

Studies on the Sediment Transport in Mopla Bay Harbour Cannanore, using Fluorescent Tracers

By

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ABSTRACT

Mopla Bay, near Cannanore on the Kerala Coast, is a small bay (about 1.2 km at its widest with a maximum water depth of 5 meters) under development as fishing harbour by the Indo-Norwegian Project. Construction of a breakwater has adversely affected the harbour by bringing about extensive shoaling due to sand accumulation and necessitated modifications in the design and orientation of the breakwater. These modifications could only be undertaken subject to the findings of the sediment dispersal pattern in the bay, which was achieved by using dyed sand as a tracer. Approximately 100 kg. each of dyed sand of red, yellow and a mixture of red and yellow were dumped at three preselected points. Results of sampling after a month indicate a net movement from all the three dumping points into the harbour. The implications of the results are discussed in relation to the breakwater modification and the sand trap location.

INTRODUCTION

Mopla Bay, near Cannanore (lat. $11^{\circ}51'$ N and long. $75^{\circ}22'$) on the Kerala coast is a small bay under development as a fishing harbour by the Indo-Norwegian

Project. The bay is about 1.5 km. at its widest and has a maximum water depth of 5 meters. Sediments in the harbour (*i.e.*, the western part of the bay) are predominantly sandy with the fine sand component (0.06 mm to 0.2 mm) being greater than 80% by weight of the sand fraction. Clay sized material (<0.002 mm) constitutes insignificant amount (1.8 to 8% with an average of 3.0%) and is confined to the middle and north western part of the harbour. As part of the development of the bay, a 250 metre long NE—SW oriented breakwater was constructed approximately perpendicular to the promontory on the southern side of the bay (Fig. 1). The breakwater, however, has given rise to extensive shoaling in the harbour which constitutes the western part of the bay. Comparative bathymetric surveys between January 1966 and January 1969 showed 0.5 to 1.3 metres shoaling in a profile running parallel and in close proximity to the breakwater on its inside. Subsequent investigation of the changes in the bottom topograph of the bay have been carried out by Srivastava (1970) who reported shoaling of 0.2 to 1.0 metre between the period January 1969 to October 1969.

Before construction of the breakwater, the littoral transport in the bay might have been in the easterly direction under the influence of waves approaching from the west (Brunn, 1969 a). Because of the fact that most of the material migrated past Mopla Bay, erosion developed with maximum intensity in the area close to the entrance of the largest creek (near the north eastern portion of the harbour) (Fig. 1). Shore stabilisation measures consisting of groynes were undertaken but they proved to be of limited success (Brunn, 1969 a).

There are indications that after the construction of the breakwater, sediment is provided to the bay by transfer of material from the extreme end of the breakwater by wave diffraction (Brunn 1969 a). Diffraction of waves gives rise to a reversal of drift in the westward direction on the harbour side of the breakwater with resultant shoaling in the harbour. The net result of the construction of the breakwater has therefore been largely detrimental, necessitating redesign of a part or whole of the breakwater. It was therefore deemed advisable that a sand movement study, using dyed sand as a tracer, be undertaken before considering the modifications of the breakwater.

The use of artificial tracers, particularly dyed sand as a tool in understanding sediment movement in various types of environments is a well established procedure and has found extensive application in many parts of the world (Ingle 1966, Zenkovich 1967, Brunn 1969 b). This report consists of the result of such a study carried out in Mopla Bay during the period Dec. 1969 to Jan. 1970.

METHOD

100 kg. each of red and yellow and 25 kg. of a mixture of red and yellow dyed sand, was injected at three widely spaced locations designated A, B & C respec-

sively (Fig. 1) on 15th December, 1969. As the wave action during this period was very weak, an arbitrary period of 30 days was allowed for adequate dispersal of the tracers. Sampling was carried out, after the expiry of the stipulated period with a Van Veen grab on a grid pattern. A total of 62 samples were collected with the greatest sampling density inside the harbour. Samples after collection were sun-dried after which 500 gms. of each sample was weighed out, coned and quartered till 5 gms. of the sample was obtained, on which the actual tracer counting was carried out. Counting was done in a darkened room, using a Hanovia make ultra violet lamp and counts recorded with a hand-tally counter. As the colour of the tracers could not be distinguished clearly, total counts were made regardless of the colour and recorded as number of grains per 100 gms. of the sample. The values were contoured and shown in Fig. 1.

RESULTS AND DISCUSSION

In view of the fact that the individual colours could not be distinguished, the values of the total counts permit only the most general conclusions regarding the sediment movement pattern.

From Fig. 1, it is seen that from the dumping point A, outside the breakwater, the movement of the tracer is partly northerly (*i.e.*, towards the breakwater) and partly north-easterly (*i.e.*, parallel to the breakwater). This agrees more or less with the direction of wave approach outside the breakwater which may also influence the northerly drift to move as north-easterly drift close to the breakwater. From the point 'B' at the tip of the breakwater, movement takes place in apparently three directions. They are (a) a north easterly drift from the tip of the breakwater (b) a northwest drift towards the middle of the harbour and (c) a northerly drift which branches off into westerly and easterly components towards the northeast side of the harbour.

Float tests (Srivastava et. al. 1972) conducted in Dec. 1970 and Jan. 1971 indicated westward flow in the surface layer outside the breakwater whereas inside the harbour the flow was partly to the west and partly to the north. The latter is in partial agreement with the findings on sediment transport inside the harbour. Outside the breakwater, there is considerable disagreement between the flow pattern and the direction of sediment transport. Since the float tests were neither carried out in the afternoon nor over complete tidal cycles, the disagreement between the two results is understandable. Moreover, waves may also play a dominant role in transporting bottom sediment.

In the eastern part of the bay from the dumping point 'C' the tracers were found to move mostly towards the west along the shore.

Thus the sediment movement pattern as delineated above not only confirms the findings of Brunn (1969 a), namely the westward drift from the tip of the breakwater but also reveals a northerly drift which branches out into east and west at the northeast portion of the harbour. His suggestion that the tip of the break water be turned clockwise forcing the littoral current oceanward and thereby reducing the amount of material carried into the bay (Brunn, 1969 a), seems to be the appropriate corrective measure to be adopted in the redesign of the breakwater.

It is also suggested that a sand trap be located close to the tip of the breakwater on its northern side so that it traps the sediment moving around the tip of the breakwater, as well as the part which moves northward from the tip.

The presence of the promontory seems to modify any waves coming from north of west in such a manner that the breakwater is subject to waves mostly from west and southwest throughout the year. Thus the sediment dispersal pattern obtained in the present study may be fairly representative of the conditions prevailing during the other seasons of the year also.

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