SQUAT!

Hardly an elegant title is it?

However, every shiphandler must have suffered from it at some time. At least, it began to become apparent once ships deserted sail for steam or diesel, growing larger, faster and deeper in the process. It was not only the deck department that suffered from the condition. Engineers on the sorely missed Thoreson car ferries used to ring the bridge to complain that they were being bombarded by stones beating on the bottom plates of the engine room as they proceeded through the North Channel, off Hillhead in the Solent. It seems the noise distracted them from the crossword or Page Three of their newspaper. (They didn't have Su Doku in those days!).

Of course, the word is used to describe the apparent increase in a ship's draught while travelling through the water. More accurately though, it ought to be described as a reduction in its underkeel clearance. It is particularly noticeable in shallow water but is even more apparent where the ship is navigating in channels which are not just shallow but narrow as well. This brings us to the next thought; Squat is merely one symptom of a more general navigational disease known as 'Interaction'. Interaction can have a very deleterious effect on river banks, lock gates, bridges, quay walls etc. and can cause any ship involved to look distinctly wrinkled and even torn.

Those of you who look after your teeth will remember the dentist thrusting a suction tube into your mouth. This was used to suck out all the dribbles you made through trying to conduct a conversation over the noise of the drill - hoping to kid him that you weren't frightened! You will recall that the tube was powered by an electric pump. However, there are people who can still remember when the tube was connected to a tap on the spitoon at the side of the patients' chair. The amount of suction could be adjusted according to how frightened they were. Some people dribbled so much that the tap had to be turned full on. That was alright until the mouth ran dry, whereupon the end of the tube would latch on to the inside of the cheek like an octopus tentacle. The patient (some people) could only be released by turning the tap off. Once the treatment was complete and the patient had ceased to dribble some people inquired how the water driven saliva pump worked. The short answer was that it was a 'Venturi'.

What's a venturi? Well, it just means a horizontal pipe of a certain cross section with a bit in the middle which has been squeezed to perhaps half its previous area. When you turn the tap on, the water runs along at the speed appropriate to keep the pipe full over its whole length (say 1 litre per second). Now here's the clever bit. When it reaches the narrow section it has to double its speed to shift the same amount of water in the same time. The water exerts a pressure on the walls of the pipe which depends on the height of the reservoir, reduced by the speed at which it's running. This means that the pressure on the walls of the narrow bit of pipe is only half as much as in the rest of the pipe. If you plumb another pipe at right angles into the wall of the narrow bit and stick it in somebody's mouth it will suck just like the dentist's.

What's that got to do with squat? Well, the sea may not be moving but the ship steaming along represents the top wall of a square section pipe and the seabed immediately under it represents the bottom, while the water between the two represents the flow through the narrow bit of pipe. You may have noticed that this pipe doesn't have any sides; well, you can't expect perfection. The narrower the gap between the bottom of the ship and the sea bed the faster the water rushes through, the more the water pressure is reduced and the more the ship will squat for a given engine power. Also, the faster it goes through the water the more it will be sucked down for a given depth. Easy innit? The principle behind all that was first described in the 18th, Century by some foreigner called Bernouille. It is the same principle that gives aircrafts' wings 'lift' to get them airborne. If you turn it vertical it also governs the ability of sailing boats to beat to windward.

Now, the engineers on those ferries weren't necessarily suffering from the d.t's. The stones they could hear were lifted up by the 'upward squat' of the sea bed. That's because squat is an 'Inter' action. Those engineers thought the ship was running aground. It just so happened that the stones were in fact loose gravel lying on the sea bed and light enough to be lifted up by the suction before the downward effect on the ship became noticeable. Some years ago the master of a ferry running across the North Sea reported that he had hit the bottom on unreported sand waves. There never was any report of damage though undoubtedly the paint would have been polished from the ship's bottom. The same thing invariably happens when large ships are proceeding through dredged channels with fairly low underkeel clearance. The bottom mud is not just churned up; it's sucked up.

A few naval architects have spent much of their careers trying to reproduce squat either by experimentation in model tanks, direct observation of ships in canals or by producing mathematical formulae and graphs. Many years ago they even laid upside down echo sounders on the bottom of Southampton Water in order to measure the draught of large container ships while running up the channel at various speeds. The results of that experiment never seemed to be widely publicised. Perhaps they didn't like the results. However, their formulae have been widely distributed and consequently the old rule of thumb underkeel clearance of 10% of the stopped draught has been modified. That had originally been used to avoid grounding on siltation high spots and supermarket trolleys.

Once, a squashed motorcar was lifted from the bottom of the old Ocean Terminal in Southampton. Ships had been sitting on it for a couple of years before it was located. Sadly, it was found to contain the remains of two ladies ('of the night'?) who had never been reported missing.

Nowadays, most large ships are supplied with graphs or tables from the builders to enable the masters to anticipate their squat in shallow water. This even applies to the passage of deep tankers and ore carriers transitting the Dover Strait and the Southern North Sea. They have a maximum draught of 22 metres but the depth of water is mostly well under 30 metres. Similarly, squat has to be taken into consideration by ULCCs passing through the Malacca Straits between Malaysia and Sumatra (especially over the last twelve months).

