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SHIPBUILDING INDUSTRY STANDARD, PRC

TechnoLogical Requirements for Ship Upgrading or Launching Relying on Air–Bags

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Preface

Ship launching or upgrading relying on air-bags is an innovative technology having promising prospect in shipbuilding. It overcomes the shortcomings of the fixed launching track, which limits the productive capability of the small and medium sized shipyards. Now it has become a Flexible Launching Technology, having the merits of time and labor saving, flexibility, reliability and safety in operation and comprehensive economic benefits etc.

In order to standardize this method, the present standard of shipbuilding industry is worked out.

Addenda A in this standard is a suggestive appendix.

This standard is put forward by the Shiprepair Technology Division of Sea-going Ship Standardization Technology Committee of China.

This standard is managed by Shiprepair Technology Research Institute of Tianjin.

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Technological Requirements for Ship Upgrading or Launching Relying on Air-Bags

1 Scope

The present standard prescribes the requirements on ship launching or upgrading by means of air-bags and the relevant equipments; the requirements on launching procedure, falling down from docking block, shifting of ship and the safety measures for launching and upgrading etc.

The present standard is applicable to launching and upgrading of ship relying on air-bags.

2 Reference standards

The articles of the following standard, if once quoted by the present standard, shall constitute a part of it and be in full effect at the time of issuing. All the standards can be revised and all the parties that use the present standard should discuss how to use the latest edition of the following standards:

CB/T 3795-1996 Air bag for ship up to or down to launching way

3 The requirements of launching ship and relevant equipment

3.1 Ship

3.1.1 The engineering work under waterline shall wholly be finished, especially those equipments, valves and others that are to be installed at the openings under ship waterline. The installation should be approved by inspection.

3.1.2 All the burrs, welding beading and the like on the ship bottom or appendages should be ground away.

3.1.3 All the welds on the shell plate (i.e. new welds for the ship repaired) must pass inspection and tightness test.

3.1.4 The main dimensions of the ship should be measured up and the mark of loadline must pass inspection.

3.1.5 All the paint work of the shell plate has been finished.

3.2 Ramp way

3.2.1 The ramp way on which the air-bags will rolling should be cleaned and be clear of sharp ends such as iron nail.

3.2.2 The ramp way should be leveled and the level error from left to right should be less than 80 mm. The ground caved in should be filled up and the ground bearing capacity should be relatively equalized.

3.2.3 The ramp way may be of mud land, sanded land, sands or concrete, however, its bearing capacity should be twice as big as the working pressure of air-bags.

3.2.4 The slope of ramp is to be determined according to the size of the launching ship and is

generally no bigger than 1/7. In the range of the whole length of the ramp way, the shape may be of multiple combination with slope line, arc line and others. However, the ship bottom shouldn't contact the ground even when the air-bags are at their lowest working height.

3.2.5 The ramp way should extend into water for certain length.

3.3 Air-bag

3.3.1 Air-bags should pass the inspection according to the regulations of CB/T 3795. They have to take no load air filling test every time before it is used to launch or to upgrade a ship. The test pressure of filling air should be 1.25 times of working pressure of the corresponding diameter.

3.3.2 For conventional ships the quantity of rolling air-bags can be calculated by formula (1):

$$N = K_1 \frac{Q \cdot g}{C_b \cdot R \cdot L_d} + N_1 \quad \cdots\cdots (1)$$

where: N is the quantity of rolling air-bag, in pieces;

K_1 is constant, $K_1 = 1.2 \sim 1.3$;

Q is the weight of launching ship, t:

g is acceleration of gravity, m/s^2;

C_b is the block coefficient of launching ship;

R is the allowable bearing force per meter of air-bag length, kN/m, see table 3 in the standard CB/T 3795-1996;

L_d is the contact length between ship bottom and air-bag body at the midship section, m;

N_1 is the quantity of air-bag replaced continuously, in pieces; normally it takes 2～4 pieces.

3.3.3 The center distance of two neighbouring air-bags should meet the needs of structural hull strength, and avoiding overlapping of rolling air-bags as well. As a rule, the center distance may be checked by using formula (2) and (3):

$$\frac{L}{N-1} \leq 6 \quad \cdots\cdots (2)$$

$$\frac{L}{N-1} \geq \frac{\pi D}{2} + 0.5 \quad \cdots\cdots (3)$$

where: L is the length of launching ship, m;

N is the quantity of rolling air-bag, in pieces;

D is the nominal diameter of rolling air-bag, m.

For ship with fine ends, the counting length L is the length overall subtracted by the length of fine ends that are unsuitable for cushioning with air-bags. If the ship has special needs on structural hull strength, the center distance between two neighbouring air-bags may be arranged according to the actual conditions.

