THE PROPERTIES OF IRON AND ITS RESISTANCE TO PROJECTILES AT HIGH VELOCITIES.

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We have no correct record as to the exact time when wrought-iron plates were first employed for the purpose of building vessels. It is, however, certain that iron barges were in use on canals at the close of the last century. In 1824 Mr. Manley, of Staffordshire, built an iron steamboat for the navigation of the river Seine, and this was the first iron vessel that attempted a sea voyage. She was navigated from this country to Havre, by the late Admiral Sir Charles Napier, and although constructed for shallow rivers, she nevertheless crossed the channel in perfect safety. From that time to 1830 no attempt was made to build iron vessels, and nothing was done toward ascertaining the properties of iron as a material for shipbuilding.

A series of experiments instituted by the Forth and Clyde Canal Company in 1829–30, to ascertain the law of traction of light boats at high velocities on canals, led to the application of iron for the construction of vessels, and the lightness of these new vessels, combined with their increased strength, suggested the extended application of the material in the construction of vessels of much larger dimensions, and ultimately to those of the largest class both in the war and the mercantile navy. Considerable difficulty, however, existed with regard to the navy; and although the principle of iron construction as applied to merchant vessels and packets was fully established, it was nevertheless considered inapplicable, until of late years, for ships of war. It is true that until the new system of casting the sides of vessels, first introduced by the Emperor of the French in 1854, was established, the iron ship was even more dangerous under fire than one built entirely of wood. Now, however, that thick iron plates are found sufficiently strong, under ordinary circumstances, to resist the action of guns, not exceeding 120-pounders, for a considerable length of time, the state of the navy and the minds of our naval officers have entirely changed. We must, therefore, now look to new conditions, new materials, and an entirely new construction, if we are to retain our superiority as mistress of the seas. There yet remain amongst us those who contend for the wooden walls, but they are no longer applicable to the wants of the State; and I am clearly of opinion that we cannot afford to trifle with so important a branch of the public service as to fall behind any nation, however powerful and efficient they may be in naval construction. Having satisfied ourselves that this desideratum must be attained, at whatever cost, I shall now endeavor to point out such facts as, in my opinion, relate to the changes that are now before us, and simply endeavor to show—

1st. The description of iron best calculated to secure strength and durability in the construction of ships of war.

2d. The distribution and best forms of construction to attain this object.

3d. The properties of iron best calculated to resist the penetration of shot at high velocities.

PROPERTIES OF IRON.

If we are desirous to attain perfection in mechanical, architectural, or shipbuilding construction, it is essential that the engineer or architect should make himself thoroughly acquainted with the properties of the materials which he employs. It is unimportant whether the construction be a house, a ship, or a bridge. We must possess correct ideas of the strength, proportion, and combination of the parts, before we can arrive at satisfactory results; and to effect these objects the naval architect should be conversent with the following facts relating to the resisting powers of malleable and rolled iron to a tensile strain.

The resistance in tuns per square inch of—

Yorkshire Iron is	24·50 tuns.
Derbyshire "	20·25 "
Shropshire "	22·50 "
Staffordshire "	20·00 "

STRENGTH OF RIVETED JOINTS.

The architect having fortified himself with the above facts, will be better able to carry out a judicious distribution of the frames, ribs, and plates of an iron ship, so as to meet the various strains to which it may be subjected, and ultimately to arrive at a distribution where the whole in combination presents uniformity of resistance to repeated strains, and the various changes it has to encounter in actual service.

There is, however, another circumstance of deep importance to the naval architect, which should on no account be lost sight of, and that is, the comparative values of the riveted joints of plates to the plates themselves. These, according to experiment, give the following results:—

Taking the cohesive strength of the plate at	100
The strength of the double-riveted joint was	70
And the single-riveted joint	56

These proportions apply with great force to vessels requiring close riveting, such as ships and boilers that must be water-tight, and in calculation it is necessary to make allowance in that ratio.

STRENGTH OF SHIPS.

