALUATION AND COMPARISON OF TENDER OFFERS**

- The evaluation of the Tender will be done as per IIT Madras guidelines for IC & SR.
- The evaluation shall include contract value of works with applicable sales/service tax, etc.,
- In case of discrepancy between the prices quoted in words and in figures, the lower of the two shall be considered.
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## SECTION – III

### TECHNICAL SPECIFICATION

#### **3.0.Introduction**

NTCPWC invites bids from the eligible tenderers for the supply, installation, integration and training for the proposed wave generation system in the upcoming shallow wave basin facility at NTCPWC, IITM Thaiyur campus. This will become one of the worlds largest facility with the proposed wave basin size of 90m (Length) x 60m (Width) x 1.1m (height) for the wave generation as shown in Annexure III. Wave generation system inter-alia covers the following,

- Capable to generate waves with inhouse IITM-WaveGen Software, and the position information (with maximum velocity and acceleration limit should be pre-set) shall be provided by IITM. The bidder should suggest the suitable control logic and implement the same.
- A portable module of wave generator consists of 8 no's of servo motors, servo drive and suitable controller with required accessories including encoder, cooling fan, cables etc.
- In all 19 such portable modules as required above will leads to 152 nos of servo motors and other accessories (Considering 60m side of the wave flume) with an additional module (8 no's) as spare.
- Wave Paddle width for each servo mechanism is 0.4m, therefore each module (8 servo actuator) will have a length of 3.2m.
- Installation, Integration of the supplied items and electrical connections are also under the present scope. (The product component involves all the items from PC outlet to Motor end, except supply of PC/Laptop.)

#### **3.1. Operating modes**

- Based on the requirements of proposed wave basin, the servo system to be operated with the following operating modes.

| Sl.no   | No of modules | No of axis |
|---------|---------------|------------|
| Mode- 1 | 1             | 8          |
| Mode-2  | 3             | 24         |
| Mode-3  | 8             | 64         |
| Mode-4  | 7             | 56         |
| Spare   |               | 8          |

The wave generation system should have the capability to be executed separately/individually or operated in any 2 or three group or all together simultaneously. The bidder architecture should adhere to the operating mode indicated.

### 3.2. Wave Generating System

In order to obtain the required wave characteristics as shown in Fig.1, the multi module electrical servo system is proposed. The Fig.1. is for the uni-direction wave generations, which can be taken for the design. The proposed wave basin comprised of 152 axis of such servo system as mentioned in section 1.0. The electrical servo system includes but not limited to:

- Servo motor with accessories.
- Servo drive with accessories.
- Servo Controller with accessories.
- Electrical panel that fits servo drive, controller and other switches.

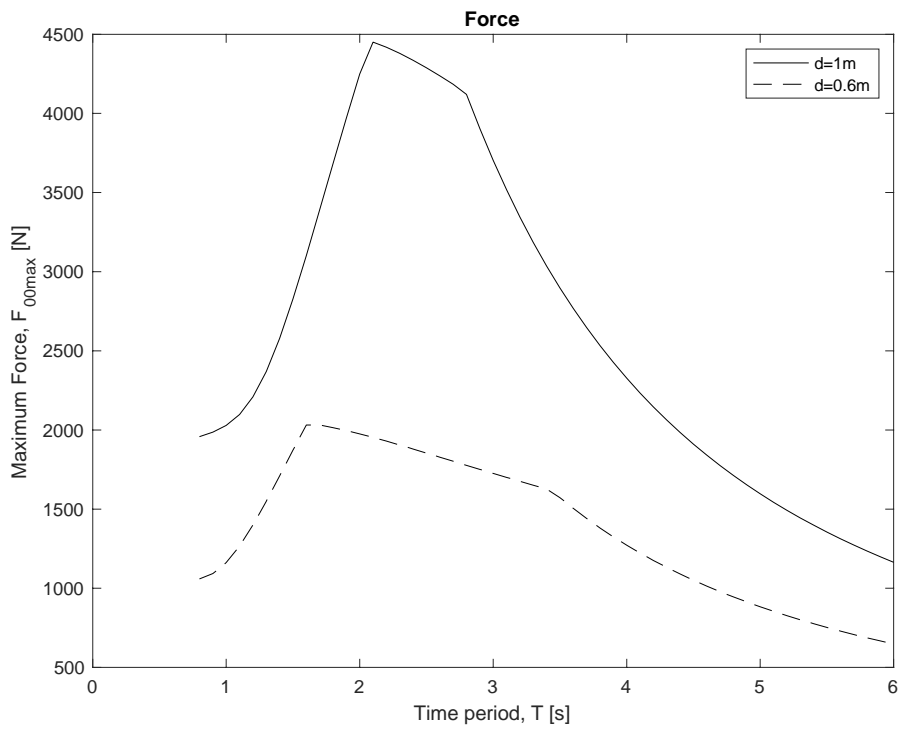
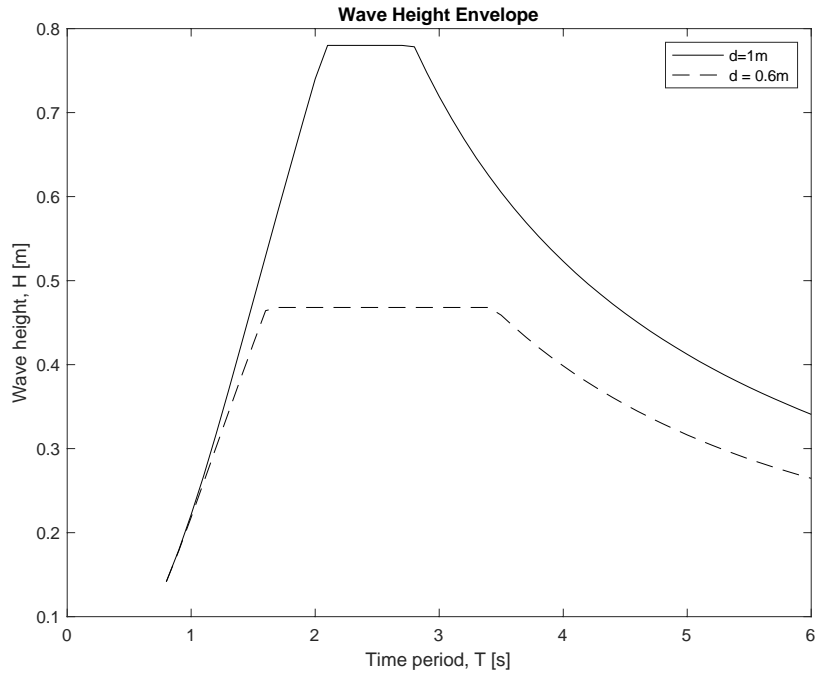
### 3.3 Servo motor