Apart from sinkage, squat is also likely to affect ships' trim. Bluff vessels such as tankers and bulk carriers tend to trim by the head in shallow water while fine lined ships trim farther by the stern. This effect used to be particularly noticeable when tankers

tankers were loaded to maximum draught and even keel in rainy weather :- as they picked up speed proceeding down a river the rainwater would start to run forward all the way to the focsle bulkhead before splashing over the side, owing to the scuppers being plugged under the ani-pollution regulations.

Manoeuvrability is also affected because stopping distance and the diameter of the turning circle are both increased proportionally as the underkeel clearance is reduced (alright, so it's actually an inverse square effect; but whatever!). Directional stability is also progressively reduced so that ships tend to yaw about when they're supposed to be maintaining a steady course.

Another feature of squat is the wake. This steepens until a breaking wave occurs which then begins to overtake the ship. It is a phenomenon that cannot be ignored as the rough water makes quite a noise. At the same time, as the underkeel clearance is reduced, the water passing under the ship accelerates backwards slowing it down. Anyone who has explored the Midland Canals in a narrow boat will recognise the signs. Since the sea bed is seldom dead flat, the distance of various parts of the bottom plating are at different distances from it. This causes ships to appear to have lost stability so that they list or roll for no apparent reason. You may not be surprised to learn that the s.s. SHIELDHALL has never been reported to suffer from the phenomenon.

SON OF SQUAT

Just over a dozen years ago a large passenger liner hit the bottom off the coast of a foreign country while travelling at high speed. It suffered considerable bottom damage and had to be drydocked locally at enormous expense. Since the accident occurred within that country's jurisdiction the local coastguard instituted a one man formal investigation in co-operation with other branches of their administration. The immediate reaction on the day had been to breathalyse all those who had been on the bridge and to seize the echo sounder and course recorder traces for analysis. They naturally secured copies of every other relevant document too. They then made a hurried hydrographic survey of the area. The inquiry proceeded to blame the Master, the local coastal pilot and the lack of formal Bridge Resource Management (BRM). That means everyone checking everyone else. On the advice of experts it established that the actual cause of the damage was squat. The chart showed a depth of 39 feet of rocky bottom in the area of the grounding while the maximum static draught had been 32 feet 4 inches. They calculated that the vessel had squatted about 2 metres, or over 6 feet 8 inches in order to hit the rocks. This immediately began to appear as though the figures were being made to fit the facts of the incident.

However, subsequent surveys showed that the vessel actually hit rocks which did not appear on any chart and were 20% higher than the 39 foot sounding. In fact the lines of sounding on the government charts had last been run in 1939 and were separated by 1300 feet. This distance was greater than the length of any ship then afloat. Each line produced a known depth zone 20 feet wide; in other words 98% of the area had never been surveyed.

Diving inspection of the rocks actually struck by the ship showed that they bore abrasions and streaks of red anti-fouling paint. They were subsequently given the names 'Red Rock 1 to 6'. They were found to be rounded boulders up to 12 feet in diameter. They obviously did not belong to where they were found but were reckoned to be what are known as 'erratics'. Such rocks are typical of those caught up in glaciers, calved off in icebergs, and subsequently dropped wherever the iceberg melted. These particular specimens probably fell to the seabed at the end of the last ice age, possibly as recently as 10,000 years ago. Nowadays hydrographic surveys include the use of side scan sonar. This would have filled in the spaces between the lines of vertical echo sounding and would have indicated such anomalous blobs.

It transpired that the ship never passed over the single 39 foot sounding at all. Moreover, we know the area of the Red Rocks was infinitesimal compared with the area of the ship's bottom. The seabed, 12 feet below would have caused some effect but we know that must have been very slight because no one on board detected any wake change, noise, water covering portholes or loss of speed.

Shortly after this disaster the country concerned issued a chart correction indicating 'Rocks Reported (1992) 34',32'. This was a minimal response since the rocks' position and depth was well known by this time while they had also been photographed and analysed. It also transpired that local fishermen had earlier been complaining about these rocks snagging their trawl nets.

As you can imagine, if a civil court action determined that the cause of the accident had been neglect of duty of care by the government's charting organisation, the cost in compensation and loss of face would have been very embarrassing. In fact, suits were prepared and at least one action proceeded for a while but then was quietly dropped. No one could say for sure why they were not proceeded with in the courts but governments can make life very difficult for foreigners trying to do business within their jurisdiction.

Anyway, that was just about the biggest fuss over squat to hit the headlines but it turned out not to have been well thought out by the experts. They simply threw a formula at the figures they were given without pausing to research whether those figures were even applicable.

Makes you think, dunnit?

Ian Stirling

Any connection between the large passenger liner pictured on the right and the events detailed in the above article are purely coincidental. I had a couple of column inches to spare and thought that the picture would look good here. Ed.