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CRYSTALLIZATION OF METAL UNDER STRESS.

The persistence with which an exploded theory maintains its hold on the public mind was shown incidentally during the recent attack by the city government upon the Manhattan Elevated Railway Company. In the newspaper discussion which was aroused by that unparalleled exhibition, the venerable bogy of the crystallization of steel and iron in bridge structures was trotted out, and the imminent collapse of the elevated columns, trusses, and girders was once more predicted. It would be difficult to find a popular engineering fallacy that maintains its hold on the public mind with greater tenacity than this; it is certainly impossible to find one that has less foundation in fact and is more completely disproved by the condition of the metal in long-standing steel and iron bridges at the time of their removal or renewal. It is probable that a large percentage of the passengers that daily cross the Brooklyn Suspension Bridge—if they give any thought to the mechanical features of the structure—are satisfied that the metal of the bridge is deteriorating—"crystallizing"—and that the wire cables, unless they are renewed, will in the course of time give way and precipitate the whole bridge into the river below.

Tests in the laboratory and half a century's tests in the field have proved that the theory of the crystallization of metal under ordinary static stresses is a myth. The stresses, of course, must not exceed or even approach the elastic limit of the material; but as long as they remain well within this limit, there is no reason, as far as our present theory and practice can enlighten us, why a properly inspected and painted bridge should not last indefinitely. A strong presumption to this effect is afforded by the experience of the engineers who had charge of the recent reconstruction of the railway wire suspension bridge across the Niagara gorge. The original structure was erected by Mr. Roebling, of Brooklyn Bridge fame, in 1853, and in making the cables, the wires of an earlier bridge, built at this site in 1848, were utilized. Consequently, when the Roebling bridge was removed in 1898, these wires had been in service for half a century, and in constant use under the trying service of the railroad bridge for forty-two years. If there is such a thing as crystallization, it would surely have been present in these wires; but, as a matter of fact, when the strands of the cable were cut into short lengths, they curled up, taking the set which was given them when they were coiled on the reels fifty years ago. This proves that the cables had never been overstrained, and that the static strains due to the weight of the bridge, and all the rolling loads of cars and locomotives for over forty years had failed to produce any injury to the material.

These facts agree with the careful tests made by Prof. R. C. Carpenter at Cornell University, which verify the growing belief among engineers that the theory that crystallization can be produced by rapidly applied stress is no longer tenable. The subject was examined by a wide variety of methods, each of which might be supposed to produce the injurious crystalline condition. The test specimens were subjected to sudden stress by moving weights; to shocks due to explosives; to fracture by blows after a number of alternate heatings and coolings; and finally to a large number of blows of small force. It was found that so far from the suddenness of the stress tending to crystallize the material, the elongation or elastic stretch of the material was greatest when the stress was most suddenly applied. The importance of this result on the question of bridge deterioration is evident, for the distrust of this form of structure is due to the fact that its load, particularly in the case of railroad bridges, is suddenly applied and has something of a dynamic effect.

These investigations also served to correct the popular impression that steel and iron are more liable to failure in winter than in summer, and that metals generally are rendered "brittle" by a lowering of their temperature. As a matter of fact, the strength of wrought iron and steel is at a minimum at 70° F., and it increases with a variation of temperature either way from this point, increasing with a rise of temperature until it is 20 per cent stronger at 500° F., and being also about 20 per cent stronger at 60° below zero F. It is remarkable also that the tests should have shown that with the increased intensity of the cold there was a perceptible rise in the elastic limit.

That increased cold should not only have increased the hardness of the steel, but also its ductility, is directly at variance with the popular belief, which is based largely upon the fact that in railroad operation it has been observed that rails, wheels, and axles fail more readily in cold than in hot weather. There is no question that failures are more frequent in frosty weather, and in the light of the Cornell experiments, we must now look for some other cause of the phenomena. It is to be found in the fact that in winter, the roadbed being frozen and inelastic, the hammering of the rails by the heavily loaded wheels is more severe than in the summer, when the ballast has regained its natural elasticity. The same cause operates to increase the shocks to which the wheels and axles are subject, and it is to this extra stress, and not to any inherent weakness, that the failures are due.

