8 October 1970 Weekly 2s

new scientist

Polymer parachute to protect parliamentarians

Managing the Flatiron project / Middle East escalation
Overseas aid in jeopardy? / CNS in the test tube

A parachute to tame the tide

Do Londoners really have to put sandbags along the Embankment? The risk of the Thames flooding during an unruly high tide is about 1 in 10 and, while the solution proposed here could be implemented in two or three years' time, for the next few winters Britain's capital must take its chance with no tidal barrier. While the Greater London Council appears to have powers to enforce raising of the River embankments, and at its next meeting on 20 October could decide to raise them a couple of feet, the record of especially high tides indicates that even after such an interim measure there would still be a risk, perhaps better than 1 in 100, of a very high tide overtopping the raised embankments

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The record of especially high tides shows clearly that the Thames will just overtop its present banks on average once every 10 years. No one really knows what will happen this winter if a gale occurs in the North Sea and sends in the sort of tide that returns approximately once in every 100 years—undoubtedly there would be some serious flooding and loss of life.

The infrequent very high tide is the sort of risk for which one needs a "parachute". In December 1967 I developed a novel design for a Thames flood barrier which used a large sheet of strong woven nylon fabric to form the barrier and employed what you could loosely call "suction" to form a foundation. After successfully testing a sectional model of the design in a 14-inch flume at Cambridge, where I was then a lecturer, I described my proposal in a memorandum submitted to the Ministry of Housing and Local Government on 18 December 1967.

My sheet barrier would work as in Figure 1. In principle it really would function as an elongated parachute. The pressure of the flood tide would make the sheet bulge upstream—while its lower edge was held to the foundation. The upper edge of the sheet could curve back over floats and be held by ties to the foundation.

Such a barrier sheet would normally be submerged flat on the foundation and would be no obstruction to shipping. It would be simple to operate. In a section shown in Figure 2a the sheet is flat. When the barrier was needed, the inflation of a float would first carry the sheet upstream into the position shown "half-up" in Figure 2b. Controlled inflation of successive floats would gradually staunch the flood without making undesirable waves. After closure the barrier would rise up with the flood tide as in Figure 2c. When that tide ebbed the sheet would be washed back downstream to the rest position in Figure 2d where floats could be deflated and the barrier allowed to sink back flat on to the foundation.

The barrier would be designed so that, while in operation, any vessel that collided with it would tear a limited gap in the sheet without loss of the vessel or flooding in London. The barrier would simply continue to work somewhat as a parachute with one torn panel. Emergency repairs could then be made.

In 1967 I envisaged the foundation to be a paved sealed area of river bed with under-drainage (see Figure 3). Continual pumping of water from the drains would make the pore pressure in the soil of the river bed lower than the water pressure in the river above the sealed pavement. The sealing membrane would be firmly pressed down against the drainage tube system which would itself form a strong grillage most effectively held on the river bed when a flood came. The paving slabs would form an inflexible layer of armour held down to the drainage grillage and would protect the sealing membrane from damage. The total effective vertical force on such a sealed pavement would be very large, and large frictional forces would thus be available to resist movement of the barrier sheet in a flood. By employing the principles of hydrostatics and soil mechanics a barrier of only a few thousand tons mass could quite well resist the many tens of thousands of tons force caused by the pressure of the flood tide.

Any barrier would require continual attendance and frequent use if it were to be relied on. This barrier would be unobtrusive and could be used occasionally without harassment of shipping. By remote observation of the pore pressure in gauges buried in the river bed, and by observation of the flow of air and of water through orifices, the engineers on shore would know that the "working parts" of the barrier—sheets and pipes and flotation bags—were in immediate readiness. Any suspected fault could be corrected by appropriate action on the part of engineers and divers. A modern system which created and sustained technical interest among engineers would be unlikely to be found in a state of neglect in an emergency.

The sheet itself might be made from a proofed fabric of woven nylon or terylene. It might use one or two million pounds weight of that material. Experience with these newer plastics materials suggests that they are no less reliable than steel and concrete.

Model tests in December 1967 confirmed that a section of such a barrier does operate as I have described. Various calculations led to tentative estimates that such a barrier could be constructed for the Thames within three years, at a cost of less than £5 million. I expected that for that cost the barrier would have a life of ten years; and in ten years' time there may be newer materials and better designs for different schemes. This barrier could have various uses in the United Kingdom and abroad and so the design has been covered by a provisional patent.

