12TH APRIL, 1888.

"ON OUR HARBOUR STEAMERS."

By Henry Selfe.

About April, 1887, the Balmain Steam Ferry Company advertised for competitive designs of a new ferry steamer specially adapted for their business.

On hearing this, the author considered that, as he had so severely criticised the existing ferry steamers in his previous paper, (*vide* "Proceedings," Vol. II.), he was almost bound, as a matter of honour, to submit a design embodying what he considered improvements.

The blue print now before you is the design that was sent in to the competition; it was accompaned by a quarter model, and a letter pointing out the special features that were claimed to be embodied in it, and was in the name of Norman Selfe, Member of the Institution of Naval Architects, England.

The author had the assistance of his brother in the working out of the design, and was of opinion that, coming from the same source as the greater part of the previous improvements in our harbour steamers are generally acknowledged to have emanated from, it would at least have met with some consideration, or have secured a full inquiry into its peculiar and novel features. But what do you think really happened? The design was thrown out without comment or thanks, and after some weeks had elapsed the gentleman who had sent it in had a notification to remove it, and that is all he has ever heard about it. Since the return of the plans, however, the following objections said to have been made to the vessel have by some means come to light.

1. She would be too weak for going alongside the wharfs.
2. The weight was too high.
3. She would be top-heavy.

These deeply studied opinions the author will endeavour to explode before he reaches the end of this paper.

GENERAL DESCRIPTION OF THE VESSEL.

The vessel is 110 feet on the keel and 103 feet between stems, 120 feet over all; 28 feet beam, with one foot of sponson amidship; 8 feet deep, with 1 foot of shear. She has a displacement of 104 tons, drawing 5 feet 4 inches of water without the keel; and this is as near as possible the total weight of the ship with fuel and water on board for a day's work, the weight being made up as follows:—

Hull, including deck	41 tons
Cabins sides, casing, and iron framework	3½ „
The two punts	5½ „
Bridge and iron roofs	3½ „
The seats	2 „
Iron in stearing gear, bollards, staunchions, etc.	2½ „
Engines and connections, shafts, etc.	14 „
Boiler and mountings, plates, etc.	15 „
Water in boiler	9 „
Tank and fresh water	3 „
Coals	2 „
Total	101 tons.

The vessel in the above condition will have over 50 per cent. of reserve buoyancy, which is equal to another 100 tons. Allowing that she carries 750 passengers at 15 to the ton (which is a heavy allowance), we still have 25 per cent. of reserve buoyancy with the largest possible cargo she could get; but should this be considered too little, then a few more frames amidship will soon settle the matter, for by adding 10 feet more in length, the displacement at 5 feet 6 inch load line is increased by 16 tons. The boiler is 10′ 0″ x 10′ 0″ of steel, with two furnaces, and constructed for a working pressure of 100 lbs. per square inch. The engines are compound 15-in. and 30-in. diameter x 20-in. stroke. There is a superficial area of 1,600 feet on the main deck available for passengers, without the sponsons, and 600 feet on the bridge, without the punts. There are 380 running feet of seats on the lower deck, and 400 feet on the upper one, making 780 in all, being 28 per cent. more than the best seated ferry steamer of her size in the harbour. It may by some persons be considered strange that the author proposes to put in ordinary compound engines, and an apology might be offered for being so much behind the age in this respect, but progress must be fettered sometimes, in order that prejudices which existing powers may have against advancement may not be too far overstepped. Triple expansion engines are now, of course, in every day use, and an accomplished mechanical success, showing a saving of from 18 to 25 per cent. of fuel over the ordinary compound engine; but even without this they are so well balanced, that the absence of vibration in them and their certainty in reversing, would be quite recommendation enough for their adoption in such a boat as the one before you, if our motto, "Advance Australia" is to have an application to ferry steamers.

SPECIAL FEATURES OF THE VESSEL.

There are certain qualities claimed by the author for this V section boat, which he will not only describe but practically demonstrate this evening, by the aid of the model and apparatus now before the meeting. It must be understood that these are not submitted as specimens of workmanship, but are intended to make the points manifest to those who cannot understand or interpret the working drawing.

SAFETY.