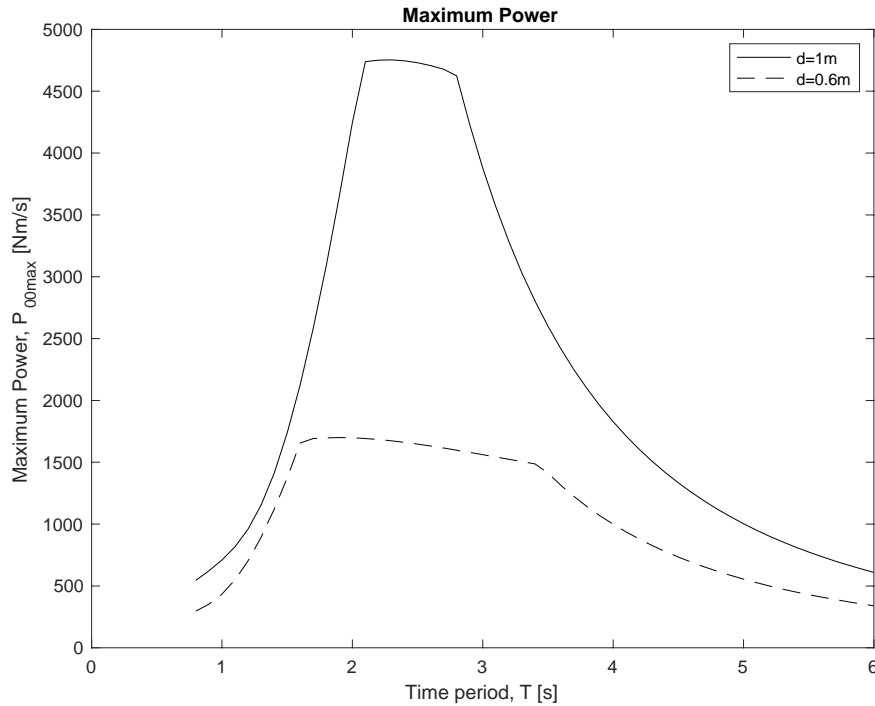
Servo motor is required for the precise linear motion of the wave generation. For this application, the bidder architecture can have single or multi axis servo motors. The servo motor should have the maximum capacity to generate the force/velocity/accelerations with respect to various wave period as shown in Fig. 1 with the broad specifications of the motor as given in Table 1. The Servo motor should have a feature with an inbuilt digital encoder fitted on the shaft. This encoder should sense the linear position as well as the linear velocity of the shaft and feedback to the controller.

**Table.1-Specifications of the Servo motor**

| Sl.no | Parameter                | Rating / Range  |
|-------|--------------------------|---|
| 1     | Type                     | Three phase Permanent Magnet Synchronous Servo Motor (with or without Gear up to the bidder to decide)                        |
| 2     | Max. Speed               | 6000 rpm (Without inbuilt/External gear) at output shaft<br>Max. Velocity is 2m/s and Max. Acceleration is 40m/s <sup>2</sup> |
| 3     | Torque                   | * To be estimated from Fig. 1 and Fig AIV 5   |
| 4     | Brake torque             | Electrical release based on Fig. 1 – Force curve.   |
| 5     | Max. Current             | To be specified by the bidder.  |
| 6     | Type of cooling          | Fan, constant speed   |
| 7     | IP                       | Motor-IP65 or better  |
| 8     | Connector/s              | Suitable power connection & Encoder connection<br>(Or)<br>Single integrated connector for both input power and encoder        |
| 9     | Shaft material           | Stainless steel   |
| 10    | Enclosure                | Aluminum or better  |
| 11    | Winding material         | Insulated copper  |
| 12    | Weight-max               | < 5 kg  |
| 13    | Shaft length / Diameter  | 30-60mm / 9-20 mm diameter  |
| 14    | Mounting                 | Flange mounting   |
| 15    | Cooling fan power supply | 230V AC/24V DC  |
| 16    | Insulation class         | Class F or better   |

Note: The bidder offers confirming to the minimum threshold criteria specified above and/or with any high end specification as per the bidder architect design alone shall be considered. However, please be informed that no extra preference shall be given for high end specifications.





**Fig.1. Required capability of the wave generation system for the width of 0.4m paddle. The maximum velocity required is 2m/s and maximum acceleration is 50m/s<sup>2</sup>**

### 3.4 Servo controller

Real time commands from the Graphical user interface (GUI) of the IITM-Wavegen installed in a PC/laptop will be executed by the controller to generate waves. The required instantaneous wave heights, periods and wave types are given as input through the Graphical user interface (GUI), based on that position/stroke time series will be generated. The controller should communicate with the continuous control reference to the servo drive using an internal PID loop. The communication of the data from PC to Controller should be through Ethernet only, this is to isolate the electric/power noise from external source. The controller and single axis driver should be placed inside an electrical panel and will be mounted above the portable wave module. The proposed servo controller hardware are provided in Table 2.

**Table.2- Specification of the Controller**

| Sl.no | Parameter                             | Rating / Range  |
|-------|---------------------------------------|---|
| 1     | Controller Hardware                   | Single or Multi axis- On board Multi ethernet, multi encoder, Engineering port I/O extension digital/ analog. |
| 2     | Communication Protocol                | SERCOS/<br>EtherCAT/FINS/SINEC/MELSEC/PROFINET/Ethernet   |
| 3     | Opensource development platform (OPC) | CoDesys/Visual studio/LabVIEW/MATLAB  |
| 4     | Firmware                              | Upgraded/Latest version of the firmware for closed loop synchronization                                       |
| 5     | EMC standard                          | IEC 61800-3 / EN 61800-3  |

Note: The bidder offers confirming to the minimum threshold criteria specified above and/or with any high end specification as per the bidder architect design alone shall be considered. However, please be informed that no extra preference shall be given for high end specifications.

### 3.5. Servo drive

Driver comprises of the converter, which converts three phase AC input to DC, a DC regulator cum filter and a PWM based inverter. The PWM inverter takes input from the DC link and supplies the three phase controlled supply to the servo motor. The drive should have following operational modes.

- Velocity
- Displacement
- Torque/ Force

The bidder needs to provide, which operational mode or control logic their proposed configuration. Please keep that IITM wavegen software gives only position and it expects linear position (not angular position) feedback. The details of the proposed driver are listed in Table 3. The driver gets the control reference from the controller in order to obtain the required wave generation.

