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THE INFLUENCE OF A SEA BED STRUCTURE (BATHYSNAP) ON NEAR BOTTOM CURRENTS

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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# THE INFLUENCE OF A SEA BED STRUCTURE (BATHYSNAP) ON NEAR BOTTOM CURRENTS

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## INTRODUCTION

Part of the deep sea benthic biology programme is to photograph an area of sea bed (about $1.5m^2$) over a number of days using time lapse exposures. This will give data on 1) the rates of movement of benthic animals, 2) the types of tracks which these animals make and 3) the speed at which the tracks disappear.

These data would further our understanding of biological rates in the deep sea environment and they would also enable species abundance estimates to be made from photographs of tracks such as have already been taken (Rice et al. 1979).

The stability of tracks is an important aspect of the data and this will depend on both the nature of the water current on the sea bed and the rate of deposition of sediment from the water column above.

The structure on which the camera is mounted is bound to influence the near bottom current and hence affect the stability of animal tracks. In order to estimate this influence a quarter scale model of the structure was made and its effect on a water current examined.

## MATERIALS AND METHODS

A quarter scale model of Bathysnap (a modified tide gauge NIO/5020) was made out of wood. The model has three forms. 1) The basic frame, 2) the basic frame with one model floatation sphere and 3) the basic frame with two floatation spheres. A false sea bed was constructed from a 1.8 x 1.2m piece of 1cm plywood and this was mounted on a dexion frame underneath the carriage of the Wormley wave tank. A 4cm high barrier of plankton mesh (132μm pore size) was mounted above the leading edge of the board with a number of trip wires behind it and this served to simulate the type of vertical velocity profile found in the sea with a constant current (Lesser 1951) (Figure 1).

There are no data on the current speeds likely to be encountered in the area of sea under investigation (the Porcupine Sea Bight) so an arbitrary value of 20cm/sec was selected for this experiment. The velocity was measured for 15 sec over a grid of 10cm sided squares using a propeller current meter probe with a rotor diameter of 1cm and a quoted response time of 30ms. The bottom velocity was taken as that recorded when the centre of the current meter was ½cm above the bottom. Heights above the bottom are taken as the distance of the bottom of the rotor above the board. Vertical profiles were examined at two points on the grid at heights of 0, 1, 2, 3, 4, 7, 10, 15, 20, 30, 42, and 60cm. The data was recorded and processed by computer (Camac/HP26 47A) to give a mean velocity at each point and a velocity frequency spectrum for certain points. The sampling rate varied from 5 to 30Hz dependent on the mean velocity.

The model was then fixed to the board in one of its three forms and the measurements were repeated to give an estimate of its influence on the current. Potassium permanganate solution was injected at several points around the model and the resultant dye trace was photographed at 4 frames/sec on 35mm black and white film to assist in interpreting the current measurements.

RESULTS

The influence of the structure in its three forms on the bottom current is represented in figure 2. The contours are the percentage reduction in current due to the structure. It can be seen that the greatest effect took place between 30 and 50cm behind the centre of the model where reductions greater than 40% were found. The addition of the buoyancy spheres did not greatly influence the bottom current. The central band of >20% reduction runs from near to the model to the end of the board in a band about 20cm wide.

Frequency analysis was carried out at G2 without the structure and at E2, G2, H2 and J2 with the basic structure (no spheres). Figure 3 shows the spectra for free flow and on the bottom at G2. There is obviously considerable noise in the spectrum and all the curves have been smoothed to remove this. These are shown in figure 4 with energy expressed on a log scale. The most outstanding feature to emerge is that the structure caused a great increase in high frequency turbulence (2-4Hz) at G2 whilst at E2, H2 and J2 the effect was simply a slight reduction in energy throughout the spectrum. There are no significant peaks in the spectrum but close to the structure each strut or beam would be expected to produce a characteristic frequency of turbulence. In some cases this is well demonstrated by the dye study. Figure 5 shows the effect of releasing dye just upstream of a leg of diameter 1.3cm. The turbulence can be clearly seen and the wavelength ($\lambda$) would appear to be about 6.3cm. According to Strouhal's law $\lambda \simeq 5d$ for a cylinder or 6.5cm in this case.

