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NEW YORK, SATURDAY, NOVEMBER 4, 1905.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

A DISCREDITED THEORY.

After reading the description of the ridiculously small results recently achieved at Sandy Hook in the test of a torpedo shell against a target representing the side of a battleship, as given on another page of this issue, our readers will surely agree with us that Congress should make no further appropriations for experiments with projectiles of this kind. The only effect produced on the trial plate, as the result of bursting 183 pounds of high explosive against it, was a slight indentation, which was due, almost entirely, to the striking energy of the shell itself. While we can well understand that the enormous energy of the gases of explosion of guncotton or nitroglycerine should have caused the idea of exploding a heavy charge against the outside of a battleship to appeal very strongly to the lay mind, we cannot understand why Congress should have authorized this latest trial of the theory, when that theory had been so completely discredited in the tests of the Gathmann torpedo shell some four or five years ago.

Let it now be set down once and forever that not 200 pounds, nor twice 200 pounds, of high explosive is sufficient to "blow the modern battleship out of existence." If the events of the naval conflict in the Far East have taught us anything at all, they have surely taught us this: that unless the charge should be so fortunate as to explode in or at the neighborhood of the magazine, a single torpedo or a single mine will not send a battleship to the bottom, or wreck it beyond the possibility of repair. If anyone doubt this, let him look at the Port Arthur fleet, the ships of which, after receiving some of them not one, but several blows, full and square from the mine and the torpedo, were so far repaired under emergency conditions, as to be able to go forth and fight that seven-hour engagement with the Japanese fleet on August 10.

Modern ship steel is so tough; the modern system of cellular and compartmental construction is so elaborate; the modern battleship is so big; and its inertia so great, that the detonation of even 400 pounds of high explosive against the side of the ship, as in the case of the "Sevastopol," causes damage which, though extensive, is strictly local, and does not impair the structural integrity of the ship as a whole. The high-explosive armor-piercing shell, which can carry its bursting charge intact through the armor and liberate its energy within the vitals of the ship itself, is the supreme engine of destruction in modern naval warfare; and the thin-walled torpedo shell must be relegated to that museum of discredited inventions, of which the Sandy Hook proving ground contains so many costly exhibits.

ONE YEAR'S OPERATION OF THE SUBWAY.

On October 27 the New York Subway completed its first year of active service, and the statistics of travel and the verdict of the public agree in pronouncing this great engineering work, with one exception, a complete success. During the twelve months, 106,000,000 passengers have been carried, at the average rate of about 300,000 per day. The total number of passengers carried daily on the elevated roads works out at an average of about 717,000 per day, so that a reasonable estimate of the number of passengers carried by the Elevated and Subway combined reaches the enormous figure of over 1,000,000 per day.

The figures for the Subway are the more remarkable when we bear in mind that only a portion of it has been in active operation for the whole twelve months. The Lenox Avenue branch to West Farms, the section from the Brooklyn Bridge to the South Ferry, and about a mile of road north of 135th Street on the Broadway branch, have been in operation only for a portion of the year. The company expects to open the road from 157th Street to the Harlem Ship Canal by January 1, and next year also the important Brooklyn branch from South Ferry to Flatbush and Atlantic Avenues will be put in service. It is reasonable to expect that with these important additions, the total daily travel will amount to an average of 400,000 per day for the year.

It is not often that a great public improvement in transportation such as this scores such a large and immediate success, running far beyond the preliminary estimates of its usefulness. Save for some confusion in the first few days of operation, due to limited switching accommodation at the terminals, and to the restraining hand laid upon the traffic by the excellent system of block signals on the express tracks, there has been but little interruption to the steady flow of travel. This, however, quickly passed away, and the system has been running day and night, for many months, with an absolutely clock-like precision. The speeds, particularly of the express trains, have been rather over than under the estimate, and the new steel cars, introduced for the first time on this road, have been an unqualified success, running with the smoothness of a Pullman car, and coming through such collisions as have occurred, in a way that proves them to be an excellent protection to the life and limb of the passengers.