**Table.3 Specification for the servo drive**

| Sl.no | Parameter     | Rating / Range  |
|-------|---------------|---|
| 1     | Type          | Single or dual/multi axis Servo drive   |
| 2     | Configuration | Within a module, the drives should utilize common DC bus facility to the maximum extent.  |
| 3     | Input Voltage | Three phase , 415V (Ph-Ph)  |
| 4     | I/O           | 2 Analog input/output channels and 2 Digital input / output channels<br>(Not required - if dedicated Analog & Digital input/output channels are provided at the controller end) |
| 5     | Accessories   | 5m standard power cum encoder/Power and encoder cable/s   |
| 6     | IP class      | IP 20   |

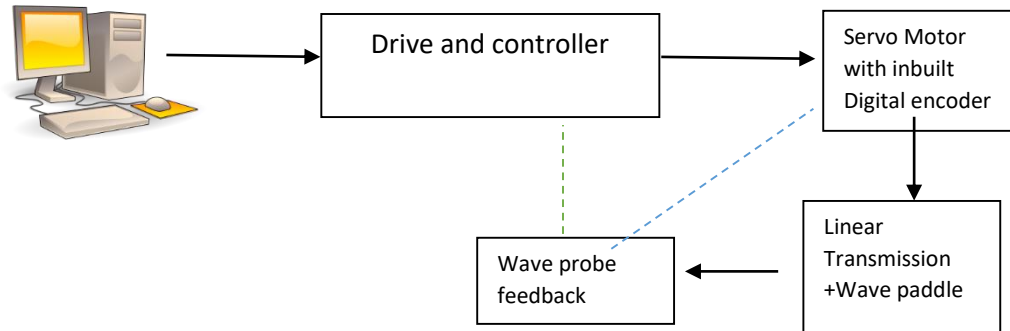
Note: The bidder offers confirming to the minimum threshold criteria specified above and/or with any high end specification as per the bidder architect design alone shall be considered. However, please be informed that no extra preference shall be given for high end specifications.

The shaft of the motor should have the provision to accommodate an Encoder for the precise feedback control. The feedback preferably in terms of displacement.

### 3.6 Overall system (Wavemaker) Architecture

The bidder has to propose the suitable architecture. The technical proposal will be evaluated based on the architecture design with respect to communications, optimum and efficient use of the controller and drive with the chosen model capability, the synchronisation speed of communications to all the 152 servo axis and time lag. In general, the input signal will be given to the controller through a customised Graphical User Interface (GUI) from IITM-WAVEGEN v.1.0 installed in a Personal Computer/Laptop. The bidder need to integrate this signal with the drive configurations using PLC coding or suitable protocol. The overall sample architecture is

shown in Fig. 3. In Fig. 3, linear Transmission and wave paddle is not the scope of the present tender.



**Fig.3. Electric Wavemaker Architecture**

The wave paddle will have a width 0.4m driven by an servo motor through a linear transmission. The controller should also has the pre-programmed interlocks to prevent the malfunctioning as mentioned below,

- Limit switches (2' nos) - Enables brake/Trip the Power supply/Trigger stop command to driver.
- Over current protection- Programmed on driver to prevent hardware failures.
- Over Voltage protection- Programmed on driver to prevent hardware failures.
- Under/Over Frequency protection- Programmed to Protect during DG operations.
- Over load/torque – programmed on driver to prevent mechanical failures.

### **3.7. Electrical Panel or Control Panel**

Nineteen numbers of electrical panel and its accessories such as electrical switchgears, power cables, and instrumentation cables, terminal blocks, panel cooling fans, auxiliary power supply and so on, as per the bidder specifications. This need to be integrated, labelled and installed by the bidder. The bidder should provide the internal assembly and general assembly drawings to NTCPWC/IIT Madras for its approval before installation.

### **3.8. Mechanical Arrangements and Linear transmission details**

The mechanical and linear transmission is designed in such a way that the motor will not take any additional load apart from the dynamic force/moving force of the water column due to the wave paddle. This is explained below with the conceptual layout provided in the Annexure IV. The isometric views of the mechanical arrangements of the mobile supporting structure for motor location, linear transmission guide and wave paddle are shown in Fig. AIV.1 and AIV.2. The size of the mobile supporting structure is 3m x 1.5m x 1.6m with 6 column and cross bracing on sides and rear end. The front portion will not have any cross bracing. The free body diagram and the deflection shape shows that the proposed designed configuration is safe, see Fig. AIV.3. The proposed linear transmission uses rack and pinion arrangement with the pitch of approx. 20mm and lead is 125mm. The size of the rack is 26mm x23mm (approx.) solid aluminium block. The rack is attached to monorail system with hollow block of size 10cm x

10cm with 5mm thick SS material. This monorail system is connected to the wave paddle. The wave paddle is made of aluminium alloy of grade 6061 with maximum weight of 7kg/ paddle can be considered for the design. The wave paddle in the isometric view is conceptually depicted as box section, however, the weight will be reduced by cutting and attaching suitable stiffeners. The width of the wave paddle is 40cm inclusive of 1mm gap between the wave paddles. This would correspond to 3.2m size. The wave paddle also has the inclined membrane with 3cm diameter rod and is connected to the monorail system and it is free to move inside the mobile structure. The motor will be vertical mounted and it will be fully supported on the plate provided and its weight will not be transferred to the linear transmission guide. This linear transmission guide will be placed below the plate with suitable supporting structure. The linear transmission guide will also have supporting guide. The details are provided in the Fig. AIV.4 and AIV.5 for shaft to rack distance. The driver and controller for the motors will be kept on the electrical panel mounted on each mobile structure. Thus, the complete system can be moved at locations and can be operated by simply connecting the Ethernet cable to the Laptop/PC. The complete structure is easily movable as the weight will be less than 1.5 T.

### 3.9. Specification test

The following specifications test should be demonstrated by the bidder in Phase I as well as during the complete installations.

1. The motion of the provided signal profile from the IITM-WaveGen for various wave period and wave heights (regular, random, multi-directional) should be demonstrated with the motor feedback. Different individual axis signal will be provided. Precision required is <1mm.
2. Working capability during sudden power cut/exceeding stroke/velocity/accelerations/limit switches/force/torque.
3. Minimum time lag between the individual axis should be less than 0.0s and the same will be measured using external sensor. Further, the final displacements by the wave paddle will also be measured by the external sensors for verification. The external sensors and DAQ will be provided by us.
4. Operation capability for solitary profile, focusing wave profile (generated from IITM-WaveGen). See Appendix V.
5. The command (Displacement and time) from the IITM-Wavegen software and the process variables will be read from the drive (drive OEM software) during wave generation.