The vertical profiles at G2 and G6 are shown in figure 6 with no model and with the model in its three forms. Velocity is expressed as a percentage of the free flow. Once again it is evident that the influence of the spheres does not reach the bottom and in fact even at G2 (60cm behind the model) there is no effect below a height of 15 cm. The photographs support this interpretation (figure 7). The main velocity defect is at 30cm, the height of the centre of the lower sphere, whether one or two spheres were present.

Considering the basic structure without spheres, the greatest effect is near to the bottom and this is undoubtedly due to the 2cm high "T" beams the centres of which are 3cm above the bottom. At G2 they reduce the current at 3cm height from 70% of free flow to 48% of free flow whilst at 15cm height, the structure reduces the current from 92% to about 80%. As expected, at G6 the effects of the different parts of the structure are contained within narrower vertical bands although the T beams still have a considerable effect on the bottom.

## DISCUSSION AND CONCLUSION

Previous examinations of near sea-bed currents have demonstrated that the velocity (V) is directly proportional to the log of the height (H) above bottom (Lesser 1951, Dyer 1980). The various constants in the equation are related to the nature of the sea bed.

When log H is plotted against V for the false sea bed used here, the relationships do not appear to be linear and the profiles for the two columns are somewhat different although they are only 50cm apart (figure 8). Currents in the bottom 3cm appear to be too high and it is likely that the board was not long or wide enough to develop a steady state current profile. Efforts to create a better simulation were not justified in this study and the conclusions are unlikely to be different had the simulation been improved.

When Bathysnap is used at sea, a sample of the sediment will be taken from beneath the structure and the free stream current recorded several metres above it. In the unfortunate event of the camera facing downstream, this information and the results presented here will enable a correction to be made to the observed sediment stability. There are a number of papers describing the relevant factors in sediment transport (e.g. Miller et al 1977) but if the currents are unidirectional in the Porcupine Sea Bight, the simple solution is undoubtedly to mount two cameras on the structure facing opposite directions. This will ensure that one is not facing downstream and will also provide more photographic data.

REFERENCES

Dyer, K.R. 1980. Velocity profiles over a rippled bed and the threshold of movement of sand. Est. Coast. Mar. Sci. **10**: 181-199.

Lesser, R.M. 1951. Some observations of the velocity profile near the sea floor. Trans. Amer. Geophys. Un. **32**: 207-211.

Miller, M.C., McCave, I.N. and Komar, P.D. 1977. Threshold of sediment motion under unidirectional currents. Sedimentology, 24: 507-527.

Rice, A.L., Aldred, R.G., Billett, D.S.M. and Thurston, M.H. 1979. The combined use of an epibenthic sledge and a deep-sea camera to give quantitative relevance to macro-benthos samples. Ambio Special Report **6**: 59-72.

