Research on the Safety of Fishing Vessels Moored in Typhoon Weather

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Abstract. As the first country of the global fishing, and year-round infestation by Typhoon in China, led to casualties among fishermen, significant economic losses, in order to better protect the safety of fishing boats in the Typhoon weather anchor, the paper around the anchorage of water depth, bottom topography, wind, wave and current ways of anchoring, to discuss research, Provide a reference for the mooring of boats better resistance and learn from.

1. Introduction

Our country is located in the Pacific Northwest, under the influence of tropical cyclones in the Northwest Pacific. The most important South China Sea and East China sea areas in the 4°N-32°N range, tropical air spinning mainly in the southern and northern hemispheres of 5°-20° between latitudes. According to the Chinese Academy of Sciences 2015 report: is the world's most active tropical cyclones in the Northwest Pacific region, about 1/3 tropical cyclone of this build, about 1/3 belongs to the Typhoon a tropical cyclone. More specific data that the perennial typhoon disaster in China; according to the fishing industry in China on the latest reported: my vessel number 104 Ranked first in the world, accounting for total world 1/4, and this data is also increasing, such a huge economy, casualties and economic losses caused by the typhoon disaster every year would be disastrous. Aiming at these problems around the anchorage of water depth, bottom topography, wind, waves and currents, anchor for major wind factors discussed proposed fishing how to effectively secure anchoring technology in Typhoon weather, Typhoon mooring for fishing vessels to provide information and reference.

1.1. Site Selection

Because of modern weather forecasting system developed, fishermen will receive a message a week before the typhoon, so most of the fishing boats moored in advance in ports or docks specified General or special anchorage, mooring location unified guidance if no relevant authority is determined by the fishermen themselves, You need fishermen according to the characteristics of fishing vessels from the sheltered conditions, anchorage water depth, bottom topography, leeway to choose a suitable mooring position.

1.2. Anchorage Water Depth

Choose a suitable mooring depth is essential to ensure the safety of fishing vessels. If the water is too shallow, wave goes under, mooring boats prone to stranding incidents, damage to the shaft; if the water is too deep, for fishing, and very easy to anchor and anchor windlass anchor hard after the typhoon caused damage or even lost an anchor. No fixed depth to anchor, you can refer to the mooring buoy anchorage required minimum water depth, when mooring, anchorage is the minimum water depth required for a lowest estimation according to the following formula [1].
\[ h = k \times d. \]  

Where \( h \) is chart depth, \( d \) is maximum draught ship at anchor, \( k \) is coefficient of resistance.

1.2.1. Choose Special Depth According to the Weather Forecast. If the weather forecast of this typhoon is large, and I ship type is small, cannot be fixed in the above deep water anchorage, chose to sit by the beach. Anchorage in Southeast China geology is relatively soft, silt, clay, aground to avoid for years by local fishermen, but it is not applicable to all anchorage, first end of anchorage terrain is relatively soft, by mud and clay, to reduce the damage to the fishing boat shafting then to note that typhoon winds should be and mooring boat fore and aft to avoid capsizing, increasing the moment. In addition, chose to sit by the beach havens also need to avoid storm surges and astronomical tides, because fishing boats as the tide rises, easily dragging anchor.

1.2.2. Sediment and Topography. Ensuring the quality of anchoring is another key factor lies in choosing the right substrate. Holding capacity can be estimated from the equation.

\[ P = P_a + PC = \lambda_a W_a + \lambda C WCL. \]  

Where \( P_a \) is holding capacity; \( PC \) is holding power of anchor chain; \( \lambda_a \) is anchor holding power coefficient, which is an anchor holding power and anchored in the ratio of the weight of the air; \( W_a \) is anchored in the air; \( \lambda C \) is holding power of anchor chain factor, it is the cable grip and cable in the ratio of the weight of the air; \( WC \) is weight per meter mooring in the air; \( L \) is ground cable length that is equal to the chain length minus the length of the suspension parts[2-3]. According to grasping experiment of sandy bottom, clayey bottom anchor holding power coefficient \( \lambda_a \) Large and hard soil, sand anchor holding power coefficient \( \lambda_a \) Smaller, easier to anchor. So, Choose sand or clay-quality seabed better, sediment mixed end of line, Try not to choose a hard soil, and sand bottom areas broke down.