### 3.9. Tender Technical Evaluation sheet ---- (COVER-2)

| Sl.no | Parameter               | Rating / Range  | Yes/No |
|-------|-------------------------|---|--------|
| 1     | Type                    | Three phase Permanent Magnet Synchronous Servo Motor (with or without Gear up to the bidder to decide)                  |        |
| 2     | Quantity of servo motor | 152 & 8 spare (160 no's in total)   |        |
| 3     | Max. Speed              | 6000 rpm (Nominal) (Without inbuilt/External gear)<br>Max. velocity is 2m/s and Max. acceleration is 40m/s <sup>2</sup> |        |



|     |   |   |  |
|-----|---|---|--|
| 4   | Voltage   | 400V/ 600V  |  |
| 5   | Maximum Torque  | <b>To be mentioned by the bidder</b>  |  |
| 6   | Brake torque  | Electrical release based on Fig. 1 Force.   |  |
| 7   | Max. Current  | <b>To be mentioned by the bidder</b>  |  |
| 8   | Encoder   | Multiturn hyperface with 128 signal periods   |  |
| 9   | Type of cooling   | Axial fan (optional)  |  |
| 10  | IP  | Motor-IP56 or better  |  |
| 11  | Connector/s   | Suitable power connection &<br>Encoder connection<br>(Or)<br>Single integrated connector for both input power and encoder   |  |
| 12  | Shaft material  | Stainless steel   |  |
| 13  | Enclosure   | Aluminum or better  |  |
| 14  | Winding material  | Insulated copper  |  |
| 15  | Weight-max  | < 5kg   |  |
| 16  | Shaft length / Diameter   | 30-60mm / 9-20 mm diameter  |  |
| 17  | Mounting  | Flange mounting   |  |
| 18  | Cooling fan power supply  | 230V AC/24V DC  |  |
| 19  | Insulation class  | Class F or better   |  |
| 20  | Controller Hardware   | Single or Multi axis- On board Multi ethernet, multi encoder, Engineering port I/O extension digital/ analog.   |  |
| 21  | Quantity of controllers   | <b>To be specified by the bidder as per the technical specification section 3.1 (Operating modes)</b>   |  |
| 22  | Communication Protocol  | SERCOS / EtherCAT/FINS/SINEC/MELSEC/PROFINET/Ethernet-IP  |  |
| 23  | Opensource protocols  | CoDesys/Visual studio/LabVIEW/MATLAB  |  |
| 24  | Firmware  | Upgraded/Latest version of the firmware for closed loop synchronization   |  |
| 25  | Type  | Single or dual/multi axis Servo drive   |  |
| 26  | Quantity of converters and inverter units                                     | <b>The number of converter units and inverter units<br/>To be Specified</b>   |  |
| 27  | Max current   | 36 A  |  |
| 28  | I/O   | Two Analog input/output channels and Two Digital input / output channels for each axis/motor/paddle. This should be available to be accessed via the controller logic.<br>(Not required - if dedicated Analog & Digital input/output channels are provided at the controller end) |  |
| 29  | Accessories   | 5m standard power cum encoder/Power and encoder cable/s   |  |
| 30  | IP class  | IP 20   |  |
| 31. | Training for the supplied product – troubleshooting guidelines to the NTCPCW. | Yes / No  |  |

|     |  |          |  |
|-----|--|----------|--|
| 32  | Know-how knowledge of the OEM in the wave generation capability and their product installed for MEWM. Proof supplied for their product as MEWM.                      | Yes / No |  |
| 33. | Reason provided for selection of servo motor configuration and compatibility of the requirement of the tender.   | Yes / No |  |
| 34. | Architecture of the communications/integrations. Mode of operations of the wave generation – synchronization/speed in communications/ failure switches are provided. | Yes / No |  |
| 35. | Reason for control logic for generating the waves has been provided.   | Yes / No |  |
| 36  | Reason for the optimum selection of the controllers/drive configuration for the operating modes.   | Yes / No |  |
| 37  | Acceptance of the specification tests  | Yes/No   |  |

**Note: The bidder shall enclose separate sheet if required to highlight their proposal to address each and every parameter, which will be duly considered for technical evaluation.**

### Declaration

I hereby certify that we can supply above items as per tender specification and I agreed tender terms and conditions

Company seal

Signature

Designation

**Form I: Checklist for Eligibility Criteria (separate COVER- 1 and sealed).**

1. Confirmation that servo motors, drive and controller is only from the Original Equipment Manufacturer (OEM). An undertaking from the authorised signatory of the OEM. The bidder is required to submit a suitable documentation to substantiate that they are an authorised person of the equipment, having their registered office in India of the goods being procured.
2. An organizational document, board resolution or its equivalent or power of attorney specifying the representative's authority to sign the bid on behalf of, and legally bind, the bidder.
3. Proof for atleast preceding last 5 years of existence in India. Company incorporation certificate, showing completion of minimum 5 years, balance sheet, P&L account.
4. Should have supplied servo system manufactured by the bidder to MEWM with details of place, end user etc.,.
5. Should have supplied servo system manufactured by the bidder in India for any other application, particularly linear displacement control.
6. OEM or its subsidiary of OEM are only eligible to participant. Dealers/Channel partners/System integrators/ Agents are not allowed to participate in the tender. The entire installation should be under the direct supervision of the the OEM. NTCPCWC will never entertain any other person apart from OEM persons.

All the above can be either in the form of certificates from the end users and/or a confirmation in the manner specified along with printed literature specifying the above details.

The documents shall be either in original or duly Notarized.

**Form II: Tender Conditions (This form should be in Technical bid cover).**

I) We \_\_\_\_\_ agree for the following conditions

- Initially, in phase 1, we will demonstrate the working capability of one (1) module through our proposed architecture. IIT Madras will release PO for one module initially, however the quote is valid for the complete system or any additional spare that will be ordered within 6 months after the release of PO. Taxes will be extra as per the prevailing rates of government policy.
- Based on the outcome and satisfaction of the IIT Madras in Phase 1, remaining 18 modules will be ordered in Phase 2. The additional spare is optional.
- The phase I should be completed within 3 months from the release of PO. We agree that the decision will be taken to order the remaining modules within 1 month after the completion of phase I.
- We will demonstrate the capability of our architecture in Phase 1, for the specification tests as listed in tender.
- IIT Madras is not committed to procure all the 152 axis servo motor/spare and accompanying accessories.
- IIT Madras reserves the right to cancel/terminate the order before or after phase 1, without assigning any reason.
- We will provide the necessary support for the product supplied during failures after installation within \_\_\_\_ hours/days/months in the warranty period and \_\_\_\_ hours/days/months after warranty period.

II) Confidentiality Provision :

We \_\_\_\_\_ understand that the proposed work is part of a research project undertaken by IITM/NTCPWC and the basic concept is developed by IIT-M through its inhouse capability. We also aware of the fact that our scope of work is limited to facilitate the success of the conceptional model for the electronic control of the multi-directional wave paddle.