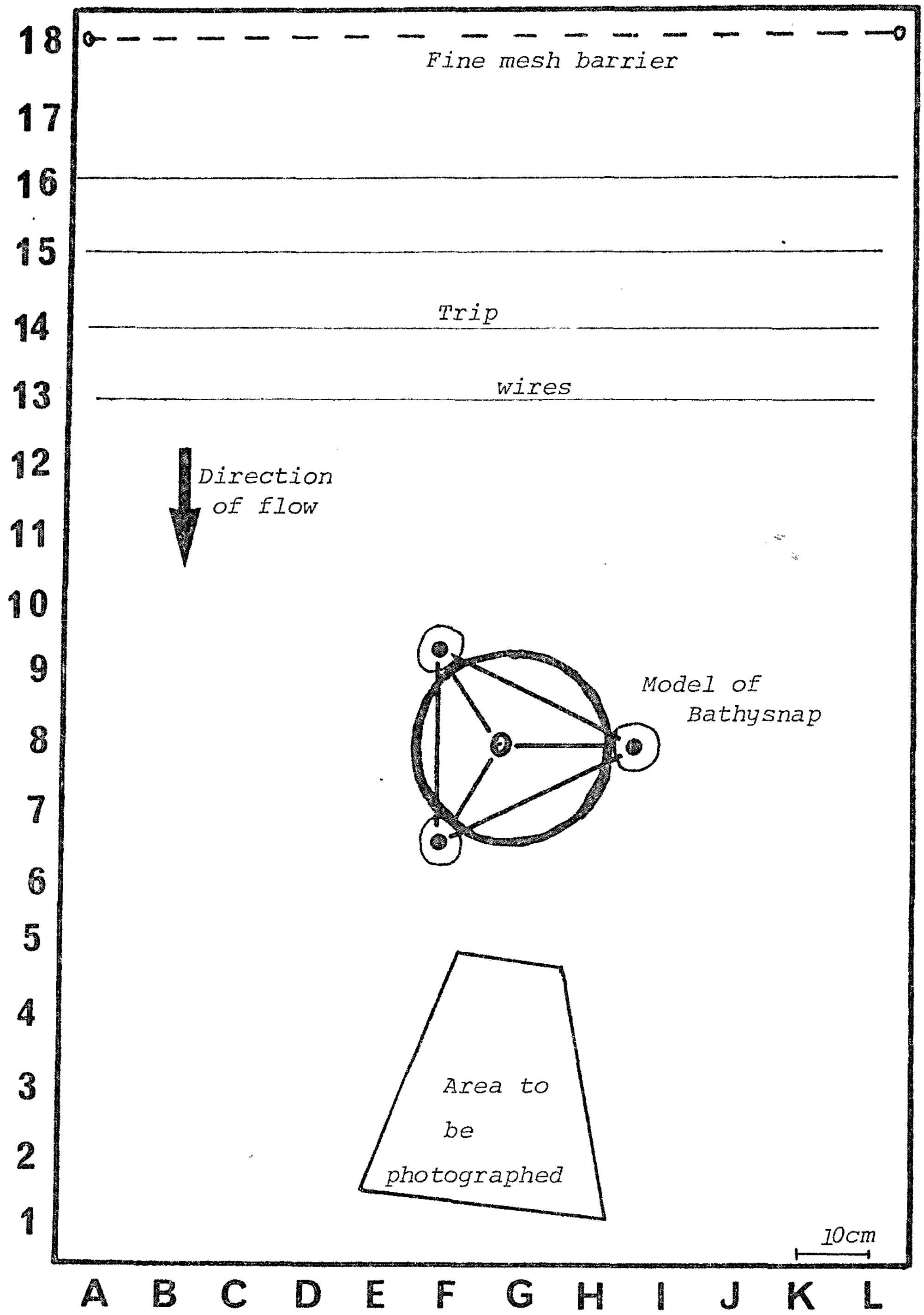
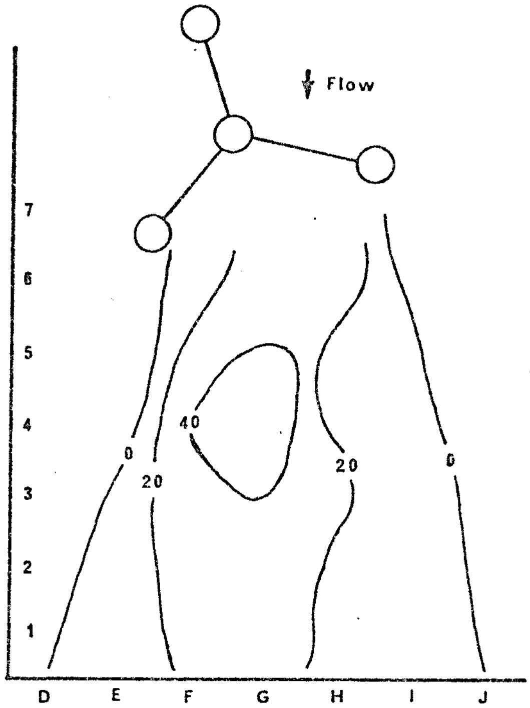