The Subway, however, has developed one most serious drawback, which during the hot summer months served to divert a measurable proportion of its traffic to the Elevated roads. We refer to the unexpectedly high temperature and its attending "stuffiness" which, in the hottest weather, rendered travel in the Subway, to say the least, extremely uncomfortable. The high temperature is due to the large quantities of heat thrown out by the motors, and developed by the constant use of the brakes. In the winter this heat served to render the Subway temperature comfortable; but as the summer months advanced, it speedily produced the uncomfortable results above referred to. The problem of ventilation is a most serious one, and it has engaged the careful attention of the engineers, and will be made the subject of a forthcoming report. It is gratifying to know that the report will propose a plan which is confidently expected to remedy this serious defect.

MR. HILDENBRAND AND THE MANHATTAN BRIDGE PROBLEM.

At the time that we published illustrations of the new Buda-Pesth bridge, it was not our intention to open the old controversy as to the respective merits of wire cable and eye-bar chain suspension bridges. That problem was very thoroughly investigated some two years ago, and formed the subject of an exhaustive debate by pretty nearly every bridge engineer, who by training and experience was qualified to speak with authority on this subject. The publication of the Buda-Pesth bridge article, however, brought a reply from Mr. Hildenbrand, our editorial comments upon which have induced this engineer to write a reply of considerable length. In his letter of transmission, our correspondent suggests that it would be only justice to him, as well as due to the engineering profession, that we publish his arguments and calculations on which the statements in his former letter were based. The letter will be found on another page, and it is inserted with the understanding that with its publication will close this somewhat belated controversy.

In reading this letter one cannot but be impressed with the courage and fidelity with which the writer pleads for what he himself must feel to be a losing cause; for although political and personal considerations have proved strong enough to reject, in the case of the Manhattan structure, the more scientific and stronger chain bridge in favor of the primitive and now discredited wire type, we are satisfied that if one could take toll of expert engineering opinion both in this country and abroad, it would prove to be almost unanimous in recognizing the theoretical and practical advantages of the eye-bar chain type. We will even go further, and state it as our conviction that the advantages of the rejected design are so elementary, obvious, and material, that if the two designs and the discussion upon them were submitted to any graduating class in engineering at our technical colleges, they would cast their vote, to a man, in favor of the trussed eye-bar chain.

Had it not been for the manifest errors in his argument to prove that the eye-bar chain must weigh over three times as much as the wire cable, we would have let Mr. Hildenbrand's letter pass without comment; but the false premises and fallacious line of reasoning followed in this portion of the letter are such a characteristic example of the "rough-and-ready" methods of argument adopted by the advocates of the wire-cable bridge, and the statements themselves are so very misleading, that this portion of the letter demands an answer.

In estimating the respective breaking strength of the chains and the wire cable, 40 tons per square inch "as accepted by the Bridge Department," is used by Mr. Hildenbrand for the chain, whereas for the ultimate strength of the wire cable, 112 tons, "the actual strength of individual wires in the Williamsburg bridge" is used. This is manifestly an unfair comparison. To place the wire on the same basis as the chain, we must use the ultimate strength of the wire as specified in the contract for the Manhattan bridge, which requires a unit strength of 100 tons to the inch in the body of the wire, and of 95 tons at the splices. This 95 tons to the inch is, therefore, the proper unit for comparison. Multiplying, then, the chain section by 40 we get 22,200 tons as the breaking strength of one chain, and multiplying 265 by 95 we get 25,175 tons as the breaking strength of one wire cable; so that the Manhattan wire cable is not 33 7/10 per cent stronger, as Mr. Hildenbrand would have us believe, but is only 13 4/10 per cent stronger, if judged, as it surely ought to be, on the common basis of contract requirement.