The subject of the deterioration of structural iron under stress has much more than an academic interest, for it affects not merely the costly and indispensable bridges which form important links in our great systems of transportation, but all the modern fireproof buildings, the vast roofs of our terminal stations and exhibition halls, and every form of framed structure that is subject to stress, whether from wind or loads. It is satisfactory to feel assured that, as far as our present knowledge goes, there is no reason why, with careful inspection to prevent its oxidation by the weather, the metal of such structures as the Brooklyn and Forth Bridges should not last as indefinitely as if it lay embedded in the ore from which it was drawn.

THE YACHT "COLUMBIA."

The choice of the name "Columbia" for the new cup defender will probably give general satisfaction, and perhaps, looking at the question from every point of view, it is better than "Golden Rod," which it was thought would be selected by those who are responsible for the yacht. The name of a national flower would have been a rather happy reply to the choice of the name "Shamrock" by the owner of the challenging boat; but "Columbia" is better because more national and distinctive.

It may not be known to many of our readers that the new yacht will not be the first cup defender to bear the name "Columbia." In the year 1871, an Englishman, Mr. James Ashbury, forwarded his second challenge for a race (his first attempt to win the cup having been made unsuccessfully in the previous year), and brought over a new racing schooner, the "Livonia," which had been built specially for the contest. The "Columbia," a typical American schooner yacht, was selected to meet her and sail a series of seven races. In those days the cup committee reserved the right to select any one of several yachts to suit the particular weather of the day. If the day of the race brought light winds, a fast fair weather boat was selected, and if it threatened to blow "great guns," a more weatherly craft was chosen, the challenger, meanwhile, having to stick to his one boat. This was pretty hard on the challenger, it must be confessed, and we manage those things better now.

In the first race the wind was light and the "Columbia" was chosen. She beat the "Livonia" over the New York Yacht Club course by 36 minutes 28 seconds. In the second race the wind was light at the start and "Columbia" was again chosen. The course was twenty miles to windward and return, and in the run to the outer mark the "Livonia" led. On the beat back to Sandy Hook lightship the "Columbia" gained 10 minutes and 33 seconds, winning by that amount. In the third race the wind was fresh, and the schooner "Dauntless" was selected, but an accident prevented her from starting, and the "Columbia" took her place. The strong breeze carried away one of her spars, and her steering gear gave way, necessitating her sailing under reduced canvas, with the result that the "Livonia" won by 15 minutes 10 seconds. In the two last races of the series the schooner "Sappho" was chosen, and she won the races by the comfortable margins of 30 minutes 21 seconds and 25 minutes 27 seconds. From the long lead with which the American schooners crossed the line, it is evident that if the defense of the cup had been confided to a single boat ("Columbia," for instance), as is now the practice, the result would have been the same.

We expect that the new "Columbia" will win, and we could wish that she might lead the "Shamrock" home by such handsome margins as her namesake did nearly thirty years ago; but it is not likely. Yacht designing was not the exact science in the seventies that it has grown to be in the nineties, and there is no such divergence now in hull and sail plan as distinguished the saucy schooners of that day. The types have slowly and surely drawn together by the inexorable law of the survival of the fittest; each has borrowed from the other, besides discarding what was useless and obsolete in its own practice, until to-day it takes the eye of an expert to tell a "Valkyrie" from a "Defender," or shall we say a "Columbia" from a "Shamrock."