*Figure 1*

*General arrangement of experimental hardware*



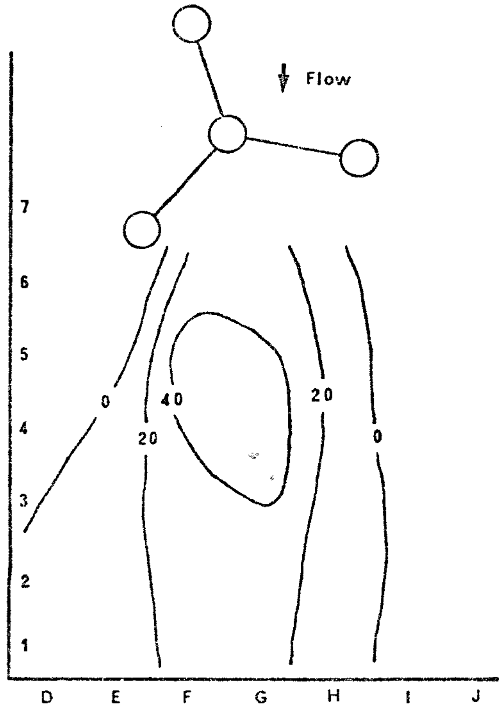



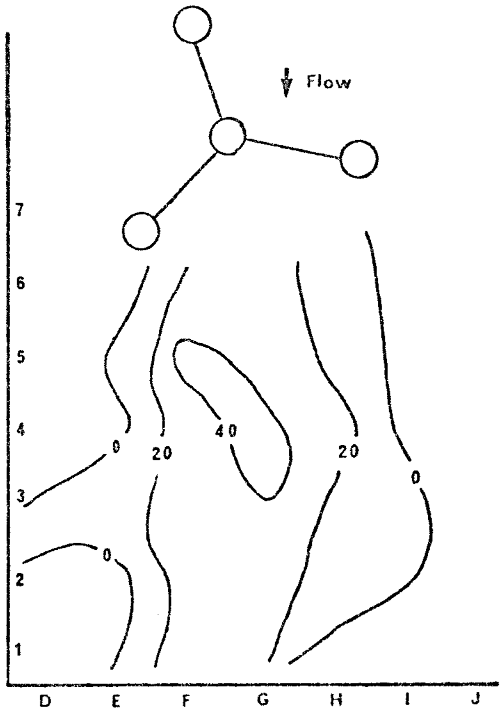

*Figure 2*

*Percentage reductions in the bottom current due to Bathysnap model in its three forms.*