After submitting my proposal to the Ministry it emerged that the sheet barrier idea had been

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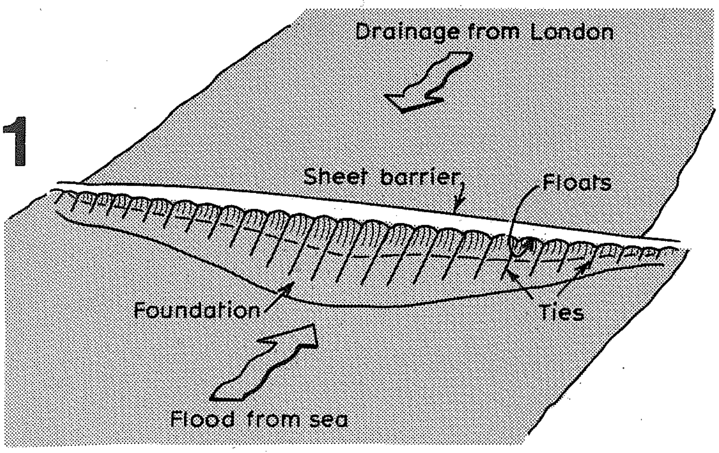

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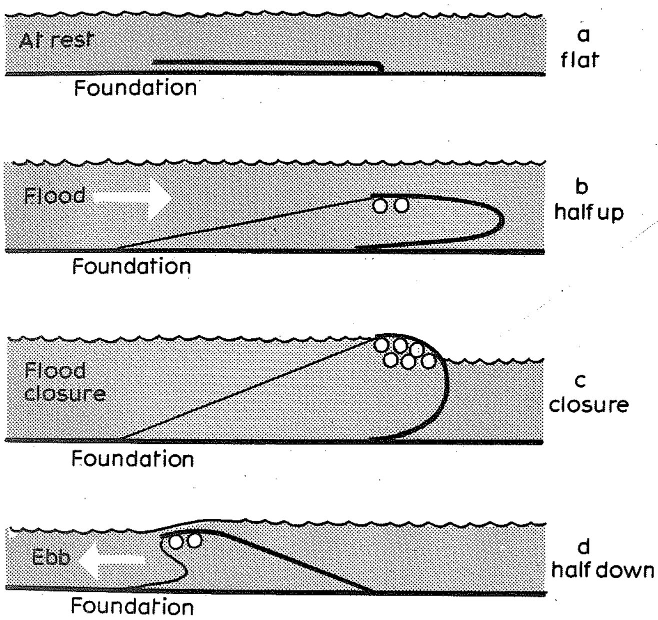

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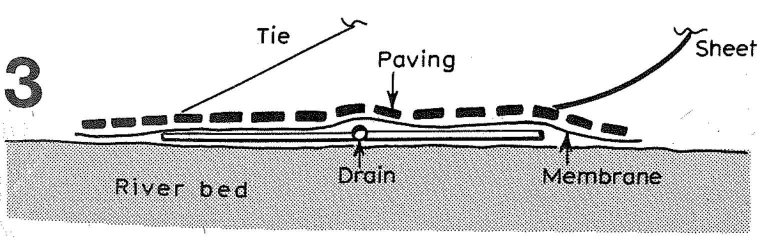

