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# EFFICIENCY OF INVERSE BOW TECHNOLOGY OF MODERN VESSELS

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Inverted bow (inverted, reverse bow) is a variant of the front part of the vessel (bow), whose front point is not in the upper part, but in the lower one. This type of bow is inherent in many types of ships: yachts, cargo and military [1].

It is obvious that the inverted bow was not invented, in the 21st century. We can mention, for example, warships with similar bows centuries ago. Russian battleships of the Borodino class were equipped with the inverted bow, which, in their turn, was based on a French prototype and collapsed sides (Fig. 3). Vessels of similar design were built in other countries, in particular, in the United States, but later the inverted bow was almost forgotten [5]. Distant descendants of medieval Scandinavian warriors from the Norwegian company Ulstein claim that they returned to the well-forgotten old not even armored monsters of the beginning of the century, namely the Hokstad find and a number of other drakkars and knorrs (warships and cargo ships) of our time. The contours of the rounded bows of ancient ships inspired the authors of ships to design new vessels using X-Bow technology (Fig. 1-2).

In modern shipbuilding, the technology of the inverted bow is called X-Bow, and this name is used not just for the sake of originality. In the name X-Bow, the letter "X" sounds similar to the word "Axe" – indeed, the bow of the ship cuts through the waves like an axe.

Instead of simply rising on the waves and then falling with tremendous force, the X-BOW can distribute force evenly over its surface, allowing the ship to remain more stable in bad weather, increasing comfort for both passengers and crew. And because it uses less fuel to overcome waves, it also helps save energy. In stormy waters, shocks to the hull are reduced, which leads to reduced vibration. This is the peculiarity of the X-BOW design [2].

Fig. 1. Ship "Bourbon Orca" with technology X-BOW, 2006

Fig. 2. A new generation ship "Viking Poseidon", 2007

The Bourbon Orca, the first ship with X-Bow technology, was launched in 2006 (Fig. 1). The new X-BOW generation vessels have the best performance in bad weather. They are able to cross the stormy sea at high speed. There are two reasons for this, firstly, the main mass of the bow of a sea vessel is lower than usual, so such a vessel resists the oncoming wave better (Fig. 2), and secondly, in new vessels with a pointed bow the exit from the waves is gradual and smooth, rather than fast and intermittent, as in typical vessels [3].

The Norwegian company Ulstein Group was the first to use inverted bow technology in the construction of its ships. X-BOW (and later X-STERN) is one of ULSTEIN's major contributions to maritime history. X-BOW ships are built at the shipyards of many continents. Currently, more than 100 vessels with this concept of the bow are being built or ply in the world [3, 4] (Fig. 4).

In 2016, the world's largest new-generation stealth destroyer appeared in the US Navy (Fig. 3). The destroyer is 183 m long and 24.6 m wide. It has a crew of 148 people. The speed of the ship "Zamvolt" can reach 30 knots (55.56km/h).


Fig. 3. American destroyer type "Zamvolt", made by stealth technology with a nose X-BOW, 2016

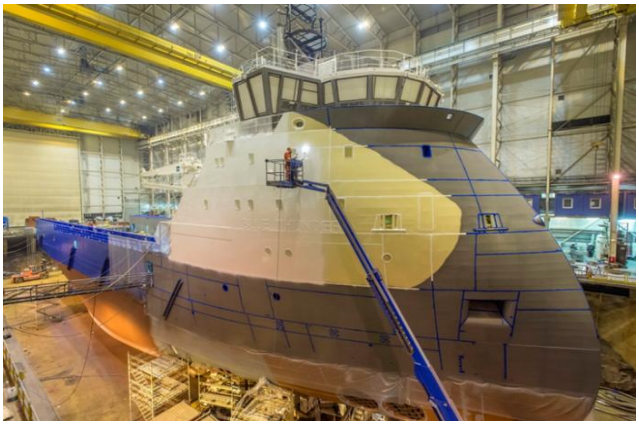

Fig. 4. Construction of the X-BOW building (Norwegian company Ulstein).

The destroyers are made with the wide involvement of "stealth" technology, integrated electronic weapons, as well as vertical launchers. The cost of a military "monster" is about $ 3 billion [5] (Fig. 4).

X-BOW enclosures are actually easier to build because the traditional enclosure has a bulb built into the X-BOW enclosure. This means that you do not have to use many plates with double curvature. It is much faster to build such a hull, and therefore, save of many working hours in the shipbuilding process are obvious [6].

**Conclusions**

Inverted bow technology is gaining popularity and is rapidly evolving in modern shipbuilding. This technology has a number of advantages over traditional raked bows, such as: increased energy efficiency; very low noise and vibration; reduction of blows to the bow and reduction of vibrations caused by waves; improved crew rest time; lower levels of acceleration; lower response in height due to volume; more comfortable conditions on board; reduction of speed loss; reduction of splashes on the deck.

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