*Top left: Structure only*

*Top right: Structure with one sphere*

*Bottom: Structure with two spheres.*



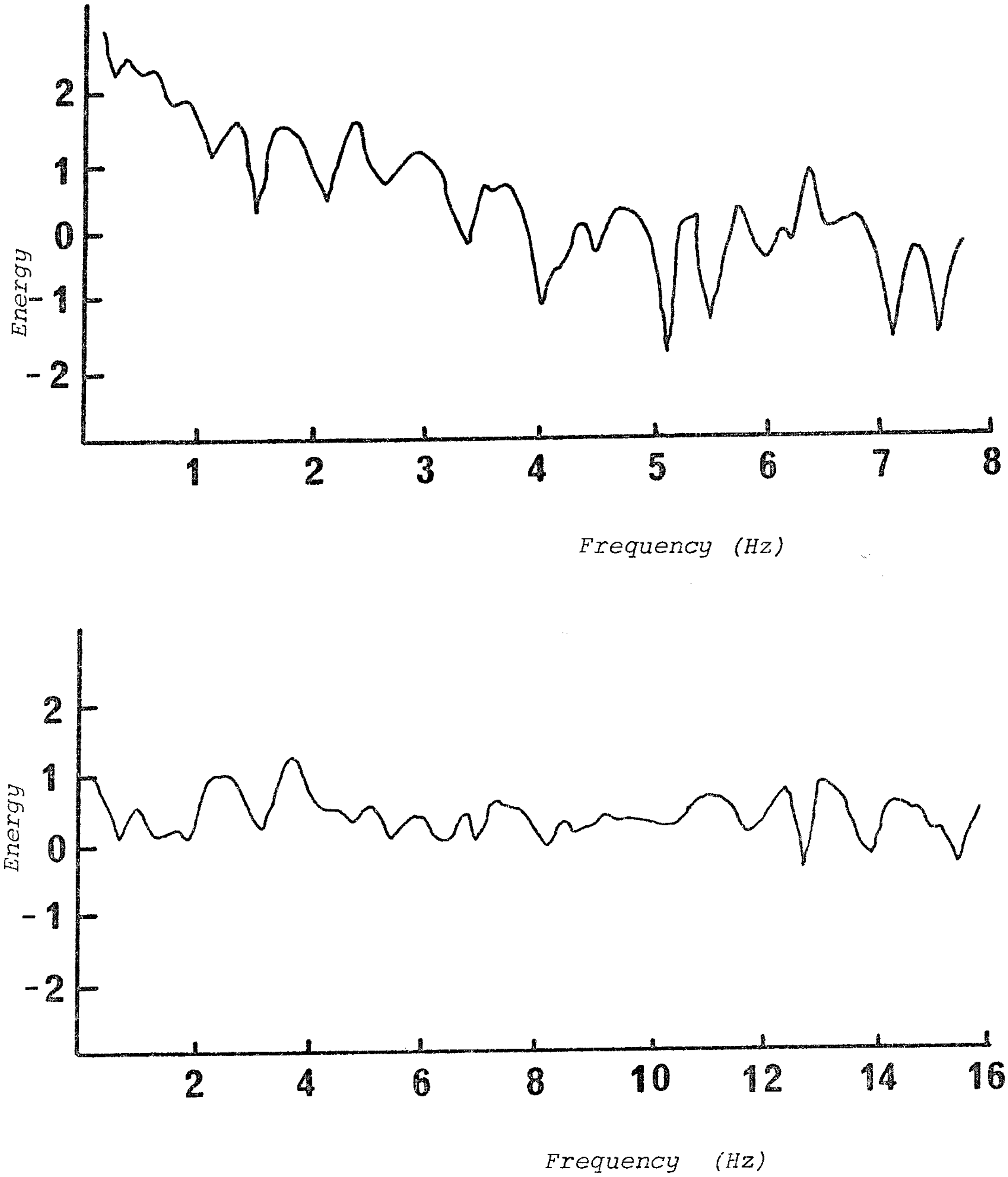



*Figure 3*

*Top: Power spectrum on the bottom at G2*

*Bottom: Power spectrum in free flow at G2*

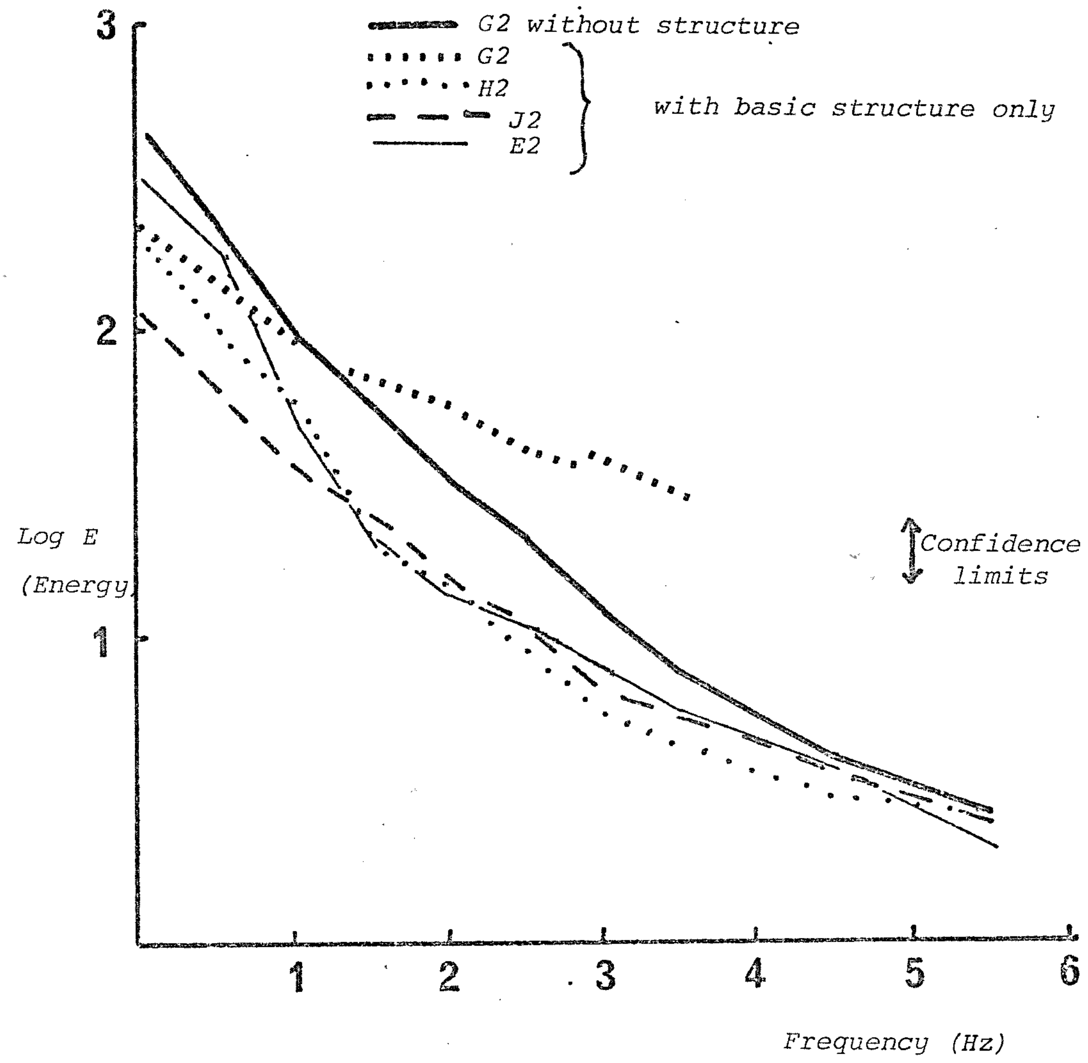



*Figure 4*

