

# **Vibrocoring Technique in the Nearshore Placer Exploration Programme along Konkan Coast, Maharashtra**

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## **ABSTRACT**

As a part of nearshore placer exploration along Konkan coast, Maharashtra (west coast of India) a detailed vibrocoring was carried out using different types of vibrocorers on vessels each equipped with different handling capabilities to map the subsurface zones of placer-rich sands. However, the results are average due to compact nature of sediments, which affected vibrocoring operations and operational limitations of the vessel to cover shallow water stations where most of the placer-rich sand exists. The problems faced during the operations are reviewed and some suggestions are put forth regarding potential modifications for increasing the efficiency of the equipment. An improved model is suggested with frames of two different sizes to tackle different operational water depths (3-8 m and 8-20 m). Special features of the suggested model are stabilizing fins mounted on the base frame to stabilize the vibrocorer against local currents; and an underwater winch for efficient pull-out of the core pipe from the sediment. Advantages gained by using pistons with either cup washers or 'O' rings together with shear pins and a core catcher with length of leaf 1.4 times the diameter of liner to collect undisturbed sediment are stated.

## **INTRODUCTION**

Offshore placer exploration in the nearshore areas along Konkan coast, Maharashtra, west coast of India was initiated in late 70's [9,10]. Till recently, most of the reserve estimation of the placers was based on surficial sediment's data and the thickness of placer-rich sediments was inferred either from seismic studies [7] or by extrapolating sand bed from coastal bore hole logs[9]. But due to lack of actual information about the concentration of minerals, etc. in placer-rich sands with depth, the reserve estimations done by the above methods appeared rather incomplete. Due to the finely sorted and compact nature of sands in this area, gravity/piston gravity coring resulted in very little penetration.

An indigenously developed electric vibrocorer was tried in the early 80's, but sample recovery was only about 25 cm. Subsequently, under a collaborative programme of National Institute of Oceanography, Goa, and Geological Survey of India (NIO-GSI), extensive vibrocoreing was carried out in some bays. During this programme, more than 100 vibrocore samples varying in length from 3 to 5 m were collected and studied for ilmenite content [11].

This paper, besides giving the results of a comparative study on the effectiveness of different types of vibrocorers used in this area, suggests a model of an improved vibrocorer, which can provide more accurate and undisturbed samples. The improved model can be interfaced with the available handling system, avoiding the need for a special vessel or expensive modifications.

## MATERIALS AND METHODS

### Vibrocorer

In vibrocoreing technique, an electric, pneumatic or hydraulic device is used to induce vibrations or hammering effect at the core cutter to penetrate through the seabed sediments [5,6]. Vibrocoreing works on the principle of liquefaction or fluidisation of fine grained sediments and displacing the sediments to allow passage of the core barrel into the sediment. By mounting the vibrating head perpendicular to the top of the core tube, a low amplitude (0.1-1.0 mm) standing wave is set up in the core tube [2-4].

The vibrocorer is required to operate in the minimum time and should have a configuration and size compatible with rapid launch and retrieval. The design of the system should consider a wave height of 1-2 m and current speeds of 4-6 knots.

The penetration is variable, depending on local stratigraphy and sediment type and is possible in most of the sediments with the exception of sand which has achieved its ultimate packing ratio [6]. The penetration depends upon the actual applied force, frequency and amplitude of vibration. At low frequency/high amplitude, the core tube is essentially in an oscillating mode (percussion) along a vertical axis, whereas at high frequency/low amplitude, the core tube is in a resonating mode with minimal force applied at the corenose. This effectively "fluidizes" the sediment and minimizes wall friction [8].

The best results are achieved in wet heterogenous sediments like poorly sorted silt, clayey sands, etc. Slower penetration may occur in a clean well sorted medium to coarse sands due to packing. Stiff clays are generally difficult to core due to the dispersion of energy. Granule to pebble grade gravels are only penetrated to the extent that the diameter of the core tube is sufficient to avoid wedging and blockage.