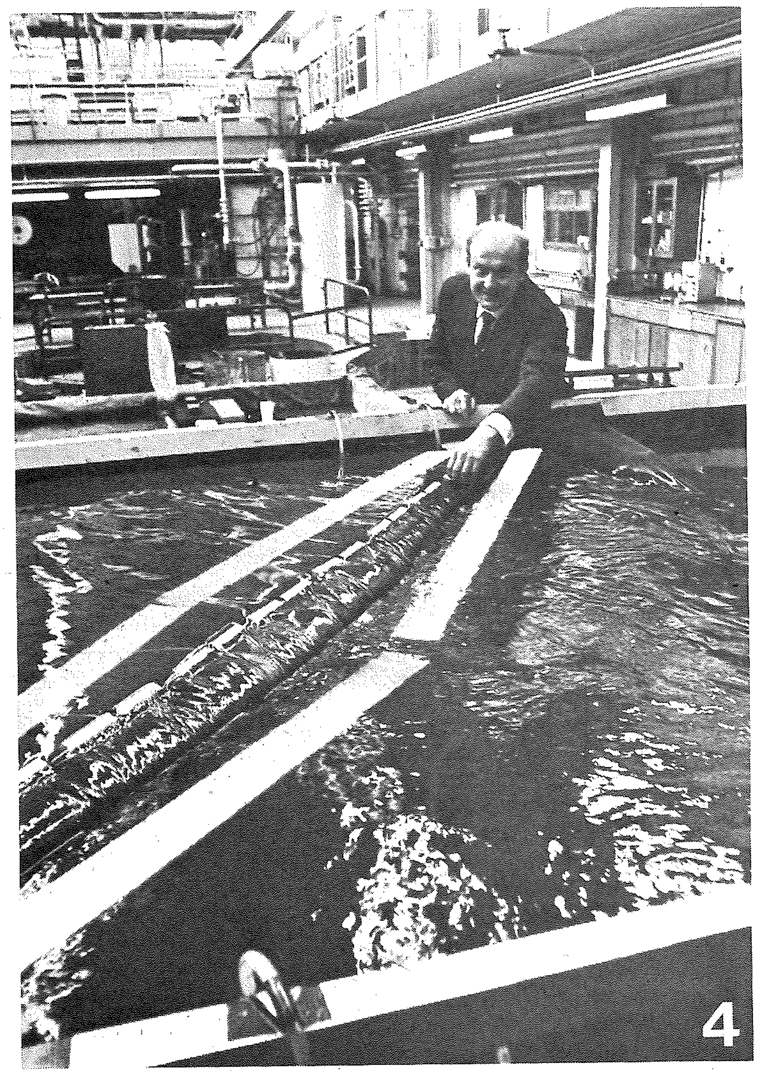

Figure 1 A strong sheet barrier of heavy nylon could act like an elongated parachute to check a flood tide

Figure 2 How a sheet dam would operate. a. Flat and out of use. b. Being carried upstream by the initial inflation of lifting floats. c. In the fully "open" position once the flood tide has filled the parachute. d. At ebb the dam would be washed back downstream to a rest position where the floats could be deflated and the sheet allowed to sink to the river bed again

Figure 3 Under-drainage beneath the dam, maintained by pumping, would anchor the sealed pavement of the dam's foundation to the river bed by "suction"

Figure 4 A model of the proposed Thames flood barrier at the University of Manchester Institute of Science and Technology operating without vibration

patented by J. Mesnager in 1952 (US Patent No. 2 609 666). It also turned out that Firestone fabricate somewhat similar structures—coated fabric tubes that have been inflated with water to form low dams of several metres height. One of these had vibrated excessively under high overflow conditions, so we began research at Manchester into vibration. A model of the proposed Thames flood barrier (Figure 4) showed no vibration. More experiments at Manchester by Hugh Clare, on inflated tubes with various inflation pressure heads under various overflows, show that it is possible to design (Figure 5) such structures to operate without fluttering or rolling. In yet other tests at Manchester (Figure 6) an inflated tube has been studied retaining water with waves.

At the Hydraulics Research Station (HRS) at Wallingford engineers are now making more detailed studies of a possible sheet barrier with Robert Trillo Associates as consultants. Robert Trillo Associates have recent practical experience of applying principles learned in the development of the Dracone and the Hovercraft in constructing cofferdams using fabric sheets.

I have no doubt that some sheet barrier structure can be safely engineered if wanted, but it cannot be ready in time to protect London from possible tidal flooding this coming winter. In a recent *Nature*

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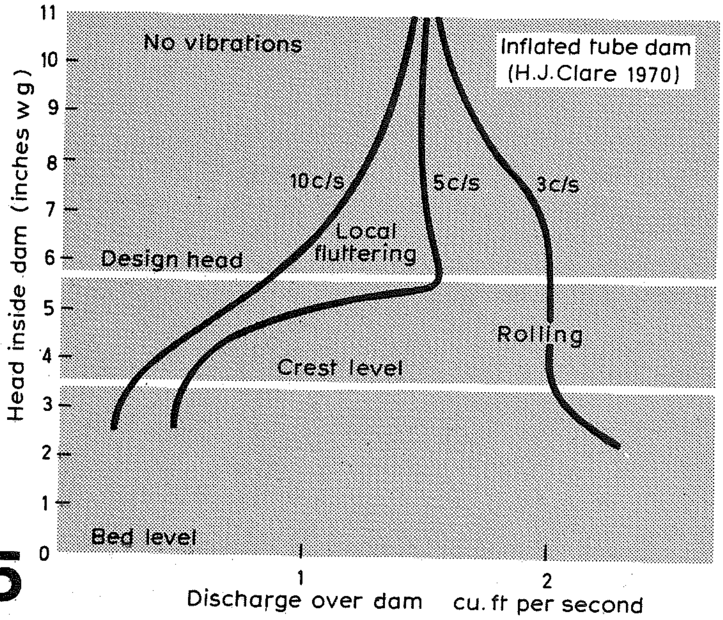