In view of the above, we hereby solemnly affirm and undertake that the

- Concepts developed by IITM shall not be shared with any third party and not even in our future designs without a written confirmation from IITM.
- Knowledge and know-how gained out of this assignment shall be kept “confidential” and any violation to this effect shall tantamount to impeaching into the parents right.

Authorised Signatory of the OEM

### Form III: Template for Technical bid

The technical bid should contain the following minimum information, but not limited to,

1. Proposed System Architecture and a detailed description for opting/recommending to IITM.
2. Servo Motor Model number, detailed characteristics, loading capacities.
3. Servo Drive Model number, detailed characteristics.
4. Servo Controller Model number, detailed characteristics.
5. Integration protocol from the IITM-Wavegen software to your drive/controller. Detailed description about the control logic that will be implemented need to be speltout and specified. Preferbly, indepth details.
6. Financial bid format without specifying the amount.

**SECTION – IV**

**4.1 Bill of Quantities and Rates.**

**(Financial bid format) – (Cover-3)**

| Item No. | Item Description   | Unit | Quantity                          | Rate      |             |          |     |         |             |             |
|----------|--|------|-----------------------------------|-----------|-------------|----------|-----|---------|-------------|-------------|
|          |  |      |                                   | INR       |             |          | FE  |         |             |             |
|          |  |      |                                   | Ex-wor ks | Loc al cost | GS T (%) | CIP | Cus tom | Loc al cost | GS T (%)    |
| 1        | Servo Motors as per specification (Section 3.4)  |      | 152 & 8 spare (160 no's in total) |           |             |          |     |         |             |             |
| 2.       | Servo Controllers as per specification (Section 3.5)<br><br>(Quantity as per the bidder configuration & as per the tender specification) |      |                                   |           |             |          |     |         |             |             |
| 3.       | Servo drives as per specification (Section 3.6)<br><br>(Quantity as per the bidder configuration & as per the tender specification)      |      |                                   |           |             |          |     |         |             |             |
| 4.       | Other accessories (with detailed breakup)  |      |                                   |           |             |          |     |         |             |             |
| 5.       | Electric panel accessories as per OEM specification/Architecture (, e.g. electrical wire, limit switch, emergency stop etc.,)            |      |                                   |           |             |          |     |         |             |             |
| 6.       | Installation and services for the supplied items   |      |                                   |           |             |          |     |         |             |             |
| 7.       | Training to the NTCPWC on servo settings and troubleshooting after successful installation   |      |                                   |           |             |          |     |         |             | <b>FREE</b> |
|          | <b>Total</b>   |      |                                   |           |             |          |     |         |             |             |

**Note-**

- 1.The payment terms and conditions as mentioned in sections.**
- 2.Payment will be released against the supplied items as per the tender specification.**
- 3. L1 bidder will be decided based on the overall cost including all elements of payment made and ultimate landing cost to the IIT Exchequer.**
- 4. As it is a research facility under MoS, 5% GST should be considered for the product supplied as required.**

**Declaration**

I hereby certify that we can supply above items as per tender specification and I agreed tender terms and conditions

Company seal

Signature

Designation

**ANNEXURE-I**

**UNDERTAKING TOWARDS JURISDICTION FOR LEGAL PROCEEDINGS**

**(NON JUDICIAL STAMP PAPER VALUE RS.100/-)**

This undertaking executed at..... on this..... (Date)..... (Month) Two thousand and ..... by M/s ..... Registered under Companies Act, 1956 having its registered office at ..... hereinafter called the contractor (which expression shall where the context so admits mean and include its successors in office) and in favour of Indian Institute of Technology Madras, Chennai- 36. Hereinafter called the purchaser (which expression shall where the context so admits means and includes its successors if Office and assigns).

WHEREAS a contract for the supply of .....has been awarded in favour of the contractor under the Purchase order No.....dated.....

AND WHEREAS in accordance with the terms of the above Purchase order, the contractor has to furnish un undertaking to the effect that no suit or any proceedings in regard to any matter arising in any respect under this contract shall be instituted in any matter in any respect under this contract shall be instituted in any court other than in the High court, Madras of District court at ..... or Sub-court at .....or at the District Munsiff court at ..... as the case may be.

IN CONSIDERATION of the Board having agreed to accept the undertaking the contractor hereby undertakes that no suit or any proceedings in regard to any matter arising in respect of this contract shall be instituted in any court, save in the High court, Madras or District court at.....or sub court at ..... or at the District Munsiff court at .....as the case may be it is agreed that no other court shall have jurisdiction to entertain any suit or proceedings, even though, part of the cause of action might arise within their jurisdiction. In case any part of the cause of action might arise within the jurisdiction of any other Courts in Tamil Nadu and rest within the jurisdiction of Courts outside the State of Tamil Nadu, then it is agreed to between the parties that such suits on proceedings shall be instituted in a court within the State of Tamil Nadu and no other Court outside the State of Tamil Nadu shall have jurisdiction.

IN WITNESS WHEREOF Thiru.....of M/s ..... hereby put his hand and seal for due observance of the undertaking in the presence of the following witnesses.





## ANNEXURE-II

### **PROFORMA OF PERFORMANCE BANK GUARANTEE**

To  
Dear Sirs,

- 1.0 In consideration of the Indian Institute of Technology Madras, Chennai - 36 (hereinafter referred to as IITM. which expression shall unless repugnant to the context or meaning thereof be deemed to include their successor interest and assigns on the one part having awarded the deployment works in favour of having registered office at (hereinafter referred to as the CONTRACTOR), which expression shall unless repugnant to the context or meaning thereof include its successors, administrators, representatives and assigns, on the other part, by signing an agreement no. IITM/OED/.....on hereinafter referred as the AGREEMENT for the execution of the works on terms and conditions set out interalia in the AGREEMENT mentioned above as "CONTRACT" documents, valued at Rs. (Rupees ) the same having been unequivocally accepted by the CONTRACTOR and the CONTRACTOR having agreed to provide a performance bank guarantee for the obligations/liabilities under the contract equivalent to 10% of the said value of the Contract to the PURCHASER NIOT amounting to Rs..... (Rupees ) as Contract security in the form of a Bank Guarantee.
- 2.0. We hereinafter referred to as 'The Bank' which expression, shall unless repugnant to the context or meaning thereof, include its successors, administrators, representatives and assignees do hereby irrevocable guarantee and undertake to pay the PURCHASER IITM, MERELY STAMP PAPER WORTH OF Rs.100/- (NON-JUDICIAL) ON DEMAND WITHOUT any previous notice andwithout any demurand withoutreferring to any other source, any and all monies payable by the CONTRACTOR byreason of any breach by the said CONTRACTOR of any of the terms and conditions of the said CONTRACTOR including non-execution of the "CONTRACT AGREEMENT" to the extent of 10 % of the Contract price upto . Any such demand made by the Purchaser IITM on the Bank shall be conclusive and binding absolute and unequivocal not withstanding any difference between the IITM and the CONTRACTOR or any dispute or disputes raised/pending before any court, tribunal, Arbitrator or any other authority. The Bank agrees that the guarantee herein contained shall continue to be enforceable till this sum due to the IITM is fully paid and claims satisfied or till the IITM discharges this guarantee.
- 3.0 The Bank further irrevocably guarantees and undertakes to pay any and all monies due and payable by the CONTRACTOR by reasons of non-fulfillment of any of the following obligations.
- 3.1. In the event of failure by the CONTRACTOR to satisfactory execute the works meeting the schedule and in complying with the provisions of the agreement.
- 4.0. The IITM shall have the fullest liberty without affecting in any way the liability of the Bond under this guarantee, from time to time, to extend the time of performance by the CONTRACTOR. The bank shall not be released form its liabilities under these presents by any exercise of IITM of the liberty with reference to the matter aforesaid.