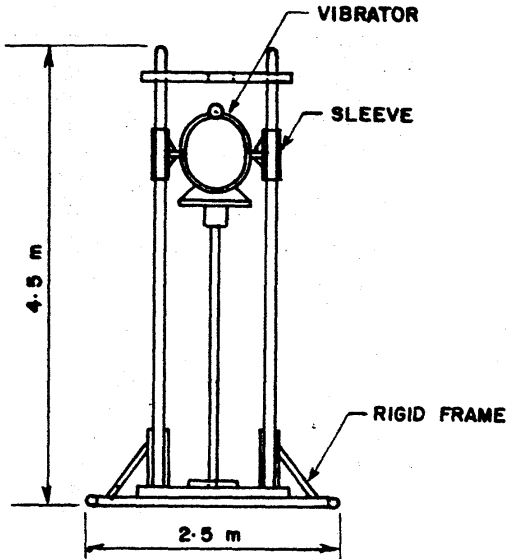


Fig.1 — NIO-designed vibrocorer

### Subsystems of vibrocorer

**Vibrator** — Electrical vibrators with identical contra-rotating eccentric weights deliver acceptable vibration frequency ranges from 3600 to 7500 vpm and mid amplitude of the order of 0.1 to 1.5 mm. The centrifugal output force of 2400 kg is good for light reconnaissance survey with the vibrator weighing underwater around 30 kg. For deep water vibrocoring (20 m), where cores of around 4m are desired, commercially available electrical motors can be used with some modifications to drive two parallel shafts through gears train. In contrast, pneumatically operated vibrators do not offer any advantage over electrical ones, mainly because they involve the handling of large diameter air-hoses and thus get subjected to drag due to water current and need a compressor of adequate size and capacity and occupy a substantial deck space.

**Core barrel** — Large diameter aluminium irrigation pipes are widely available with a recommended wall thickness of the order of 1.7% of the outside diameter (1.25% minimum). Contrary to steel barrels, they are inexpensive, lighter in weight, have less resistance in penetration due to area ratio and can be reused. They are generally preferred for geochemical/toxicological analysis with the

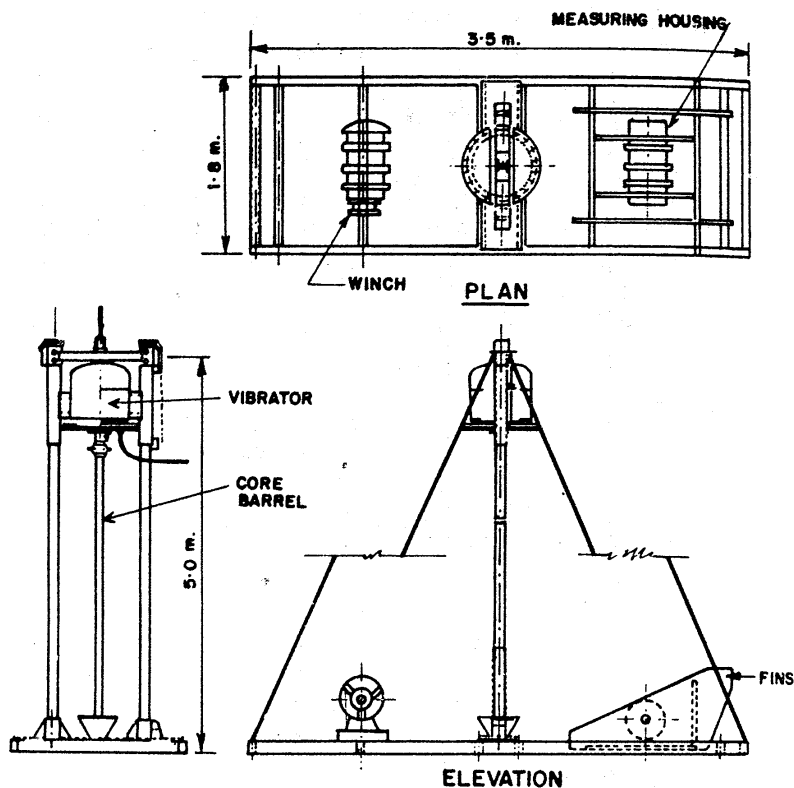


Fig.2 — Suggested innovative model of vibrocorer for placer exploration-deep water 8-20 m

aluminium wall either left bare or lined with some specific coating. Core cutters mounted with pop-up rivets and/or machine screws are advisable.