The vessel is constructed with five water-tight bulkheads, which in no way interfere with the working of the ship. Any one of the six compartments thus formed can be run into and filled without causing the vessel either to sink or to list over. The bulkhead between the engine and boiler, as will be seen, is no obstruction to the working; and should the vessel be struck on this, so as to destroy it entirely (which is very improbable) and allow the two compartments to fill, she would not even sink then with 500 passengers on board, but remain perfectly upright, and should any extraordinary circumstance occur to fill three compartments, we have still the two life rafts formed over each end, that will remain intact until they float off. They are not more expensive to construct than ordinary decks, and these deck rafts are capable of carrying the whole of the passengers, should it be so required for them to do so, as each one has a capacity equal to 36 tons. They should be allowed to carry 125 passengers on each under ordinary circumstances, allowing five square feet to a passenger, and would float with this number and leave a freeboard of about 18 inches all round, or carry double that number with over a foot of freeboard. If we consider this deck or raft to be made of timber weighing 40 lbs. to the cubic foot, the total weight of the whole will then be about two and three-quarter tons; if anything should even happen to swamp this, we still have a raft of timber with a floating power of about one ton, sufficient to keep all the people that could stand on it head and shoulders above water. This, even, would surely be a condition of affairs preferable to that of the ferry steamer which recently collided and sank in Sydney Cove without leaving so much as a single plank on the surface of the water to assist in saving life, and lucky it was that none required it. The whole of the double seats shown are also detached, and can be used for life-saving, should they be required. Several of the author's friends have made some very startling remarks concerning these punts, one of them saying that they would be sure to get fastened down somehow, and that the paint would stick them; while another one asserted that they would be blown off by the first southerly buster. The two opinions you will see, scarcely agree, and it will, perhaps, be admitted that a deck weighing about 3 tons 5 cwt. with seats and all, would require a strong breeze to move it off its sockets; and, further, a punt with 36 tons displacement would want some good wire nails or paint to hold it fast enough to take it under water. Another idea seems to exist also, that there might be some difficulty in securing these punts without bolting them down, but after a moment's consideration by a mechanic, he would suggest many ways for effecting this. The forward punt is supported on a framework made of $\frac{3}{16}$-inch plate and angle iron, supported on boiler tubes, with a fancy capital and base cast on them; they are bolted on to the deck, and the strain that comes on them is carried through to the bottom of the ship. The angle irons above are turned up at the ends in the model to keep the punt on, but possibly some hardwood pegs driven through the holes in the angle irons and into the beams would be better. The after punt is the top of the cabin, and requires no fixing; in fact, in all our present ferry steamers the upper deck has no knees on to it, and, therefore, it adds nothing to the rigidity of the sides of the cabin. If a saw-cut was put all round, a few inches below the deck, and a plate was put on both sides and bolted through the lower part so as not to grip the upper one, the deck would be the same as now, and free to float off should the vessel sink. The decks in existing vessels (supported on the orthodox 4 x $2\frac{1}{2}$ beams with the chamfered corners) might be treated in a similar manner by sawing them through six inches from the top, and then bolting on a brass capital in two pieces, forming a socket for the upper piece to fit in; or, perhaps, as a preferable plan, a casting could be made to fit on the post for the fore and aft stringer that supports the beams to fit in.

The original intention of the designer was to make the vessel 10 feet longer, and the wooden quarter model is made to that length, but the length of the vessel required for the Balmain Ferry Co. being limited, that extra length had to be taken off in the drawing which reduced the displacement at 6 feet draught by 19 tons.

It appears that the relationship between speed and safety is not very generally understood; at least, such may be inferred from a proposal that was lately made to limit the speed of our harbour steamers in certain waters, with a view to greater safety, the fact evidently being lost sight of that such a regulation would tend to make owners put less power into them, and where there is less power to go ahead, there is of necessity less power, in a far greater ratio, to go astern. The resistance of water to a vessel's progress is, as generally accepted, as the square of the speed, and, therefore, a vessel going at ten knots would have four times the resistance to commence bringing her to a standstill that a similar vessel going five knots would; but as the power required is as the cube of the speed, the ten-knot boat would have eight times the engine power to stop her and bring her astern that her slower companion would have, and the result would be to stop her in an incredible short time by comparison. How short this time and distance may be in a full-powered boat may be illustrated by an experiment that was made with the "Port Jackson" Co.'s steamer of that name, which was brought to a complete standstill in less than two of her own lengths, by suddenly reversing the engines when she was going at the rate of twelve knots an hour. After some consultation, the distance she travelled was allowed to be 180 feet. In designing the boat now before you, the author had some notion of extending the forefoot at both ends, and of putting smaller balanced rudders made to work together, in order to increase the steering power; but advanced ideas must be administered carefully, for, as it has been already shown, the shape of the vessel alone caused her to be discarded as top-heavy and unsafe.

STABILITY OF THE VESSEL.

In speaking on this part of the subject, it is the intention of the author to endeavour, by the use of a few simple blocks of wood and a five-gallon oil drum, to explain some of the first principles on which the stability of a vessel depends, and should any of the more learned of our members during the course of the discussion choose to treat the subject in a more scientific way, it will in all probability, be instructive and interesting.