But the contract requirement, as drawn up by the present Bridge Department, is entirely too favorable to the wire cable; for this 95 tons to the square inch shown by the individual wires must not be taken as applicable to the mass of wires, 20 or more inches in diameter, when strung across the towers and banded into cables. It has been proved that wires assembled in a cable do not possess an aggregate strength equal to the sum of the individual wires as developed in the testing machine. That eminent bridge engineer, the late Mr. Morrison, in working out a wire-cable design for the North River bridge, investigated this subject, and found that while the average strength of five wires, separately tested, was 172,588 pounds to the square inch, the strength of straight wire strands of the same quality of steel, with the wires laid parallel, was only from 150,000 to 146,640 pounds to the square inch, the strands showing about 15 per cent less strength than the individual wires. Strands of special plow-steel wire showed only 188,000 pounds to the square inch ultimate strength, as against an average strength of the individual wires of 226,000 pounds to the square inch. Mr. Morrison, very properly, took only 180,000 pounds as the unit stress in proportioning his cables.

No falling off in strength between the test specimen and the whole bar has ever been urged against an eye-bar chain, and hence, to make the comparison a true parallel, 15 per cent must be deducted from the 95 tons to the square inch unit strength as found above.

But a further reduction of 10 per cent must be made in our estimate of the strength of the assembled wires, to allow for the great fiber stress which occurs in the wire cable due to its bending over the edge of the saddles. In the construction of a wire-cable bridge, as soon as the wires have been strung they are heavily clamped and wrapped with wire applied under considerable tension, and any movement of the wires, one upon another, is thereafter impossible. The cable as thus strung and clamped hangs in a certain curve; but when the massive floor and stiffening trusses have been attached to it, and the live load comes upon it, and it lengthens under the high temperatures of the summer season, the cable will deflect and, of course, will be bent down to a more acute angle at the saddles. The bending of the compacted mass of steel 20 inches in diameter (for the heavy clamping and the pressure of the cable at the saddle render it a compact mass) will cause the outer wires at the point of bending over the edge of the saddle to be strained to an extent which calls for an addition of at least 10 to 15 per cent to the section of the cable, in order to provide for these stresses. If, as in the case of the Manhattan bridge, no increase of section has been made, then a lower unit stress should be used in estimating its total strength, the reduction amounting, at the most conservative estimate, based on a simple mathematical examination, to at least 10 per cent. Adding this 10 per cent to the 15 per cent reduction above referred to, we get a total reduction of 25 per cent, which must be considered, if we are to place the chain and the wire cable upon an even basis, as desired by Mr. Hildenbrand. This brings the unit stress down to 71.25 tons to the square inch, and shows the breaking strength of the wire cable to be 18,881 tons, as against 22,200 tons for the eye-bar chain, from which we see the chain is 17.5 per cent stronger than the cable. Adding 17.5 per cent to the section (265 square inches) of the wire cable, in order to cancel this difference (still following Mr. Hildenbrand's method of argument), and, further, adding 10 per cent for the weight of the suspender saddles, sheathing, etc. (which Mr. Hildenbrand omits) we get a total section for the wire cable of 342 square inches, as against 666 square inches (555 + 20 per cent for weight of eyes and pins) for the eye-bar chain. Therefore, the sections are not as 1 to 3.23, as deduced by our correspondent, but as 1 to 1.95; which agrees very well with the proportion of 1 to 2, as stated in our editorial of September 30.

It is scarcely necessary to point out that, with such serious errors existing in his premises, the whole fabric of our correspondent's argument falls to the ground.

If this question were merely academic, no harm would be done, but unfortunately this exaggerated estimate of the strength of a wire cable has already postponed the construction of a great public utility for nearly three years; for, to-day, the present Bridge Department has nothing to show for its incumbency but a couple of piers built by its predecessors, and a serious lawsuit induced by its own faulty contract.

THE HEAVENS IN NOVEMBER.

BY HENRY NORRIS RUSSELL, PH.D.