- 5.0. The IITM shall have the fullest liberty, without affecting this guarantee to postpone from time to time the exercise of any powers vested in them or of any right which they might have against the CONTRACTOR and to exercise the same at any time in any manner, and either to enforce or to forbear to enforce any covenants contained or implied in the agreement between IITM and the CONTRACTOR or any other course of remedy or security available the IITM and the bank shall not be released of its obligations / liabilities under these presents by any exercise by IITM of his liberty with reference to the matters aforesaid or any of them or by reasons of any other act of forbearance or other acts of omission or commission on the part of IITM or any other indulgence shown by IITM or by any other matter or thing whatsoever which under law would, but for this provision, have the effect of relieving the Bank Guarantee. The Bank further undertakes not to revoke this guarantee during its currency without the previous consent of IITM.
- 6.0 The Bank further agrees that the decision of IITM as to the failure on the part of the CONTRACTOR to fulfill their obligations as aforesaid and/or as to the amount payable by the Bank to IITM hereunder shall be final, conclusive and binding on the Bank.
- 7.0. The Bank also agrees that IITM shall be entitled at his option to enforce this guarantee against the Bank as a principal debtor, in the first instance notwithstanding any other security or guarantee that it may have relations to the CONTRACTOR'S liabilities.
- 8.0. This guarantee will not be discharge due to the change in the constitution of the Bank or the CONTRACTOR.
- 9.0. Notwithstanding anything contained hereinabove, our liability under this bank guarantee shall not exceed Rs. ( ). This bank guarantee shall be valid upto. It is a condition to our liability for payment of the guarantee amount or any part thereof arising under this bank guarantee that we receive a valid return claim or demand for payment under this bank guarantee on or before, failing which our liability under this bank guarantee will automatically cease.

WITNESS:-

1..... SIGNATURE.....  
 (Signature with name in block letters and (Printed Name)  
 with designation)

2..... Bank's Common Seal:-  
 (Signature with name in block letters and  
 with designation)

APPENDIX IV

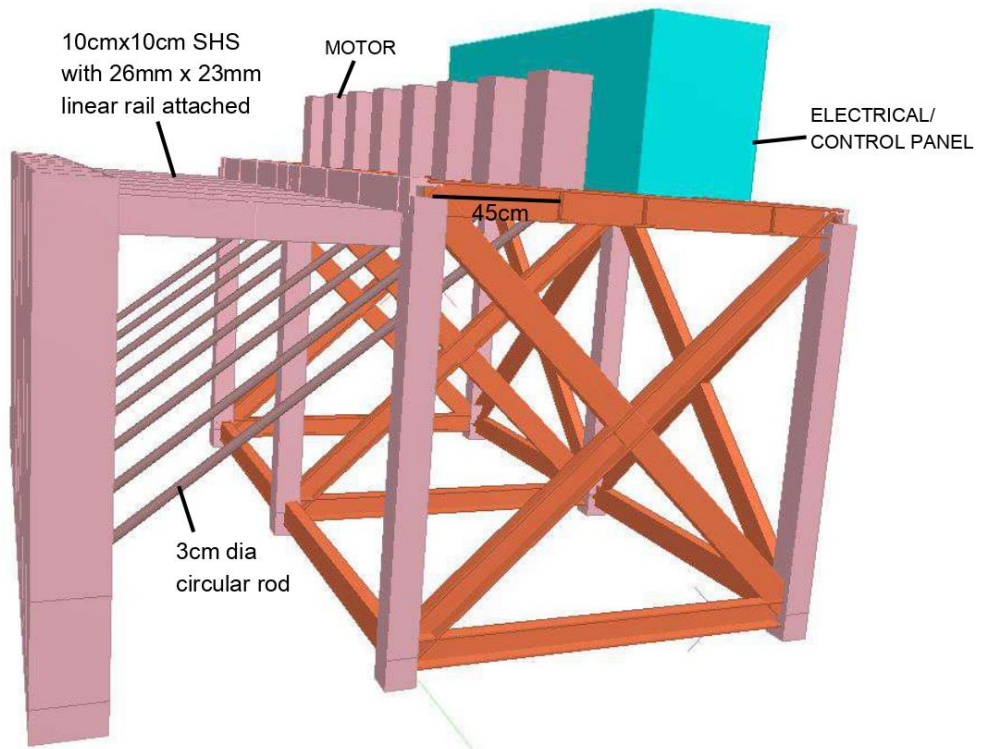
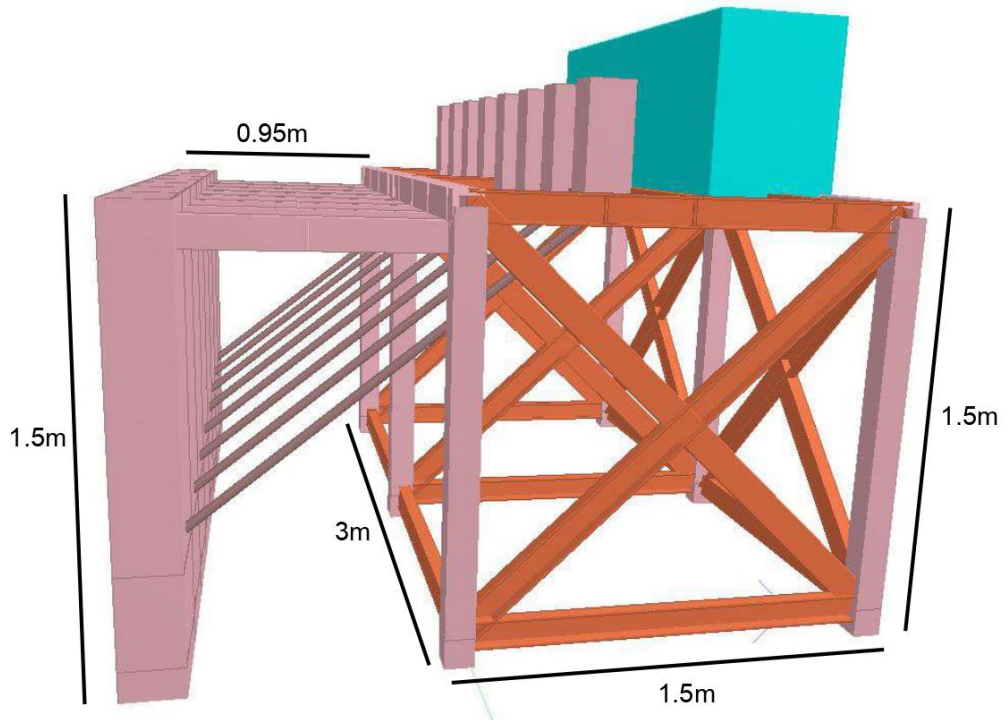