Of late years it has been found convenient to increase the length of steamers and sailing vessels to as much as eight or nine times their breadth of beam, and this for two reasons; first, to obtain an increase of speed by giving fine sharp lines to the bow and stern; and second, to secure an increase of capacity for the same midship section, by which the carrying powers of the ship are greatly augmented. Now, there is no serious objection to this increase of length, which may or may not have reached the maximum. But, unfortunately, it has hitherto been accomplished at a great sacrifice to the strength of the ship. Vessels floating on water and subjected to the swell of a rolling sea—to say nothing of their being stranded or beaten upon the rocks or sand banks of a lee shore—are governed by the same laws of transverse strains as simple hollow beams, like the tubes of the Conway and Britannia tubular bridges. Assuming this to be true, and indeed it scarcely requires demonstration, it follows that we cannot lengthen a ship with impunity without adding to her depth or to the sectional area of the plates in the middle along the line of the upper deck.

If we take a vessel of the ordinary construction, or what some years ago was considered the best—300 feet long, 41 feet 6 inches beam, and 26 feet 6 inches deep—we shall be able to show how inadequately she is designed to resist the strains to which she would be subjected. To arrive at these facts we shall approximate nearly to the truth by treating it as a simple beam; and this is actually the case, to some extent, when a vessel is supported at each end by two waves, or when rising on the crest of another, supported at the center with the stem and stern partially suspended. Now in these positions the ship undergoes, alternately, a strain of compression and of tension along the whole section of the deck, corresponding with equal strains of tension and compression along the section of the keel, the strains being reversed according as the vessel is supported at the ends or the center. These are, in fact, the alternate strains to which every long vessel is exposed, particularly in seas where the distance between the crests of the waves does not exceed the length of the ship.

It is true that a vessel may continue for a number of voyages to resist the continuous strains to which she is subjected while resting on water. But supposing in stress of weather, or from some other cause, she is driven on rocks, with her bow and stern suspended, the probability is that she would break in two, separating from the insufficiency of the deck on the one hand, and the weakness of the hull on the other. This is the great source of weakness in wrought-iron vessels of this construction, as well as of wooden ones, when placed in similar trying circumstances.

CHANGES IN PROGRESS.

Having directed attention to the strength of ships, and the necessity for their improved construction, we may now advert to the changes by which we are surrounded and to the revolution now pending over the destinies of the navy, and the deadly weapons now forging for its destruction, it is not for us alone, but for all other maritime nations, that these Cyclopean monsters are now issuing from the furnaces of Vulcan; and it behoves all those exposed to such merciless enemies to be upon their guard, and to have their *Warriors, Merrimacs* and *Monitors*, ever ready, clothed in mail from stem to stern to encounter such formidable foes. It has been seen, and every experiment exemplifies the same fact, that the iron ship with its coat of armor is a totally different construction to that of the wooden walls which for centuries have been the pride and glory of the country. Three deckers, like the *Victory* and the *Ville de Paris* of the last century, would not exist an hour against the sea monsters now coming into use.

The days of our wooden walls are therefore gone; and instead of the gallant bearing of a 100-gun ship, with every inch of canvas set, dashing the spray from her bows and careering merrily over the ocean, we shall find in its place a black demon, some five or six hundred feet long, stealing along with a black funnel and flag staff, on her mission of destruction, and scarcely seen above water, excepting only to show a row of teeth on each side, as formidable as the immense iron carcass that is floating below. This may, with our present impressions, be considered a perspective of the future navy of England—probably not encouraging—but one on which the security of the country may ultimately have to depend, and to the construction of which the whole power and skill of the nation should be directed. I have noticed these changes, which are fast approaching, from the conviction that the progress of the applied sciences is not only revolutionizing our habits in the development of naval constructions, as in every other branch of industry, but the art of war is undergoing the same changes as those which have done so much for the industrial resources of the country in times of peace. It is therefore necessary to prepare for the changes now in progress, and endeavor to effect them on principles calculated not noly to insure security, but to place this country at the head of constructive art. It is to attain these objects that a long and laborious class of experiments have been undertaken by the Government, to determine how the future navy of England shall be built; how it should be armed, and under what conditions it can best maintain the supremacy of the seas. This question does not exclusively confine itself to armor-plated vessels, but also to the construction of ships which, in every case, should be strong and powerful enough to contend against either winds and waves or to battle with the enemy. It is for these reasons that I have ventured to direct attention to the strength of vessels, and to show that some of our mercantile ships are exceedingly weak, arising probably from causes of a mistaken economy on the one hand, or a deficiency of knowledge or neglect of first principles on the other.