Flat topography is conducive to anchoring quality. Seabed terrain is flat or not for fishing this type of poorly equipped boats, it is difficult to determine, contours on a chart is a more scientific approach, try to avoid the isobaths denser waters or seabed conditions unknown waters. Of course, near the wrecks, reefs, including areas such as ship safety should also pay special attention to.

1.2.3. The Room for Maneuver. Anchor Also need to consider whether there is a risk of collision, so how do you identify with his ship without a collision danger? The latitude range of single anchored vessel as a reference value, single mooring waters occupied an area of a circle. In addition anchoring the stern of the ship and navigation buoys, fixed facilities and satisfy the depth requirement borders the waters of 2 3 Times the captain's safe distance to spare.

2. The Effects of Wind
The Chinese fishing vessel safety analysis report (1999-2003) displayed 428 ships accidents in typhoon, which occupied fish ships’ 52.6%. In certain circumstances, wind speed, wind direction, wind area effect wind pressures. The wind pressure coefficient Relative bearing is closely related with the wind, and the relative wind relative bearing equals 00 or 1800, wind pressure coefficient is the smallest; when relative wind bearing is approximately 300 or 1600, this coefficient is the largest. Wind speed affects fishing dragging and overturning, and can result in other damage. Fishing boats anchor should be selected according to the typhoon wind azimuth direction. Typhoon fixed ships fore and aft and to the agreement. Specific methods for the stern with a cable attached to a fixed object (float), stand up to wind, the bow shot eight anchors fixed shipping, using triangular fixed characteristics of resistance.
3. The Effects of Stream
The effect of water for fishing vessels safe mooring is an important key point. When ship anchoring, there exists a stream pressure force, because of the presence of relative motion between ship and water. This pressure can be calculated as the following:

\[ Y_w = \frac{1}{2} \rho C_{wy} V_w^2 L d \]  
(3)

Where \( \rho \) is water density (kg/m\(^3\)); \( C_{wy} \) is pressure coefficient; \( V_w \) is the relative water’s velocity; \( L \) is ship's length (m); \( d \) is ship's draft (m). Different ship types, different ratio of water depth and draft, stream pressure forces vary. Stream pressure forces can be shown in table 1 under different condition.

Table 1. ship’s stream pressure forces

| Ship condition | pressure forces (N) under different stream velocity |
|---------------|---------------------------------------------------|
|               | 1(0.514m/s)                                      | 2(1.028m/s)                                      | 3(1.542m/s)                                      | 4(2.056m/s)                                      |
| Drift angle 90° (H/D=1.1) | 39 762.4                                      | 159 049.1                                      | 357 860.2                                      | 636 195.6                                      |
| Drift angle 10° (H/D=1.1) | 43 22.0                                       | 17 288.0                                       | 38 897.9                                       | 69 151.7                                       |
| Drift angle 90° (H/D=7)    | 864.4                                         | 3 457.6                                        | 7 779.6                                        | 13 830.3                                       |
| Drift angle 90° (H/D=1.1)  | 58 702.9                                      | 234 811.6                                      | 528 325.6                                      | 93 9245.9                                      |
| Drift angle 10° (H/D=1.1)  | 6 380.8                                       | 25 523.0                                       | 57 426.7                                       | 102 092.0                                      |
| Drift angle 90° (H/D=7)    | 1 276.2                                       | 5 104.6                                        | 11 485.3                                       | 20 418.4                                       |
| Drift angle 90° (H/D=1.1)  | 70 972.9                                      | 234 811.6                                      | 638 755.5                                      | 1 135565.7                                     |
| Drift angle 10° (H/D=1.1)  | 7 714.5                                       | 25 523.0                                       | 69 430.0                                       | 123 431.1                                      |
| Drift angle 10° (H/D=7)    | 1 542.9                                       | 6 171.6                                        | 13 866.0                                       | 24 686.2                                       |