3.4 Winch

3.4.1 In general, a slow winch is to be selected, its veering speed is about 9～13m/min.

3.4.2 The slip force of launching ship and the hauling force of winch wire are shown in figure 1 and can be calculated by formula (4) and (5):

$$F_C = Q \cdot g \cdot \sin\alpha - \mu \cdot Q \cdot g \cdot \cos\alpha + Q\frac{V}{T} \quad \cdots\cdots (4)$$

$$F \geq \frac{KF_C}{N_C \cdot \cos\beta} \qquad \cdots\cdots (5)$$

where: F_C is the slip-down force of launching ship, kN;

Q is the weight of launching ship, t;

g is acceleration of gravity, m/s^2;

α is slope angle of ramp way, (°);

μ is friction coefficient of ramp way;

V is moving speed of ship, m/s;

T is time needed for braking the winch, s;

F is the hauling force of winch wire, kN;

K is safety coefficient, $K = 1.2 \sim 1.5$;

N_C is the number of hauling wire on the moving tackle;

β is the included angle between the hauling wire and the ramp way, (°); As a rule, β shouldn't be more than 6°

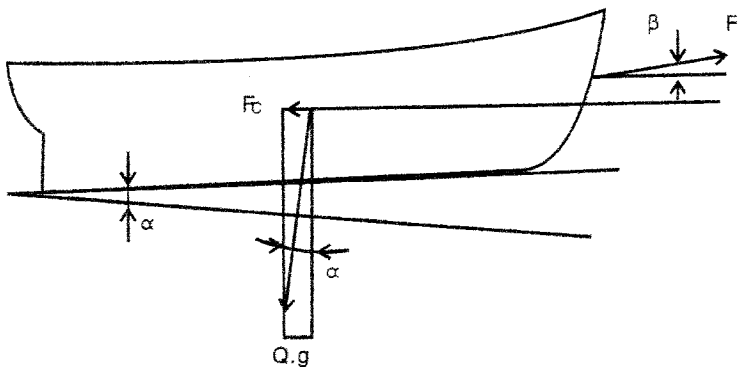

Fig.1 The analysis of forces on launching ship when it is on ramp way

3.4.3 The moving speed of a ship mustn't be more than 6 m/min with the control of hauling force of winch wire. If the ship weight is less than 200 t, the moving speed can be increased properly.

3.4.4 The wire must be inspected and replaced with regularity.

3.5 Air compressor

3.5.1 The type and capacity of the air compressor is to be selected according to the total volume of all the air-bags provided for the launching and the time required for air filling and the air pressure.

3.5.2 The gas tank of air compressor should be installed with adjustable pressure-limiting valve.

3.5.3 When multiple air-bags are cooperatively working (see fig. A2) a distribution manifold should be provided, such that every air-bag will be filled at the same time.

4 The operative procedure of launching

4.1 Clear all the obstacles away from the place that is under the ship bottom and ahead of the air-bags' rolling path.

4.2 Fasten the ship to the moving tackle of winch with guy rope, the strength of which must

meet the requirement of the hauling force, and the guy rope should be led into the bow and tied to the strength member such as bollard. Upon necessity, it is permissible to tie up a part or the whole of the ship.

4.3 Disassemble and remove all the docking blocks under the ship bottom and put the rolling air-bags in with the spacing fixed by calculation; finally the ship weight is entirely borne upon rolling air-bags.

4.4 The workers following the ship launching shall get on board, then the ladder, bridge approach and others can be removed away from the ship.

4.5 Start the winch, release the wire from the winch, and set the ship moving to the water on rolling air-bags.

4.6 According to the conditions of ramp way and waters, choice can be made between rapid launching and launching under winch's control at the end of launching way.

4.7 Tow the launched ship to wharf.

4.8 Retrieve all the air-bags.

4.9 Measure the forward and aft drafts of the ship and inspect every compartment against leakage.

5 How to let a ship falling down from docking blocks and the matters for attention

How to let a ship falling down from docking blocks and the matters for attention are described in Addenda A (a suggestive appendix).

6 The requirements of shifting ship

6.1 The rolling air-bags under the ship bottom should be arranged in single rank if possible, and the axial center line of all the rolling air-bags should be perpendicular to the moving direction. It is inadvisable to extend both ends of air-bag too much out of the ship sides. For such ships as towboat, fishing boat and the like, whose block coefficient is small, both ends of air-bag should be extended beyond the ship sides so as to gain good stability during ship shifting, and that extended length in each side must be longer than the diameter of air-bag.