That the principles which are the cause of a vessel standing up in the water are generally misinterpreted may be clearly inferred from the remark so often repeated, "that the model before you has no bearings," the impression evidently being that what is required to make a vessel stand up on the beach is just as necessary in the water. That the reverse of this is the case is clearly visible to any observant person, for squared timber, even if a little less than half the weight of water, always floats corner up; so that in this feature of the design, as in another one that will be referred to hereafter, it is only the operation of natural laws that are being utilised, however much they have been overthrown by old and orthodox fallacies.

Before entering on the experiments and their practical explanation, it is just as well that there should be an understanding as to the terms about to be used, so that there may be no misunderstanding either now or during the discussion.

Stability, then, may be defined as the increasing power a vessel possesses, as the angle of inclination increases, to resist a force that tends to list her from her natural position.

Stiffness is the resistance offered by the vessel to being listed from her natural position, and in all cases it varies, more or less according to the angle of inclination; or it may perhaps be better defined by the height which a weight can be carried above the deck without listing the vessel.

The centre of gravity is the centre of gravity of the whole weight of the ship, and as we have nothing to do with the pitching motion we will consider it the centre of the line running fore and aft that the vessel would balance on if put in a lathe.

The centre of buoyancy, or, as it is sometimes called, the centre of gravity of displacement, is the centre of gravity of the bulk and weight of water that is displaced by the ship as before described, which displacement is, of course, exactly equal to the weight of the ship.

The metacentre is an imaginary point from which a curve is struck on which the ship rolls when subjected to any power which has a tendency to list her over from her natural position.

The theory of the metacentre was first introduced in France by Mons. Bougeur, and it has been looked upon with great favour both there and in the old country by those more advanced in scientific knowledge; it is always used in, and is especially adapted for, calculating the stability of ships of war, where their armament and plating takes the place of the cargo in the merchant ships. In this class of vessel the metacentre is almost a fixed point, and it is only in the case of all the bunkers being half emptied at once that the metacentre would be somewhat raised. Its consideration has not hitherto come much into use among our merchant shipbuilders, but some of the most prominent of them, notably Messrs. Denny and Sons, furnish all the vessels they build with a book of diagrams, showing the curves of stability at different drafts and angles, with general cargo. This, of course, can be done with a greater degree of accuracy in a steamer than in a sailing vessel, where the entire nature of her load is continually changing, and the weight of the vessel herself bears such a small proportion to the total weight as compared with that of a steamer and her machinery.

The reason we do not hear much of the theory of the metacentre and its application, lies in the fact that it involves an enormous amount of abstruse calculation, and takes a very long time to work out. We have read of some authorities being over three months on the calculations for one vessel, and it is therefore only when such calculations are backed by the names of men of undoubted scientific attainments, that ordinary individuals set any value on them.

The best practical illustration of the metacentre that the author can think of is the motion of a child on a rocking horse, this motion is similar to what it would receive when placed in the corresponding position of a rolling ship. The metacentre of the rocking horse is the centre from which the curve of the rocker is struck, and may or may not change as the horse rocks. If this centre is below the centre of gravity of the child and horse there must be an inevitable capsize; if the centres are at or about the same height, the motion would be slow, easy, and nearly horizontal while if the curve is struck from a centre much above the child's head, the weight would rise in a reverse curve as it rocked, and the motion would be quick and jerky.

From the above illustration it will be seen that either extreme is bad for a ship at sea, for in the first place the vessel would capsize, and in the last case she would make very bad weather, as all seafaring men know ships do when all the weight is in the bottom of the hold. The author has thought it better to introduce this subject as it has a direct bearing on ordinary seagoing ships, and as such is not generally understood; in the case of the vessel now under consideration, however, which we will for argument's sake call an extraordinary ship, he is of opinion that its qualities can be better explained and understood on a model or diagram of a ferry boat, by a reference to the effect which is produced on the centres of gravity and buoyancy by the position and weight of a crowd of passengers.

In the vessel now exhibited the stiffness is equal to carrying five hundred people on the upper deck, if they can find room there, and then six or eight tons on the top of the funnel will fail to disturb her equilibrium; before, however, proceeding to demonstrate this practically, it will be well to first consider theoretically why this V-shaped vessel has so much more stiffness than another one, and prove it at the same time, if it can be done.

PRACTICAL EXPERIMENTS.