*Power spectrum with current meter at various squares on the bottom (Height 0cm)*

*Figure 5*

*Trace from injection of dye just in front of one leg of the model. The squares have sides of 10cm.*

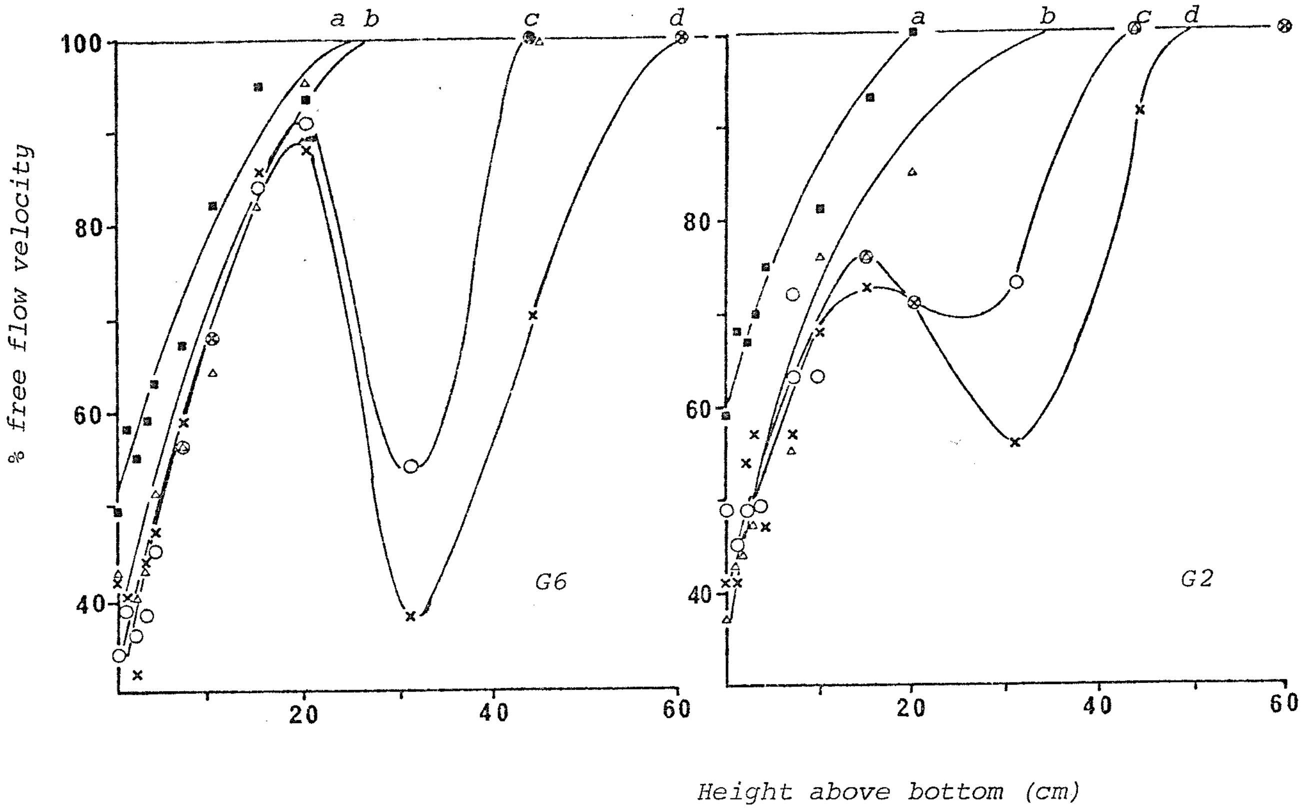



*Figure 6.*

*Vertical velocity profile expressed as a percentage of free flow for two squares G6 and G2.*