6.2 In case of beamy ships, to arrange rolling air-bags in two ranks is allowed, and the space between two ranks of the rolling air-bags should be no less than 0.5 m.

6.3 In time of ship moving, the working height of rolling air-bags should be reduced as much as possible, usually no higher than 0.3 m; provided that all the protrusions such as rudder, stern post, propeller, etc. are out of contact with ground.

6.4 In case of level ground, the ship may be shifted by winch that synchronizes both releasing wire and drawing wire at bow and stern; if the ship is at ramp way, then it can be shifted only by releasing wire at bow.

7 Choice of the type of water entry and the protective measures

7.1 Choice of the type of water entry.

7.1.1 Calculate the free skid distance of the launching ship from the bank to waterway. If the waterway can't meet the need of skid distance, then the ship should enter into water slowly under the control of the winch.

7.1.2 If the waterway is wide enough and the slope angle of ramp meets the condition that tan $\alpha > \mu_0$, the latter being the static coefficient of friction, then the ship can be launched without

winch control, i.e. either by petican hook, or by wire cutting, such that the ship can freely into water by its own weight.

7.2 The protective measure against stern falling (or pitch-up of bow).

7.2.1 In accordance with specific conditions, ballast may be added at the bow so as to reduce the moment of stern falling.

7.2.2 In case of stern falling, the air-bag under the ship bottom which bears the highest pressure must be checked on its strength; if necessary, high-pressure air-bag is to be selected.

7.3 Bow protection after the stern floating up.

When the stern floats up, additional rolling air-bags should be arranged at the stem to reduce the spacing and to keep more air-bags bearing the load simultaneously; if necessary, high-pressure air-bag is to be selected there to ensure bow safety.

8 Safeguard

8.1 The winch's wire must have enough strength and be inspected and replaced with regularity. The winch operator should be qualified with certification. In the process of ship shifting, it is necessary to incessantly put the rolling air-bags under the ship bottom; Upon necessity, even to stop shifting for air-bag placing. Stopping a ship must be applied slowly to avoid large impact on wire caused by sudden brake.

8.2 When removing the docking blocks, the first thing to do is to disassemble the docking blocks in the center part of the transverse section; then from center to both sides in succession. When disassembling the final side docking block, the operator should stand out of ship side, and it is strictly prohibited to let any personnel go under the ship bottom again. A part of loose hard-blocks should be arranged under the bottom and near ship sides that will be disassembled at the final moment before ship shifting.

8.3 Sudden impact of the ship on air-bags under bottom during falling down from the docking blocks should be avoided.

8.4 The operator should learn the performances of air-bag, and should stand by the side of nozzle of air-bag for filling it with air.

8.5 The transverse stability of the ship should be carefully guaranteed both in the process of ship shifting and upon entering into water.

8.6 In case of fine-ended ship, special carriages can be added at the forward and aft ends.

9 The requirements on ship upgrading relying on air-bags.

9.1 Ship

9.1.1 Freight should be unloaded up; ballast water should be drawn up to the greatest extent; other weights should be removed from the ship as much as possible.

9.1.2 In case the ship bottom has thick marine lives, proper measures, e.g. using thickened air-bags, should be adopted to avoid air-bag broken by stabbing.

9.1.3 After knowing ship's main dimensions, hull form and relevant performances, based on drafts at the bow and the stern, the ship's displacement and the longitudinal center of gravity can be calculated by Bonjean curves. If Bonjean curves are not available, then estimate the total weight of the ship, taking the height of bilge water and the condition of outfit etc into account, and fully consider the quantity of air-bags required.

9.2 Ramp way

9.2.1 The ramp way should have certain bearing capacity, especially at the place where the first air-bag is to be put under the bow bottom; the bearing capacity should be two times bigger than the working pressure of the air-bag.

9.2.2 The slope of ramp that extended into water should be bigger than the actual slope of ship's keel, such that the ship's stern shall not touch ground.

9.3 Air-bag

When a ship with a V-type bow is upgrading, it is customary to select 1～3 shorter air-bags with higher capacity in accordance with the shape of the bow so as to put the air-bag into place and to take up higher air-bag working pressure for bow lifting.

9.4 Winch

The hauling force for upgrading a ship on ramp way can be calculated by formula (6):

$$F_d = Q \cdot g \cdot \sin\alpha + \mu \cdot Q \cdot g \cdot \cos\alpha \quad \cdots\cdots(6)$$

where: F_d is hauling force for upgrading a ship, kN;

Q is weight of ship, t;

g is acceleration of gravity, m/s^2;

α is slope angle of ramp way, (°);

μ is friction coefficient of ramp way.