Figure 1 represents an oil drum of equal weight all round, it has a three-quarter rod running longitudinally through the centre and extending beyond each end, to allow of its being encircled by small leaden rings for sinking it to any depth, without disturbing its equality of balance, it has also eight studs at each end projecting at equal distances around its circumference, to carry the weights, we are about to apply to it.

We now load it with leaden rings on the spindle, until its whole body is practically the same specific gravity as the water, or that it only just floats, and we have then the centre of gravity, the centre of buoyancy, and the metacentre, all in one point or line, and we start from this basis.

We now take off one half of the total weight from the spindle thus raising the centre of buoyancy in the water, and lowering it in relation to the centre of gravity to the point marked B on Figure 1, and leaving the centre of gravity still the centre of the spindle. We can now spin the vessel round, it has no stiffness or stability, the centre of buoyancy maintaining its position immediately under the centre of gravity, and it will stop in any position. The drum is $11\frac{1}{4}$ inches in diameter, and the centre of bouyancy when half immersed is as near as possible $2\frac{3}{8}$ inches below the centre of gravity as shown on the plan. We will now take one pound of lead off the spindles and place it on the studs, and we have now a vessel with a certain amount of stiffness, but no stability, for as she is listed over from her normal position by an equal weight on top, there is no extra displacement on the side entering the water to bring the centre of buoyancy under the weight and prevent a capsize. In Figure 2, we carry the sides of the vessel straight up from the water line, keeping the centre of gravity in the same place, then we have a vessel in what is called unstable equilibrium that is, she will not stand upright, and this is the condition, or very closely approaching to it, in which many vessels at the present time are sent to sea. Although it may seem strange yet these are the most comfortable vessels to travel in. The "Austral" was in unstable equilibrium when she sunk in the harbour. Her foundering was caused by getting the centre of gravity too high through filling the upper part of the bunkers after the ballast tanks were pumped out. She would have stopped listing after she had gone a certain distance, but unfortunately her great coal ports were open and by them she filled and sank. But had these ports been closed, then the ship would undoubtedly have remained in the position she took when her immersed part formed a V and her side had got new bearings further out from the centre. The stiffness of a vessel is dependent on the height of the centre of buoyancy as compared with the centre of gravity. But the stability depends on the changed position of the centre of buoyancy by the listing of the vessel. If we take this weight off the top of the drum, leaving the same stiffness as before, and place on two bilges of clear pine, thus making her about the section of a paddle ferry steamer, as shown in Figure 2, we find we have lowered the centre of buoyancy in the vessel, and she will not stand upright. She has lost her equilibrium, and we also find that no stability is attained until the vessel is considerably listed. Now by taking off the clear pine bilges, and putting on two made of hardwood, whose weight is equal to 64 lbs. per cubic foot (that is, about the same proportionate weight as they would be under ordinary circumstances if filled up with coal), we find we have ballasted them until they are exactly the same weight as the water they displace, and the consequence is that until the vessel is very much listed they leave it in exactly the same position as if they were not there. In fact these bilges have no effect on the vessel until one of them begins to come out of the water, and then the vessel is uncomfortably listed for passengers.

It will be noted that in all these experiments with the drum the additional part immersed on the depressed side is equalled in bulk and weight by that coming out on the other side; but in Figure 2 we gain stability by carrying the sides straight up, the displacement being further out from the centre on the one side as she is listed gives the stability, and it is plain to anyone that the more there is of this displacement, and the further out it is from the centre of the ship, the more stability there must be attained. If the vessel has no tendency to list, this reserve buoyancy offers no resistance to the vessel's course, but if excessive top weight is added under extraordinary circumstances, then it is so much reserve buoyancy just in the right place to keep her upright or nearly so.

We will now float the blocks of wood made to the several sections shown on the plan as 3, 4, 5, 6; they all weigh exactly the same, they have the same cubic contents, 420 inches, and they are fifteen inches long, and one-half the specific gravity of water, which corresponds with the condition of a ferry steamer having a reserve of 50 per cent. of buoyancy. These proportions are taken because they are as near as possible the existing conditions under which the vessels are working We will now place a light mast in each of these models, and load them with a piece of lead equal to one quarter of their own weight, which is a fair load of passengers, and we find No. 1 crank with it on deck, No. 2 will carry it 7 inches up the mast, No. 3, 9 inches up the mast, No. 4, 18 inches up the mast. This test is simple, but it is very certain, and it should carry conviction to the mind of that expert who considered the model of the V boat was the wrong way up.

From the foregoing it will be seen that even with a top-gallant deck above the present bridge to carry 100 passengers that the V steamer would be more stable than most of those now in use—but so as not to overpower the existing main springs of our ferry navigation all at once, this idea has not been further advanced at present.