In all probability we shall see a fine display of shooting-stars about the middle of this month. We cannot be quite sure about it, however. It is certain that the earth will cross the path of the meteors which follow in the wake of the lost Biela's comet; but we have no means of knowing whether they will be thickly or thinly spread along this track, and so we cannot tell how much of a shower there will be.

All that can be done is to predict the date of the possible shower, and even this is not as simple a matter as it seems. The orbit of Biela's comet—which these meteors follow—used to intersect the earth's orbit at a point which the earth reaches on November 27 of each year; and for several successive returns the shower came at about that date. But the meteor-swarm has since then passed close to Jupiter, and its orbit has been considerably altered by the planet's attraction. It is a very laborious matter to calculate how large this alteration is, but Dr. Downing, an English astronomer, has done the work. He finds that the orbit has been so changed that the place where it comes nearest the earth's orbit is more than 15,000,000 miles distant from its former position at a point which we reach on November 18. The orbit has also been shifted sidewise, so that those meteors which previously just missed striking the earth will now pass about a million miles away from it, on the side remote from the sun.

If the meteor-swarm, measured in this direction, is more than a million miles in extent, we will pass through part of it, and there will be a conspicuous shower; but if not, we will only see a few straggling shooting-stars, as we did in 1899, when the Leonids suffered the same fate. The Leonids themselves are due on the 13th or 14th of this month, but the thick part of the swarm went by several years ago, and there is no chance of a great display this year.

The Bielid meteors are more convenient to observe, for they appear in the early evening, radiating from a point in Andromeda, which is well above the horizon at sunset, so there will be no need to sit up all night to see if we are to get a shower this year.

THE HEAVENS.

The principal constellations visible at 9 P. M. in the middle of November are as follows: Beginning in the west, where the Milky Way cuts the horizon, we see Aquila with its bright star Altair. On the right, and higher up, is the still brighter Vega in Lyra. Above Lyra is Cygnus. The large cross which is the most prominent figure in this constellation is now almost erect. Still following the Milky Way we pass over Cepheus and come to the zigzag line of Cassiopeia, now almost overhead. Then follows Perseus, and below it Auriga with the very bright yellow star Capella. Below this again is Gemini, whose twin stars, Castor and Pollux, have just risen.

To the right of this, a little south of east, Orion is also rising. Above it is Taurus, one of the easiest constellations to remember, since it contains the two star-clusters of the Pleiades and the Hyades. The latter name belongs to the V-shaped group of stars of which Aldebaran is the brightest. The planet Jupiter is at present between these two groups, and far outshines anything else in the sky.

The southeastern sky contains two of the largest and least brilliant of all the constellations, Eridanus and Cetus. Above the latter, southeast of the zenith, is the little triangle which forms the head of Aries. The great square of Pegasus is almost overhead, and Andromeda lies northeast of it, toward Perseus. The uninteresting zodiacal constellations Pisces, Aquarius, and Capricornus occupy the southern and southwestern sky. Lower down is one bright star, Fomalhaut, in the Southern Fish. Higher up and farther west is the planet Saturn. Mars, which is in Capricornus, has just set, but is visible earlier in the evening.

THE PLANETS.

Mercury is evening star in Scorpio. On the 27th he reaches his greatest elongation, but, as he is very far south, he will not be easy to see, though he sets rather more than an hour after the sun.

Venus is morning star in Virgo, and rises about 5:30 A. M. in the middle of the month.

Mars is evening star in Sagittarius and Capricornus, and sets at about 9 P. M. in the middle of the month.

Jupiter is in opposition on the 24th, and is visible all night long. He is farther north now than he has been for seven or eight years, and is admirably placed for observation. Transits and eclipses of one or more of his satellites are visible almost daily, and afford one of the most interesting spectacles that can be seen with any telescope, small or large.

Saturn is in Aquarius, and sets about 11 P. M., so that he is still observable in the evening. Uranus is in Sagittarius too near the sun to be satisfactorily seen.