And the hauling force in winch wire can be calculated by formula (5).

9.5 Operative procedure

9.5.1 Fastening the ship in accordance with the requirements of 4.2.

9.5.2 The ship, that has been moored to the end location, should be fixed properly according to the length of the ship, wind direction, wind force, current etc, such as shooting off ropes from both sides of stern to stabilize the location.

9.5.3 First of all, put some air-bags under the bow bottom, using one of following methods:

a) Insert some unfilled air-bag or not fully filled air-bag into the bottom of bow with centers aligned.

b) At one side of the bow pull the air-bag from another side to the bottom of the ship by bamboo stick or rope prearranged.

c) In order to utilize the tidal range, prearrange air-bags to the favorable place at lower tide. When tide rising, put the ship upon them and fill it with air so as to raise the bow.

9.5.4 When the ship's bow is jacked up by the air-bags, that have been firstly put, start the winch to draw the ship ahead. If it couldn't jack up the bow, then operator should change air-bag's position or increase number of air-bags till the bow rising.

9.5.5 According to the calculated requirement on air-bag spacing, put air-bags one by one from bow to midship, then to stern, till the ship lies up to the appointed position.

9.5.6 Jack up the ship with lift air-bags and set docking blocks.

9.5.7 Retrieve all the air-bags.

Addenda A

(Suggestive appendix)

The methods of falling a ship down from docking blocks and the matters for attention

A1 In case that the ship's weight is small and the shipyard has enough lift air-bags to jack up the ship levelly, put the lift air-bags under the ship, then fill the air-bags with air properly. When the ship bottom rises off the docking blocks, disassemble and remove the docking blocks step by step from midship to both bow and stern; at the same time, put in the rolling air-bags one by one according to the calculated spacing. Generally, in using this method, the lift air-bags can be turned straightly as rolling air-bags; for special case, it is allowed to remove the lift air-bags and to replace with rolling air-bags.

A2 In case that the ship's weight is relatively large, when the combined working of all the available lift air-bags and rolling air-bags(temporarily used as lift air-bags) in the shipyard can't jack up the ship levelly, then a method can be adopted by placing lift air-bag at the stern for jacking up. Select suitable position at the bow as the front fulcrum, then remove the docking blocks in front of the front fulcrum, place lift air-bag to the favorable position of the stern (See fig.A1), the ship bottom will rise off the docking block when the following formula (A1) is met by the launching ship:

$$W \cdot L_w > Q \cdot g \cdot L_{Qg} \quad \cdots\cdots\cdots(A1)$$

where: W is lift force caused by the lift air-bag that placed at the stern and after filling, kN;

L_w is the distance from the center of lift air-bag at the stern to the front fulcrum, m:

Q is the launching ship's weight, t;

g is acceleration of gravity, m/s^2:

L_{Qg} is the distance from the center of gravity of the launching ship to the front fulcrum, m.

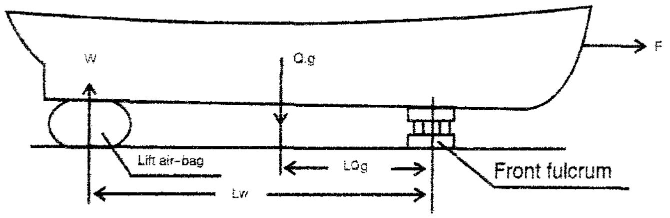

Fig.A1

Using this method to make a ship detached from docking blocks, the following matters should be yet paid attention to:

a) A combination of multiple lift air-bags, including the utilization of rolling air-bags as a part, can be used to jack up the ship as shown in fig. A2.

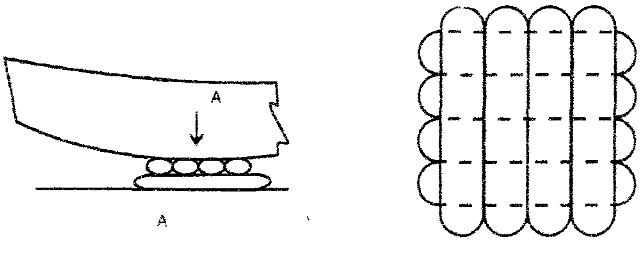

Fig.A2

b) To maximize the moment of jacking force caused by lift air-bag, the center position of lift air-bag should be the nearer to the stern the better. However, if the ship's hull at the stern is very fine, the contact area between the lift air-bag and the ship's bottom is very small, causing the jacking moment less than required, then, if moving the lift air-bag forward could increase the jacking moment, it is better to select a favorable position for the lift air-bag.

c) In case of the stern's bottom is high apart from baseline, the working height H is too high to produce enough jacking force, then it is imperative to move the lift air-bag ahead as shown in fig. A3, i.e. to move the lift air-bag from A to B to increase the jacking moment.