Fig.AIV.1. Isometric view of the modular sections having 8 wave paddle and linear transmission.

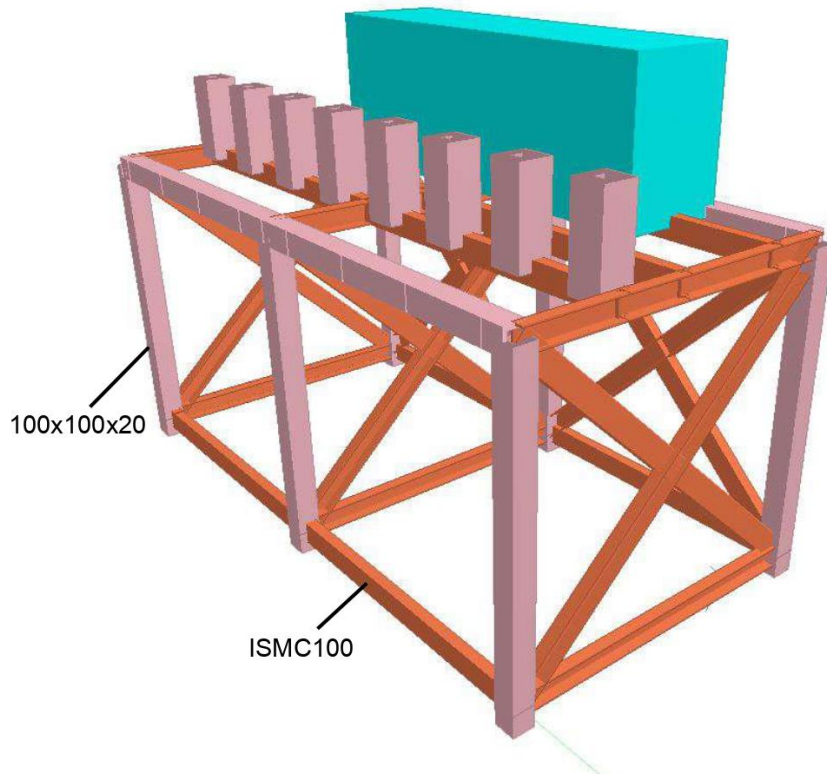


Fig.AIV.2. Isometric view of the modular support section.

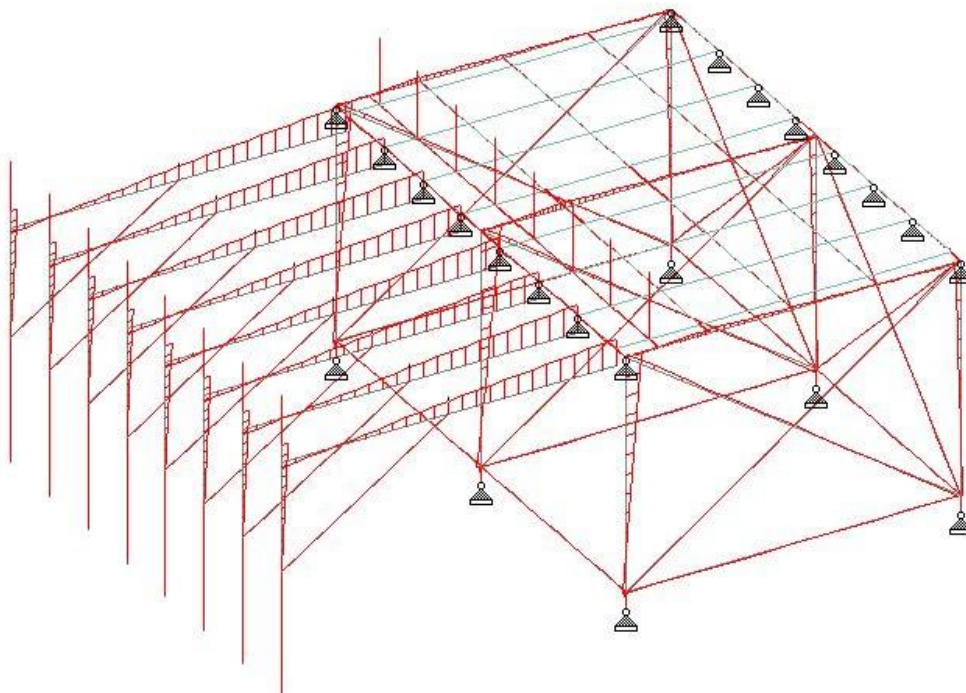


Fig. AIV.3. Free body diagram and loading conditions for the modular support with overhanging wave paddle. The deflection of the cantilever transmission is less than 5mm.

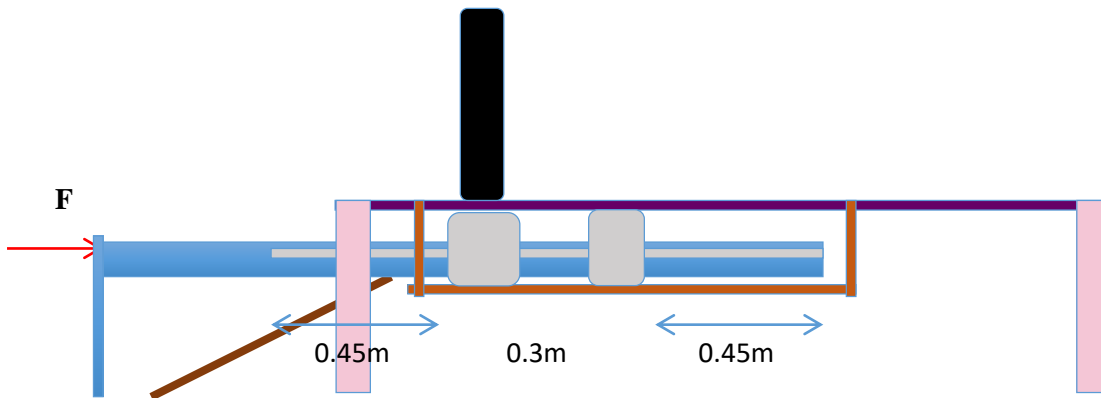


Fig. AIV.4. Linear Transmission arrangement (Conceptual view, not to scale)