Now it is evident that our future ships of war of the first class must be long and shallow; moreover they must contain elements of strength and powers of resistance that do not enter into the construction of vessels that are shorter and nearly double the depth. If we take a first-rate ship of the present construction, such as the *Duke of Wellington*, and compare it with one of the new or forthcoming constructions carrying the same weight of ordnance, we should require a vessel nearly twice the length and little more than half her depth. Let us, for example, suppose the *Duke of Wellington* to be 340 feet long and 60 feet deep, and the new construction 500 feet long and 46 feet deep; we should then have for the resistance of the *Duke of Wellington* to a transverse strain tending to break her back,

$$W = \frac{a\,d\,c}{l}$$

Taking 60 as the constant, and the area of the bottom and upper deck as 1060 square inches, we have

$$W = \frac{1060 \times 60 \times 60}{340} = 11{,}223 \text{ tuns,}$$

as the weight that would break her in the middle. Let us now take the new ship, and give her the same area top and bottom, and again we have

$$W = \frac{1060 \times 46 \times 60}{500} = 5{,}851 \text{ tuns,}$$

which is a little more than half the strength. From this it is obvious—if we are correct in our calculations—that the utmost care and attention is requisite in design and construction to insure stability and perfect security in the build of ships.

MECHANICAL PROPERTIES OF IRON.

It is unnecessary to give more examples in regard to strength, and the proportions that should be observed in the construction of our future navy. I have simply directed attention to it as a subject of great importance, and one that I am satisfied will receive consideration on the part of the Admiralty and the Comptroller of the Navy.

The next question for consideration is the properties of iron best calculated to resist the penetration of shot at high velocities, and in this I am fortunate in having before me the experiments of the Committee on Iron Plates, which may be enumerated as under :—

Specific Gravity.	Tensile Strength in tuns per square inch.	Compression per unit of length in tuns.	Statical Resistance to punching in tuns ; one-inch plate.
7·7621	24·802	14·203	40·1804

The specimens subjected to compression gradually squeezed down to one-half their original hight, increasing at the same time in diameter till they attained 90 tuns on the square inch. In these experiments, four descriptions of iron were selected, marked A B C D : the two first and last were taken from rolled and hammered iron plates, excepting C, which was homogeneous, and gave higher results to tension and dead pressure than the others.

In density and tenacity they stood as follows :—

Mark on Plates.	Density.	Tenacity in tuns.	Remarks.
A Plates..............	7·8083	34·644	
B Plates..	7·7035	23·354	
C Plates, homogeneous	7·9042	27·032	
D Plates.....	7·6322	24·171	

Here it will be observed that the strengths are in the ratio of the densities, excepting only the B plates, which deviate from that law. On the resistance to compression, it will be seen that in none of the experiments was the specimen actually crushed ; but they evidently gave way at a pressure of 13 to 14 tuns per square inch, and were considerably cracked and reduced in hight by increased pressure.

From the experiments on punching we derive the resistance of A B C D plates to a flat-ended instrument forced through the plate by dead pressure, as follows :—

Mark on Plates.	Shearing Strain in tuns per square inch.	Ratio, Taking A as unity.
A Plates...........	19·511	1·000
B Plates...........	17·719	0·907
C Plates...........	27·704	1·168
D Plates...........	17·035	0·873

Here may be noticed that the difference between the steel plates of series C, and the iron plates of series A, is not considerable, though in all the others the steel plates exhibit a superiority in statical resistance.

[To be continued.]

ROTTING HEMP AND FLAX.