From the above data, we can see that leeway angle is smaller, the force is smaller; the ration of water depth and draft is greater, the force is smaller. And if drift angle changed of the ratio of water depth and draft changed, the pressure changed great, the effect is very significant. Fishermen should be clever use of this feature, the ship moored fore and aft when aligned with the direction of flow, to reduce the strong water pressure, but beware not moored in the Typhoon and the current whereabouts of waters, Flow pressure and wind pressure for ship's direction, the force added, easily lead to a ship's anchor chain rupture accident. In summary, choose better sheltered sea anchor to avoid, because the shield zone water stable, no reflow and flow rate is small.

4. The Effects of Wave
Though with the strength, fishing management standards, but There are a lot of wood in coastal inshore fishing boats. These wooden fishing boats aging, ship type is small, poor and water tightness, it is difficult to maintain a floating State, storm-proof ability. Typhoons are sure to bring waves, huge waves easily fishing upset or cause fishing vessels dragging anchor. According to marine incidents occurring in waves that, Ship heading for transverse waves, waves and first corner 135°~225° Most prone to capsizing when the waves [4]. Recommended fishing boats to do the following things:

(1) Keeping good water tightness: mooring at a time when need to check the vent, the watertight doors is closed, broken or missing should be updated in a timely manner;
(2) Ensuring good drainage system: Normally should be regularly check the drain, drain hole, sewer is smooth;

(3) Enhancing marine wind resistance: Fishing vessels anchoring meet right after the metacentric height, proper ballast, to improve storm-proof capability.

Reasonable operation and avoidance of advance preparation is very important. Typhoon approaching vessels in previous years to avoid in the process of fishing crews often don't prompt attention to Meteorological Center issued the typhoon forecast, resulting in a typhoon fast approaching panic feel free to select a nearby anchorage, anchorage found poor or unsuitable for this ship type and then find an anchorage, sail under the big storm, resulting in channel congestion, overturning or collision, and regulation of relevant management departments is a big trouble. Ship type of anchorage and anchorage are not suitable and appears wasted, greatly weakening the resistance capacity. Therefore, fishermen should focus on early Typhoon forecasting, for harbor anchorage information, choose in advance of the ship's anchorage and other preparatory work.

5. Anchor Methods
Choose the right way of anchoring effect of anti-matter. The choice of anchor way is not a constant dust, but to consider the intensity of typhoons, wind pressure, flow direction and magnitude, their ship type, such as a combination of factors to decide on one way to avoid one.

In China's Southeast coastal areas, since ancient times, formed by local fishermen sit side-by-side Beach havens, has been very good to avoid the effect on the ground. Of course, in other areas, investigation and experiment to meet the conditions can also learn from this way to avoid. Apart from the Beach also uses mooring buoys to avoid, along the navigation channels, mooring, a former cable attached to a buoy, anchor by the stern, ship to ship with ropes fastened.

Anchor mooring or anchor can be divided into single and double two. Riding at two anchors on the basis of which the angle between the two anchors different is divided into eight-character anchor, one bolt and anchor three parallel. Based on fishing and the environment, anchoring and other characteristics suggested parallel anchoring resistance. Comprehensive earlier in this article for the sediment topography, wind, wave and current analysis results, fishing boat maintained Typhoon fore and aft and to the consistent good havens, anchoring in parallel can satisfy the above conditions have great advantages of anchoring force. And in the South China Sea, some parallel anchoring the captain after practice, good effect of avoidance. The following figure is shown for the parallel mooring.

**Figure 1.** Parallel mooring

Summary: Anchorage water depth, bottom topography, wind, waves and currents, anchor for major wind factor discussion, Comprehensive analysis available Fishing boats in the Typhoon weather According to their own ship characteristics, sediment topography and latitude, and select the anchor location; listening to the weather forecast, ahead of resistance, according to Typhoon strength and the choice of location for the ship mooring; according to the characteristics of wind, wave and current, adjust the best wind side angle, drift angle, area, On anti-wave measures in advance.
6. References

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