*a (squares) no structure*

*b (triangles) basic structure only*

*c (circles) basic structure with one sphere*

*d (crosses) basic structure with two spheres.*

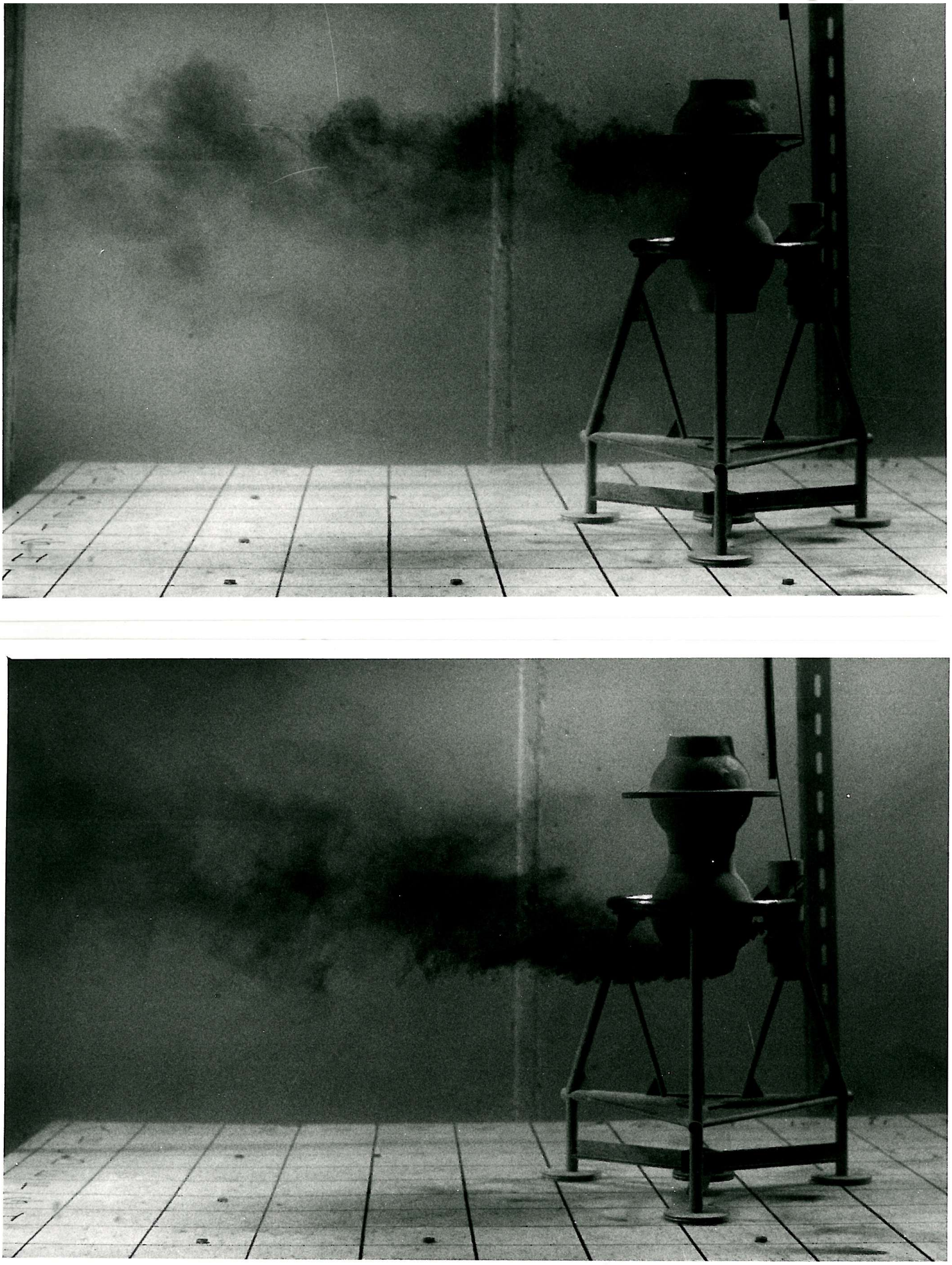


*Figure 7*

*Trace from injecting dye in front of upper and lower floatation spheres at heights of 42 and 30cm respectively.*