From all that can be reliably gathered, the two new boats will be more alike than any two that preceded them. Both are constructed of an alloy, the home yacht of Tobin bronze and the challenger of phosphor bronze; and both are being built up to the full limit of size and power. There will probably be very little to choose in the matter of weight of the hulls, rigging, and spars, and, indeed, as far as the mere structural features are concerned, the race will scarcely be won by any great advantage so gained. The fortunes of the cup will depend on the form of the hulls, the sail plan, and, above all, on the skippers and crews that will handle these magnificent and costly yachts during the eventful days of next October.

THE USES OF FLORIDA MOSS.

The freeze of this year killed the Florida moss. People who do not recognize what this means must think that this somber gray drapery of the Southern forests gives one hundred bales a week of "moss hair" to the Northern upholsterers from the little village of Micanopy, Florida, alone, and other factories in the State yield many times as much, and this is only about one half of the weight of the moss when taken from the trees. The other half is the useless envelope to the inner and valuable hair. There is a mistaken idea as to how the outer portion of the moss is removed. It is generally supposed that the covering is removed by chemicals or by passing through some ingenious stripping machine. The latter would be too expensive and the former open to the danger of injuring the natural elasticity of the fiber.

The moss when first gathered is greenish-gray. When killed by frost or lack of proper sustenance, it is easily distinguished from the live moss. It turns gray, and if bitten feels soft, while the live moss "crunches" between the teeth. But the outer covering will remain on either the dead or fresh moss for months. If the moss, either alive or killed, is simply piled in heaps in a moist place and covered with muck or sand, it soon begins to ferment. The temperature of the interior of the heap rises to a point too hot for the hand to bear, and, if not checked, it keeps heating till too hot to walk over. But this stage means damage to the interior hair, and must be avoided. Properly conducted, the fermentation means the complete destruction of the outer skin, and the moss is left duly "colored," i. e., showing the dark brown color of the hair.

It reaches this stage in the hands of the pickers, who then deliver it in loose wagon loads, like hay, to the gins. There are about fifty of these ginning establishments in the State—very simple affairs. The building is constructed as cheaply as possible and costing from $200 to $300—no insurance is obtainable. The floor is six feet from the ground and made of slats 1½ inches apart, so that short fibers, sticks, and dirt will sift out. In the building is nothing but a cheap modification of a cotton gin—a cylinder two feet long, and of the same diameter, with two-inch teeth, which beat the moss against similar stationary teeth, taking out sticks and rubbing off most of the adhering remains of the outer covering of the moss. The machine is cheap and very inefficient. The resulting moss is either "2 cent moss" or "3 cent moss"—the price per pound after ginning, according to the care with which the picker delivered it.

The writer was surprised to learn that this is the only preparation the moss receives. It is shipped in bales direct to the wholesaler, who generally distributes them unopened to the upholsterers.

The freeze will not interfere with this year's crop. The dead moss is treated just as before the freeze. But the outlook for next year is bad. The crop will be small. Usually where a tree has been picked clean, plenty of small bits are left, so that in a favorable locality the tree will be full again in two or three years. This was shown by the practice in moss localities of cleaning it from the orange trees every two years. But when the temperature fell to 8° in the center of the State last February, the moss was quite generally killed and its development so checked that the yield will be smaller for several years. South of Ocala little harm was done.

PROF. CHANDLER HONORED.

Prof. Charles F. Chandler, of the School of Mines of Columbia University, has been nominated for president by the Society of Chemical Industry, which has been in session at Glasgow. Prof. Chandler is the first American to be nominated for the president of an English scientific society. In his new office Prof. Chandler will succeed such men as Sir Henry Roscoe, Sir Frederick Abel, Sir John Evans, Sir Lowthian Bell, and others. Prof. Chandler is now sixty-one years of age. He graduated from Göttingen in 1856, and in 1864, in connection with Prof. Eggleston and Gen. Vinton, he founded the School of Mines of Columbia College. In 1866 he was appointed chemist for the Health Board of New York, and in 1873 to 1884 he was president of the Board. He is at present the expert for many corporations. When Prof. Chandler returns to the United States, a reception will be tendered him.