This is a subject of much importance, just now, to our farmers who have raised crops of flax and hemp this season. There are two methods employed for rotting hemp, viz., dew-rotting and water-rotting. By the first method the plants are spread thinly and evenly upon the ground about the middle of October. Clean sward is preferable for the operations, and from six to ten weeks are required to complete them. The plants are occasionally carefully turned, and their condition is determined by taking up a handful and breaking them in the hand. When the shive or woody pith is found to separate easily from the lint the process is considered complete. Warm wet weather hastens the rotting operation, the object of which is to induce the action whereby the woody separates from the fibrous part of the plant. When the rotting is completed the plants are again bound in bundles and stacked until they are required to be scutched. Dew rotting generally injures the strength of the fiber more than water rotting, therefore the latter is held to be the better, although the most troublesome system. The method pursued by E. S. Cox, an extensive hemp cultivator of Sangamon county, Ill., is set forth in the Transactions of the State Agricultural Society, and quoted with commendation as follows, by the *Prairie Farmer*. In describing his method, Mr. Cox says :—For the purpose of water rotting hemp I have excavations made in the ground into which are built six framed vats 90 feet long by 9 feet wide and 6 feet deep, the tops being on a level with the ground. These vats are constructed of 36 by 8-inch sills laid crosswise, at each end of which upright 6 by 8-inch posts are mortised and keyed, and stayed at the top by an occasional cross timber. The bottoms, ends and sides are planked with 2-inch oak timber and ship caulked. The bundles of hemp are laid crosswise the vats, which are filled to the top. Four strings of planks or rails are placed lengthwise the vats, across the hemp, over which again cross timbers are placed and confined at each end under cap pieces projecting from the top of the vat. Thus is the hemp firmly confined under the water. The vats are then filled with water from a cistern arranged for the purpose, and the hemp is completely submerged, the water rising six inches above it. The water for rotting the hemp, by means of three very powerful suction or force pumps, is drawn from a creek near by through cast-iron pipes into a framed, planked and caulked cistern, 56 feet long by 15 wide and 6 feet deep, constructed above and at the end of the vats. This cistern, by the action of the pumps, can always be kept filled with water, which can settle and become clear and be let into the vats at pleasure.

The pumps and machinery for dressing the hemp are propelled by a steam engine, the escape steam of which is admitted into iron pipes laid at the base of the vats, and the heat thus communicated raises the temperature of the water in the vat to 90° Fah. With this temperature the hemp is rotted in five to seven days, the glutinous or cementing matter which fastens the lint to the stalk being dissolved by the process of fermentation, and the filaments of the wood becoming concrete and brittle are easily broken and separated from the lint. At this time all fermentation has ceased and the water is unpleasantly stagnant. The water is now let off through plug holes at the end near the bottom of the vat and passes off through a ditch into the creek. The hemp in a few hours is drained ready for throwing out. The confining timbers being first removed the bundles of hemp are then easily thrown out, two men emptying a vat in one half day, each vat holding stalk to make one tun of lint.

By this method of water rotting the business can be carried on every month in the year, in winter as well as in summer, as the water can be kept of a uniform temperature, by means of steam. The workmen are protected from wet by oil cloths. The business is not unpleasant or unhealthy.

From the vats the hemp is hauled in carts to the drying grounds, where it is set up in shocks of three or four hundred each—a band being tied around the blossom ends to keep them from falling down, the old bands are cut and the stalks are well spread, the butts to the ground inclining outward. As soon as thoroughly dry it is bound in large bundles and secured in the store sheds ready for breaking.

For rotting flax similar vats may be employed. There are but few farmers however, who can afford to use a steam engine, therefore all those who may have the conveniences of running streams near their farms, should connect their flax pits with a stream in such a manner that the fresh water may be admitted at pleasure. Many experienced flax growers in Ireland prefer to sink their flax pits in yellow clay beds. They assert that the clay absorbs the oil of the plant, and also imparts a beautiful cream color to the flax, which enhances its value. These flax pits should be filled to within six or eight inches of the top, and soft water alone should be used. It is of no consequence whether the top or root end is downward, and a slanting position is best for it. We may here remark that the same water should not be used twice the same season, and a great economy is effected by the pits or vats being so constructed that the water from them could be made to flow over the same or other fields, thus restoring to the soil almost all the constituents it took from it. It requires to be covered securely with sods and other material to keep it under the water and to exclude the air during the fermentation. The rotting process will usually occupy from six to nine days or perhaps longer. The rule for testing it is quite simple ; remove a portion of the covering, take up a little of it and if found, on examination, the fiber or skin separates easily from the extraneous vegetable matter or pith, it is then fit to be taken up and spread to dry. The flax should be evenly laid on a clean grass field in equal layers, and care should be taken to keep the roots all evenly together through all its operations and prevent it from mixing, which injures it both to the farmer and spinner. The drying will occupy but a few days on the grass in good weather if the rotting has been properly done. It should then be lifted off and stacked in a very dry condition for at least a fortnight, when it will be ready for scutching, which may be done either by the hand or by machinery.