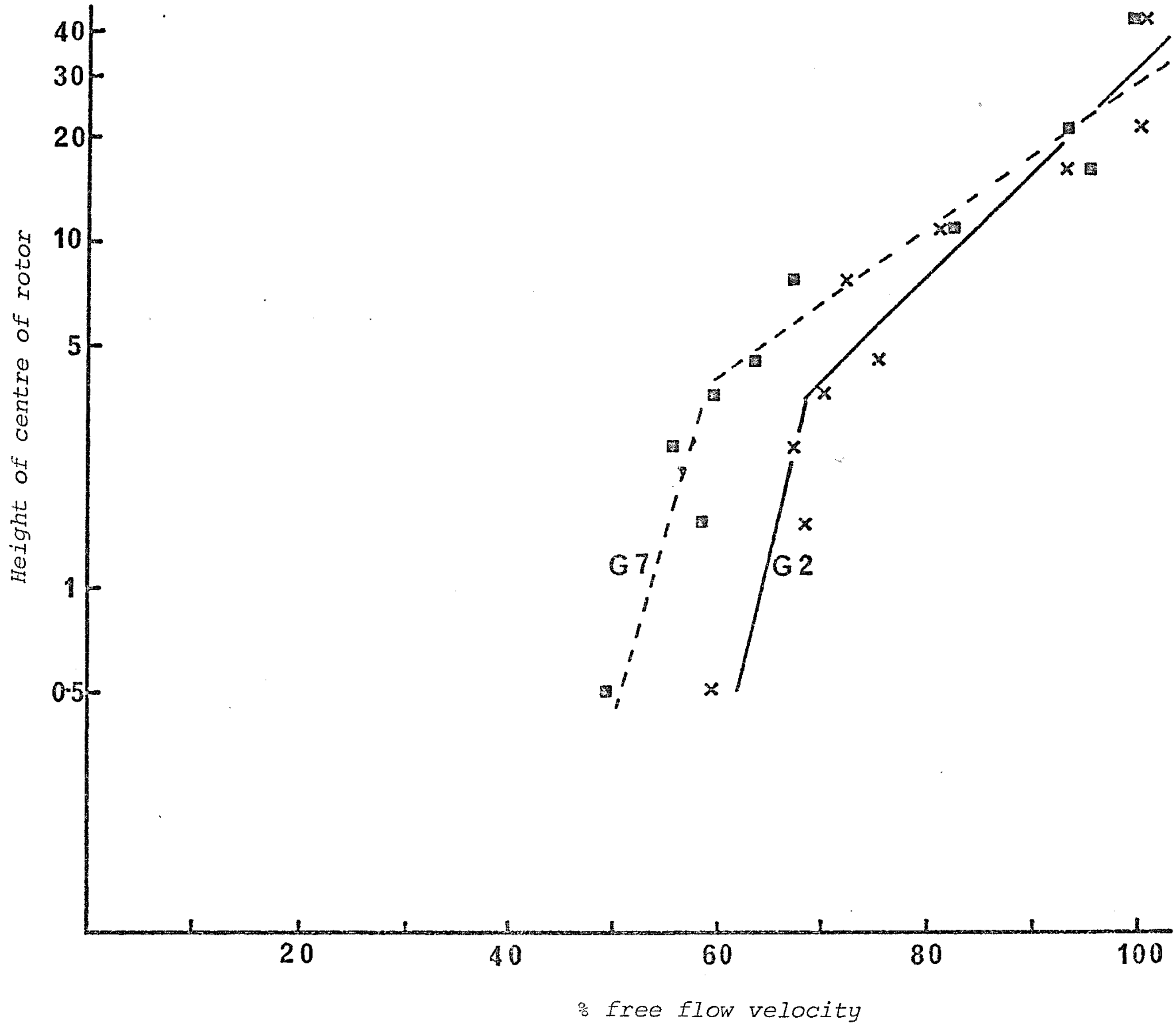



*Figure 8*

*Vertical velocity profiles with the logarithm of the height of the centre of the current meter rotor plotted against the percentage free flow velocity for two squares G2 and G7.*