*Core catcher* — A simple passive orange-peel (basket) type core catcher with leafs nearly 1.4 times the diameter was found to be ideal for core retention. A similar catcher (see Fig.3) was used at Jaitapur very close to the area of vibrocoring operations [1]. The core catcher served the purpose for 20 operations on an average.

*Piston* — The piston in the corer increases collection of undisturbed samples, whereby a partial vacuum is created above the top surface of sediment by the cup type washers or 'O' ringtype pistons, enabling almost an undisturbed sample to penetrate with ease. Provision of upper stop-valves on corer top helps prevent wash-out of sample which closes due to hydrostatic pressure as the corer is being

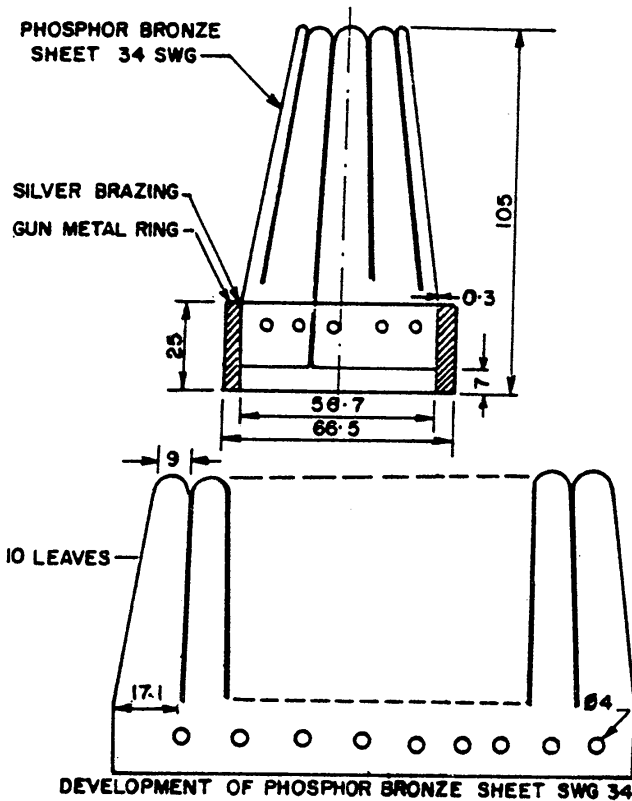


Fig.3 — Core catcher

retrieved back. By using the automatic release piston [12], or in other words piston having an arrangement to get 'immobilized' as soon as further penetration of the barrel in sediment is stopped, such that there is no suction, thereby avoiding distortion of the top surface of the sample during pull out.

*Frame* — The type of the frame to be used is controlled by the handling system available on the vessel and aims to provide maximum stability. If the frame is so designed that it is portable and can be varied in shape, this is of much advantage. Common shapes are either tripod or rectangular. Some use hinged towers with quick release guy wires to facilitate operations in limited space.