The scutching operation is simple, and may be performed during winter and at the convenience of the flax grower. Its object is merely to separate the pith from the fiber. From the previous action of the steeping and drying the pith becomes rotten and breaks easily by being passed through rollers having a fluted surface working on each other like cogs. This machine may be either cast metal or hard wood ; if of the latter, it can be driven by a man, and attended by boys. The cost of this machine should not exceed five dollars, and is very useful when the scutching is done by hand ; a stout boy may clean forty pounds for market in a day.

London Exhibition---Jewelry and Precious Metals.

The London *Times* contains elaborate and able articles on several branches of manufacture in the Great Exhibition. The following extracts are selected and condensed from its columns :—

Of all others, this is peculiarly the department of the Exhibition of which description is out of the question, and which "must be seen to be appreciated." It is a feast for the eyes, as rich as it is rare, to gaze on the piles of plate and heaps of glittering gems which fill the cases of the English goldsmiths near the center of the nave, or those of the French and Italian jewelers in their respective Courts.

As a rule, but scant praise can be given, in an artistic point of view, to the figure subjects in silver plate. There is for the most part a stiffness and conventionality about them which is very unprepossessing. Messrs. Elkington have acquired such a reputation for their bronzes as almost to eclipse their merit as silversmiths ; but their productions in the latter branch are the best in the Exhibition. The most note-worthy object in their collection is an emblematically adorned silver table, by Morel. It is executed in *repoussée* work, and its manufacture has occupied three years. This is the slowest and most difficult mode of working in silver. The relief on the metal is all beaten out from the inside by means of an iron rod, one end of which is placed in contact with the plate while the other is struck by a hammer. When skillfully performed, the labor is repaid by the superb effect obtained. The subject illustrated in the composition of Morel's table is "Sleep." At the base slumber the troubadour, the soldier, and the laborer. A column, encircled by poppies and other narcotic plants, supports the table on which the dreams of the sleepers are portrayed. The first has visions of love and fortune, the second of victory and fame, the third of peace and plenty. A fanciful border of gnomes and monsters typifies the horrors of the nightmare.

The combination of enamel and metal in the decoration of table ornaments is illustrated by some attractive specimens in Elkington's collection. The pattern is first cut out of the metal ; on the hollow spaces thus formed the enamel is placed, and fused under a violent heat. When cool, the rough surface is polished on a stone lathe. A dessert service in this style has a very attractive aspect. It is in the Pompeian style, and the enamels employed are of turquoise blue, red, and black. The service is valued at $10,000.

There are exhibited by Messrs. Bell, of Newcastle ; Manders, of Wolverhampton ; and Christofle & Co., of Paris, works in aluminum. This metal is white, with a bluish tinge. It lacks the brilliancy of silver, but, on the other hand, never tarnishes. By itself it is as malleable as gold or silver, but when alloyed with any other metal this property disappears. It is singularly light. Its weight is only a third of that of iron, a fourth of copper, and a fifth of lead. Not only is its complexion unaffected by air or moisture, but even by tartaric acid, salt or sulphur. This quality renders it very suitable for domestic purposes, while its lightness and hardness adapt it to scientific uses. For pure ornament, however, it can scarcely vie with silver. A casket of aluminum, 12 inches long by 8 in depth and 9 in width, is shown by Messrs. Manders.

In jewelry the English rely mainly on the value of the stones and the solid work of the mountings ; while the French display more fertility and ingenuity in the modes of setting. Of all the British exhibitors, Emmanuel exhibits the greatest novelty and variety in the treatment of jewels. He revives the ancient practice of combining gold and ivory,