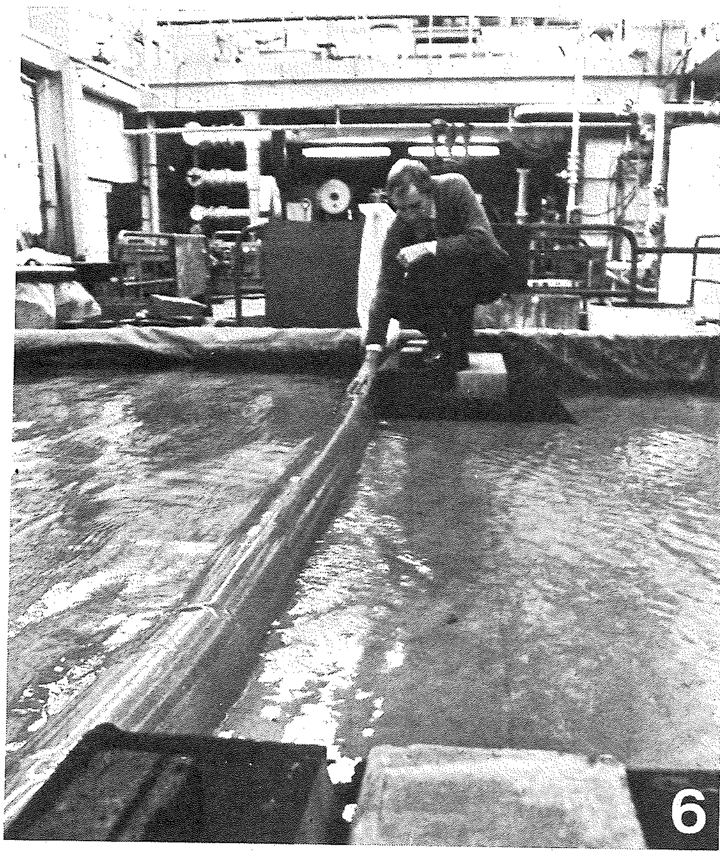

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Figure 5 Models using inflated tubes to study the relationship between water pressure head and overflow at the dam show that parachute dams could be designed which would function without unstable fluttering or rolling

Figure 6 An inflated-tube experiment in progress at Manchester demonstrates stable behaviour to water waves

article (vol. 227, p. 1178) I used a simple calculation from an Institution of Civil Engineering publication with data from the Greater London Council's Report of Studies, both of which were published in 1969, to show the overriding importance of obtaining some interim protection for London quickly. Since it appears to be within the GLC's powers to require frontagers to raise flood defences to, say, 20 feet above ordinance datum, in my view the GLC should take this decision at their next meeting on 20 October. Once this additional protection is effective, the risk of a tidal flood will fall to less than a one in 100 chance. I believe it would still be prudent to inform the occupants of the flood plain fully of the nature of that risk: marks on the street lamps at the 20-ft level would prepare occupants for concerted action in the event of a tidal flood warning. While such a flood would be less likely to occur, it would be no less serious if it actually happened.

It would also seem appropriate to consider a sheet barrier design along with the alternative proposals for future full tidal flood protection. Steel and concrete structures appear to be expensive to make and maintain. Plastics material—nylon, terylene, neoprene, butyl, asphalt—which is at a disadvantage when used in air because it must be insured against fire as if it were wood, has great potential in hydraulic structures. It surely cannot be long before a fabricator and specialist consultant between them engineer a fabric structure working in the manner of Figures 2c and 2d as a regular tidal sluice to drain some fen. The tonnage of polymer that would be used if ever a large dam were made on these principles, perhaps using a new strong fibre in the fabric, should be sufficient to interest one of the great producers of plastics material in this development.

Tantalizer No 171 Trial Balance

You probably know that old teaser about the twelve billiard balls. All look identical but in fact just one is of slightly different weight to the others. You have a balance with two pans slung from a crossbar (but no weights) and are invited to detect the odd ball with just three uses of the balance.

Three weighings would not be enough if two of the balls were odd. But you would have a rotten weekend trying to find two odd balls with the minimum number of weighings. So, instead, suppose there are only seven balls, five being of one weight and the other two slightly heavier and identical to each other.

Now how few weighings do you need to be sure of finding the odd two and how do you do it?

Martin Hollis

(For solution to Tantalizer No 170 see page 97)