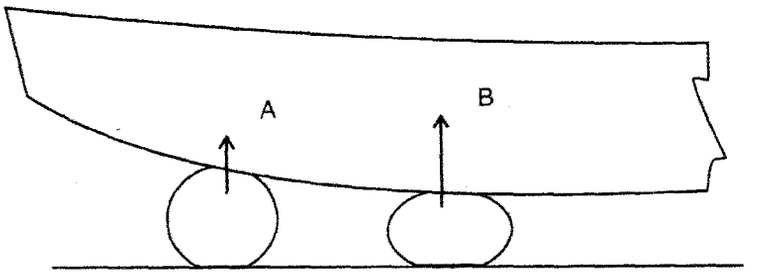

Fig.A3

d) The selection of position of front fulcrum should take into account the strength of the hull, during jacking and docking blocks removing. Generally, the fulcrum should be located at the nodes of both longitudinal strength members and transverse strength members so as to minimize the deformation of hull.

e) The nearer the front fulcrum is to the center of gravity, the easier it is to jack the stern up, but all the docking blocks in front of the front fulcrum must be removed before jacking the stern up. This job is so big that it might counterweigh all the merits of jacking stern up by lift air-bag. Therefore, the position of front fulcrum should be selected according to the conditions of both the ship and the site as well as the quantity of air-bags.

A3 After the position of front fulcrum is determined, according to the ship's weight, it is necessary to set docking block with enough strength at that position, so as to ensure both the ground (berth) and block self strong enough to bear the ship's concentrated load.

A4 Disassemble and remove all the docking blocks in front of the front fulcrum.

A5 Disassemble and remove all the docking blocks at the place where the lift air-bag to be installed subsequently. Then the lift air-bag shall be filled with air.

A6 Once the ship's bottom leaves the docking blocks, removing the docking blocks shall take place; at first from midship toward the stern, one after another. According to the requirement on rolling air-bag spacing, put in the rolling air-bags subsequently at the right transverse section and fill them with air at once. Likewise, remove the docking blocks at the stern one by one and put the rolling air-bags in accordance with the calculation requirements.

A7 Adjust the internal pressure of the filled rolling air-bags and the lift air-bag, then remove the docking blocks from midship to the front fulcrum one by one as explained in A6, and put the rolling air-bags in immediately. If the above method does not answer the purpose, then it may be required to disassemble the lift air-bag and place it at the bow for jacking up so

as to complete the job of ship falling at the fore end.

When all the rolling air-bags have been installed and all the docking blocks removed, adjust the internal pressure of all the air-bags so as to allow the ship falling down to the working height of rolling air-bags.

A8 The lift force of lift air-bag can be calculated by the following:

a) In case of having only one air-bag to work, the lift force can be determined according to Table 3 of CB/T 3795-1996 and the actual contact length of air-bag.

b) When the air-bag surface contacted with hull to be of curvilinear surface, the lift force equals to the product of orthogonal projection area of contact surface and internal pressure of air-bag.

c) When using combination of multiple air-bags, including multi-rank air-bags overlapped across, to take up the jacking, the contact area should be the sum of orthogonal projection areas of all the top air-bags that contact the hull, and the lift force equals to the product of the contact area and internal pressure of top air-bags.

A9 For shipbuilding or ship-repair, if the ship's baseline is too high from the ground, then a temporary mid-platform can be set up, and the falling process can be divided into two steps; at the first step, put the lift air-bag on the mid-platform to let the ship falling from high blocks down to low blocks; at second step, remove the mid-platform, then remove all the low blocks as shown in fig. A4.

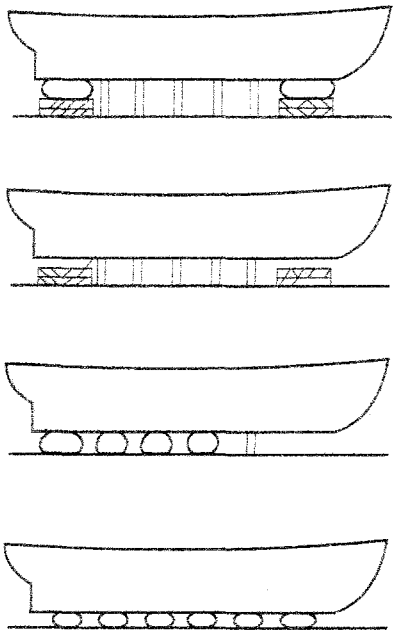

Fig.A4