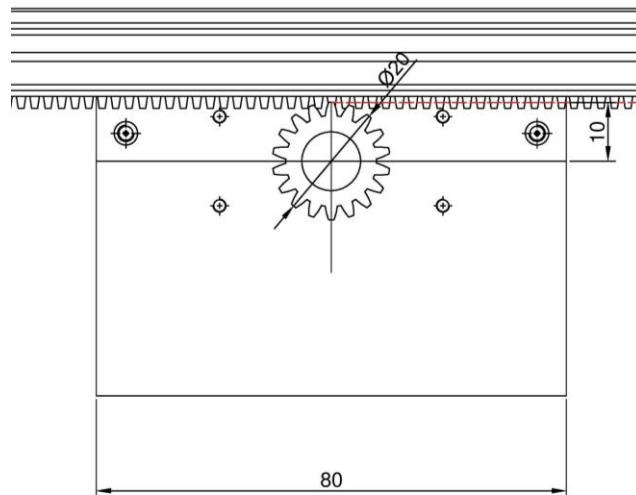
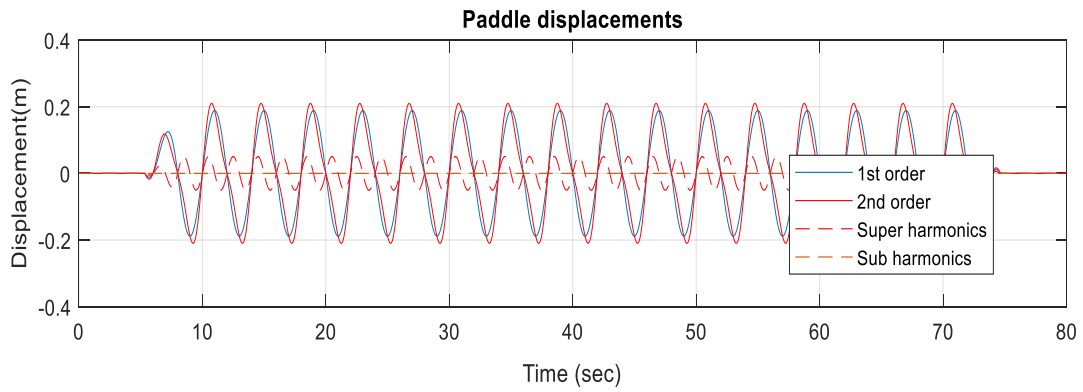


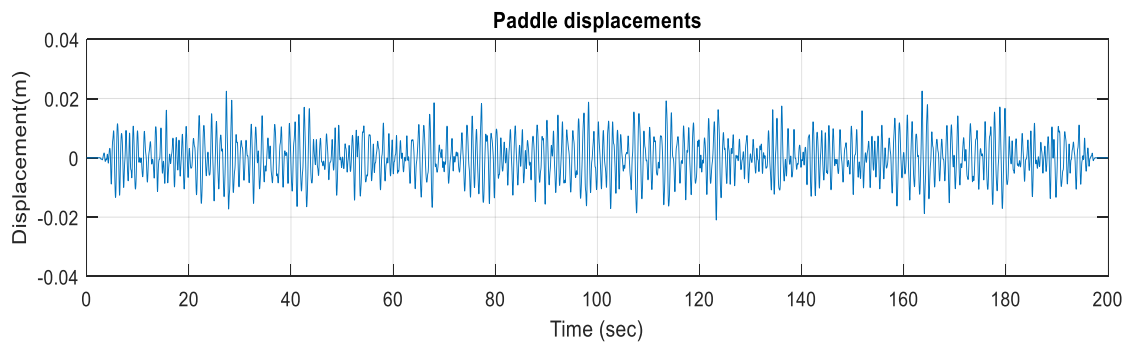
Fig. AIV.5. Linear Transmission details near shaft (all units in mm)

## APPENDIX V

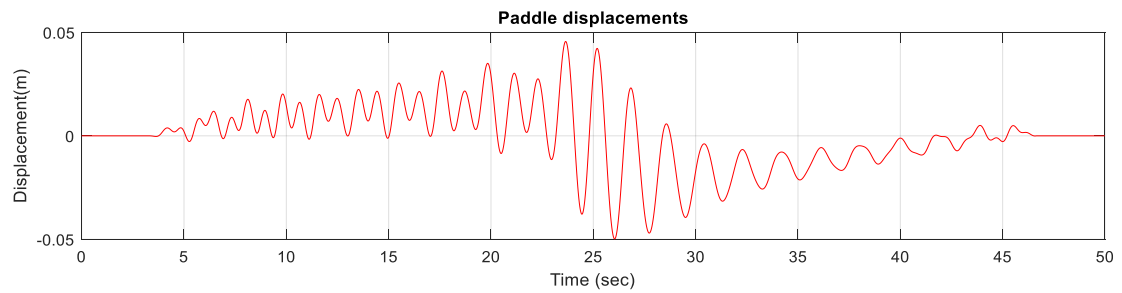
### Specification Test profiles that need to be generated



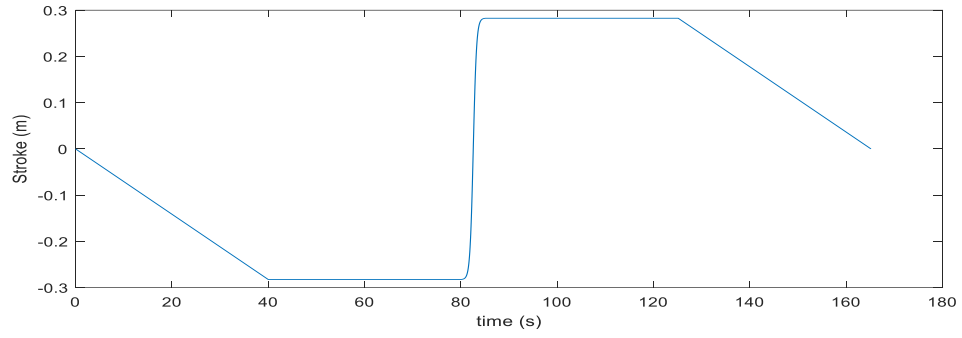
### Typical Regular Wave Profile



### Typical Random Wave Profile



### Typical Focusing Wave Profile



Typical Solitary Wave Profile

**APPENDIX III: NTCPWC Layout (PDF file attached separately)..**