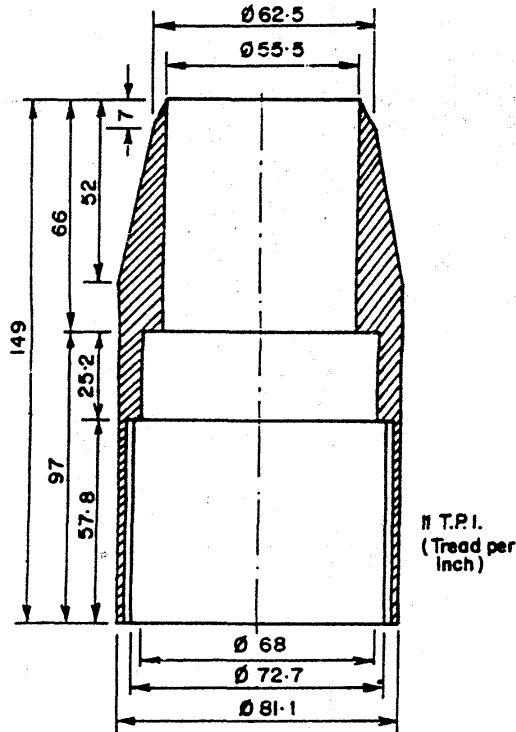


Fig.4 — Core cutter

## RESULTS AND DISCUSSION

The placer deposits off Konkan coast are found in the shallow nearshore areas where water depth varies between 3 m and 20 m. A characteristic feature of the sediment is a wet heterogenous medium with usual matrix, with medium to fine sands and a minor amount of clay.

So far two types of vibrocorers [NIO designed (Fig.1) and another imported one belonging to Geological Survey of India, hereafter referred to as NIO type] and GSI type were operated in this area to get the desired sample. The specifications and the difficulties faced during the operations are illustrated in Table 1.

Based on the field experience of using these two vibrocorers and similar equipment and incorporating a combination of features discussed in the literature cited, some modifications are suggested which might increase the usefulness of the system in similar type of nearshore placer exploration. The suggested design

Table 1— Specifications of Vibrocorers Used and Problems Faced during Vibrocoring along Konkan Coasts

Specifications	Problems faced
	<i>NIO designed vibrocorer</i>
<p>Frame 2m x 2m GI Pipes            Core barrel: 62 mm, 2.5 m long.,            Liner: inner 44 mm acrylic.            Vibrator: 400 w, 230 VAC,            Single phase.,            Amplitude 0-1.5mm.            Frequency 3000 VPM at 50 Hz            Driving force 2800 kg            Total weight 50 kg            Working water depth upto 30 m</p>	<p>(1) Vibrator used was a modified motor with shaft overhanging on either side of rotor and two eccentric weights bolted on the shaft. Due to this vibrations in both vertically upwards and downwards plane were also accompanied simultaneously by vibrations in horizontal plane forming a couple around the axis of the motor with the result the whole frame vibrated (jumping). (2) Plugging of core catcher with coarse sand and granules which arrested further penetration and vibrations passed on to the cover plate caused water leakage through rubber gaskets thus damaging electrical winding.</p> <p>Vessel: As the work was restricted up to 11 to 12 m of water depth a fishing trawler 'Kalpana' (10 m long, 3 m wide and draft 0.5 m) was deployed. The hoisting capacity of the winch was 0.5 ton safe working load using a wire rope of 8 mm and the aft deck area was about 6 m<sup>2</sup>. The rigid welded frame weighing 200 kg was very difficult to handle and operate and particularly as the sea condition worsened.</p>
	<i>GSI type vibrocorer</i>
<p>Frame welded base 5 m x 1.8 m.,            height 6.5 m, weight 1700 kg            (in air)            Core barrel: 75 mm, 5.25 m long Liner:            inner 67 mm PVC            Vibrator :Power required 1.5 kVA,            380 VAC Amplitude 0.1-1.5 mm            Frequency 3000 VPM            Driving force 3000 kg at 50 Hz            Hoisting capacity of winch 3 tonnes            Working water depth up to 100 m</p>	<p>(1) Core catcher was found to function better in clay/clay mixed sand compared to that in sand. It could be due to short length of leaf thereby reducing elasticity to close with sufficient force.            (2) Quite frequently the core barrel got bent due to difficulty encountered in maintaining vessel exactly above vibrocorer during pull out of barrel from seabed.            (3) Due to navigational limitations and also due to the size and weight of the frame the vessel could not cover shallow water stations less than 5-6 m.</p>