Neptune is in Gemini in R. A. 6 h. 43 m., dec. 22 deg. 6 min. N. on the 15th, and comes to the meridian about 3 A. M.

THE MOON.

First quarter occurs at 9 P. M. on the 3d, full moon at midnight on the 11th, last quarter at 9 P. M. on the 19th, and new moon near noon on the 26th. The moon is nearest us on the 25th, and farthest away on the 10th. She is in conjunction with Mars on the 2d, Saturn on the 5th, Jupiter on the 13th, Venus on the 25th, and Mercury on the 28th. The conjunction with Saturn is quite close.

THE SUN.

At the date of writing (October 23) two large sun-spots, visible to the naked eye, are in sight at once. No one can say with certainty how long they will last, but if they endure for another rotation of the sun (which is probable) the first of them, which is a large diffuse spot with several nuclei, will reappear at the sun's eastern limb on or about November 7, and remain visible till the 20th. The second, which is smaller but blacker, came into view on October 21, and will pass round the sun's western limb about November 3, reappear on the 17th, and stay in sight till the 30th. Both spots can be seen without other aid than a piece of smoked glass, but their outlines can be better seen with a field-glass, holding the smoked glass close to the eye.

Observatory, Princeton.

TUNNEL BORING IN ANCIENT PALESTINE.

Unmistakable evidence exists that 2,500 years ago certain Hebrew engineers (in the time of King Heze-Kiah) executed exactly the same kind of work which was carried out in the Simplon tunnel, though perhaps on a slightly smaller scale. Dr. Bertholet, a professor at the University of Basle, is the gentleman who claims to have made this discovery. The Jewish records state that King Heze-Kiah, or Ezekias, who reigned at Jerusalem 727 B. C., was much troubled at the bad state of the water supplied to the people of that city. He accordingly had a vast reservoir made at the gates of the city, to which water was fed from various springs lying at more or less greater distances from the reservoir in question. At first his project seemed doomed to failure, as there existed, between Jerusalem and the springs, from which the water was to be derived, a high chain of hills, over which it would be impossible to convey the water. It was therefore determined to open a passage for the water through the solid rock; one of the Sirach MSS. dating from this period states in this connection: "Heze-Kiah fortified his city by bringing water thereto, and he bored through the solid rock by means of bronze, and he collected the water in a reservoir."

It is true that, about fifteen years ago, an open conduit was found in the vicinity of the Holy City, but this appears to have been made by a predecessor of Heze-Kiah's, which seems to be clearly proven by an inscription in old Hebrew characters found close to Jerusalem and preserved in the Constantinople Museum. Translated, this inscription reads: "The piercing is terminated. When the pick of the one had still not struck against the pick of the other, and while there was yet a distance of three ells, it was possible to hear the voice of one man calling to another across the rock separating them. And the last day of the piercing, the miners met pick against pick. The height of the rock above the heads of the miners was one hundred ells. Then the waters flowed into the reservoir over a length of 1,200 ells."

Recent explorations have enabled this predecessor of the Simplon to be thoroughly identified; it is said to be the Shiloah tunnel, by means of which water was brought down from a source to the east of Jerusalem, and poured into the Pool of Siloam mentioned in the Bible. This conduit is 360 yards long. The distance as the bird flies between the two mouths of the tunnel is also only 360 yards, which proves that the work was not executed in a perfectly straight line—due doubtless to the difficulties which the engineers encountered in their task, which (for the period) was of a really marvelous nature. That the work was commenced from both ends of the tunnel is not only proven by the inscription, but also by the fact that the marks of the boring tools, picks, etc., may still be seen, all bearing in opposite directions. The direction of the tunnel was altered several times during the construction thereof, as there are several short galleries, which were evidently abandoned as soon as it was noted that working was being done out of line. The floor of the tunnel is finished with the greatest care, and the workings vary from five-eighths of a yard to one yard in width by from three feet to nine feet in height, more or less, according to the hardness of the rock.