### AUTOMATIC — RELEASE PISTON

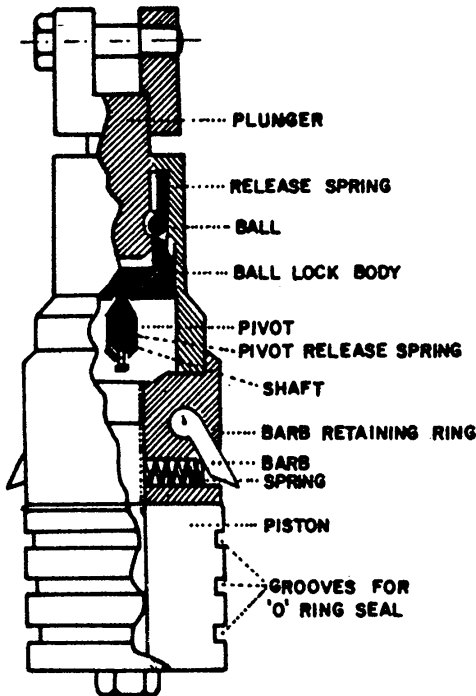


Fig.5 — Automatic release piston

(Fig.2) enables switching between two types of frames: (1) for water depth 3-8m, size 1.8 x 2.5m, height 2.5m, and (2) for water depth 8-20m, size 1.8 x 3.5 m, height 5 m; through quick connect sleeves pin joints: Stabilizing fins are essential to stabilize the frame against local currents. An underwater winch and a measuring housing are fitted on base plate for the extraction of barrel and determination of dip and speed of penetration when the second type of frame is in use. The core barrel for the shallow depth model is of 2.5m length, whereas for the deep water model it is 4 m long. For the core barrel a 75 mm thin-walled aluminium irrigation pipe without liners or diagonally screwed square boxes 10 x 10 cm is suggested with an alternative of M S seamless pipes with PVC liners. The vibrator (750 W, 230 VAC), of single phase with twin geared contra- rotating eccentric weights of striking force of about 1000 kg and an energy source of 3kW at 380 VAC, 3 phase at 50 Hz, is required when using underwater winch and measuring housing. For



the core catchers (Fig.3), leaf made from 34 SWG phosphor bronze sheet is desirable and the appropriate length of leaf is 1.4 times the diameter of the linear. It is felt that core cutter of square threaded steel is better than 'V' threads, as 'V' threads are damaged very frequently and pose the problem of their removal from barrel (Fig.4). This problem gains more significance if the vibrocoring operations are done in remote areas, where workshop facilities are either not available or else are ill equipped to cater to repairs/maintenance of such nature. Alternatively, cutters with holes through which pop rivets are hammered are found to be very useful. Modification is suggested in the piston [12] automatic release piston which avoids sample disturbance (Fig.5). The total weight of the system is 700 kg.

The vessel has a length of 12-15 m and draft 0.5 m with free deck space of 4-5 m<sup>2</sup>. Winch capacity is 1.5 tonnes. S.W.L. using wire rope of 8-10 mm is good enough for coastal operations.

The cost of an imported vibrocorer ranges between Rs. 5 and 9 lakh. The vibrocorer suggested here is based on indigenously available materials and engineering facilities. The cost of fabrication and successfully testing of one vibrocorer would be around Rs.1.5 lakh.

The improved or the proposed improved vibrocoring system is specially useful in meeting the requirement of shallow water placer exploration. The device is capable of obtaining undisturbed cores 2.5-4 m from nearshore sands by mounting the system on a fishing trawler. The effectiveness of the system is enhanced by providing stabilizing fins at a nominal cost, whereas the underwater winch and measuring housing is an optional attachment, as it is expensive. But it can ensure independent, safe and speedy retrieval of the barrel.

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