In the light of modern engineering science, the following questions suggest themselves: How did these old-time engineers gage their direction, recognize and remedy their errors in alignment? What tools did they use to execute a piece of work which has remained without equal or rival for 2,500 years? To these inquiries no answer can be given; the wondering student can only turn away with the exclamation: "In good sooth, my masters, there is nothing new under the sun!"

SCIENCE NOTES.

Theoretical crystallography, approached by Steno (1669), but formally founded by Haüy (1781, "Traité," 1801), has limited its development during the century to systematic classifications of form. Thus the thirty-two type sets of Hessel (1830) and of Bravais (1850) have expanded into the more extensive point series involving 230 types due to Jordan (1868), Sohncke (1876), Federow (1890), and Schoenfliess (1891). Physical theories of crystalline form have scarcely been unfolded.

The evolutionist is spared the surpassing difficulty of the human element, yet he needs imagination. In its lowest form his imagination is that of the detective who reconstructs the story of a crime; in its highest it demands the power of breaking loose from all the trammels of convention and education, and of imagining something which has never occurred to the mind of man before. In every case the evolutionist must form a theory for the facts before him, and the great theorist is only to be distinguished from the fantastic fool by the sobriety of his judgment—a distinction, however, sufficient to make one rare and other only too common.

The science of architecture, if under this head we include the principles of building construction, and the heating and ventilation of buildings, has done and is doing much of interest and importance to the student of public health science. The air supply, especially for the modern civilized and too often sedentary form of mankind, is in the long run quite as important as the water supply, the milk supply, or any other supply. Surely, we can not be too careful of the purity of a substance which we take into our bodies oftener, and in larger volume, than any other, and which has come, rightly no doubt, and as the result of long and painful experience, to be known as the very breath of life. Human beings may survive and seemingly thrive, even for long periods, in bad air, but for the best work, the highest efficiency, the greatest happiness and the largest life, as well as for perfect health, the very best atmosphere is none too good. Hence the permeability of the walls of houses and other buildings, and the heating and ventilation of dwellings, school houses, churches, halls and other public places, require, and in the near future will receive, a much larger share of our attention than they have to-day.

Aside from their economic value, grape vines are often cultivated for purely ornamental purposes, owing to their beautiful foliage and the rich coloration they assume, the shade they afford, and their hardihood and longevity. The vine is one of the few plants that can be conveniently grown in cities or towns either as bushes or for making delightful arbors that not only beautify the home, but furnish cooling shade and luscious fruit. The more tender sorts can be grown in graperies in many regions with good profit, and when grown in pots not only serve as handsome decorations in the dwelling and on the table, but add one of the choicest of morsels to the menu as well. To quote the language of an enthusiast: "The grape is the poor man's fruit, especially one who has only a house lot of the smallest possible dimensions. He can plant vines beside his cottage and their roots will extend and profitably occupy every inch of ground underneath it, and from that small space produce all the fruit his family can consume, while the vines afford shade and protection and add beauty to his little home, occupying no space, either above or below the ground, to interfere with other interests, and producing more fruit in less time and with less labor and attention than any other thing that was ever planted."

Information is being sought by people all over the country on the subject of testing of clays for the various purposes for which they are used, other than road building. Special tests are now carried on to that end. A furnace has been installed by the Department of Agriculture and actual burning tests on clays are now made. In order to further stimulate interest in the development of native clay bodies, a special circular was issued on "The Useful Properties of Clays." The aim of this circular was to give information in the simplest possible way to people who were not supposed to possess technical knowledge of clays. The circular particularly points out that for the year 1902, the last year for which the official figures are valuable, the total imports of foreign clays to this country were valued at $1,154,805, while the domestic clays produced were valued at $2,061,072. Since the country possesses unusually fine clay bodies, a great many of which up to the present time await development, any stimulation of interest among the people to develop our native clays must be of great value.