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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 PORTENTOUS BRIDGE DISASTER.

Quite apart from the lamentable loss of life which it involved, the fall of the great Quebec cantilever bridge is the most disastrous calamity that could possibly have overtaken the profession of bridge engineering in this country. If we were to select out of the many fields of activity which are covered by modern civil engineering, some particular one in which the American engineer has displayed most signally his originality and freedom from tradition, we would choose that of bridge engineering; and if we had been called upon to name some one particular structure which stood as the highest exemplification of his skill in this particular branch of his profession, we would have selected the great cantilever bridge across the St. Lawrence River at Quebec. Not only did it contain the largest and most massive single span of any bridge in the world, but it was constructed upon a system of which the earliest types, on any large scale, were built in this country. Moreover, not only was the bridge American in type, but in the details of its construction also it was essentially American, the tension members consisting of eye-bars and the compression members of rectangular latticed sections, built up of plates and angle bars, the whole bridge being pin-connected. The skeleton design shows also the distinctive American features of wide panels, great depth of truss, and a resulting apparent lightness of the individual members. Furthermore, the consulting engineer of the bridge is perhaps the most distinguished bridge engineer in this country, his "Specifications for Railroad Bridges" having been for many years the standard authority on that subject. The actual design of the steelwork, moreover, represented some three years of careful labor on the part of another of our leading bridge engineers; and his computations had been checked, and rechecked, and every care taken to obviate any possible errors in the design. Let it also be borne in mind that the steelwork was built and the erection done by one of the biggest and most experienced bridge firms in the country. In view of the fact that this was the most monumental and daring structure of the kind ever erected, it was natural that special care should be taken, as it unquestionably was, both by the engineers and the contractors, to insure that everything connected with the bridge, from the inspection of the steel to the details of the erection, should be done with the utmost care and fidelity.

Nevertheless, on a comparatively calm summer's afternoon, the giant structure collapsed in one of its most important members—crumpled in upon itself—and sank into the shapeless mass of ruin so graphically depicted elsewhere in the columns of this paper.

The tremendous significance of this disaster lies in the suspicion, which to-day is staring every engineer coldly in the face, that there is something wrong with our theories of bridge design, at least as applied to a structure of the size of the Quebec bridge.

It would be a mighty consolation if only there were some evidence that faulty material or poor construction had entered into a vital part of the bridge; but thus far everything points to the contrary. There would be comfort also in the fact, if it could be proved, that the sudden fall of some massive member which was being lifted into place, or a sudden displacement of one of the erecting gantries weighing several hundred tons, had produced a dynamic shock throughout the huge framework, which had caused the stresses to rise beyond the maximum calculated stresses, and so had brought the bridge down. But alas! there is no evidence to show that sudden dynamic stress or anything approaching it occurred.

Are we to conclude, then, that those theories, those formulæ, upon which we have been building our bridges so successfully during the past quarter of a century, are inapplicable when the structure exceeds a certain magnitude? Can it be that for some unsuspected reason a stress per square inch which is perfectly safe in the end-post of a 500-foot railroad truss becomes perilous when used in the bottom chord of an 1,800-foot cantilever? As far as our engineering knowledge goes, there is no reason whatever why this disparity should exist. But if not, why is the Quebec bridge now lying at the bottom of the St. Lawrence River?

When we first heard of the fall of the bridge, we were satisfied that the failure was not due to the breaking of any of the tension members. Eye-bars, if the heads be carefully welded (and great attention is always paid to this point) are the most reliable portions of a framed structure. They are never known to give way. It was our expectation that the cause of failure would be found in the compression members; and, as we have shown elsewhere in this issue, the breakdown seems to have begun in one of these, namely, the bottom chord of the anchor arm of the cantilever. Two or three days before the accident it had been observed that this particular member was showing incipient signs of yielding, by springing from an inch and a half to two inches out of line, the deflection being toward the inside of the truss. We confess to profound astonishment that upon this discovery work was not instantly suspended. Instead of this, an engineer was dispatched to New York to see the consulting engineer, and another was sent to Phœnixville to the works of the bridge company. At about the very hour that instructions were being forwarded to suspend work, the bridge fell.

The methods of calculation of the strength of posts, struts, and chords, that is, of all members subject to compression, are based upon combined theory and experiment. Many years ago large posts which had been built upon the accepted formula were placed in a testing machine, and subjected to compression until failure occurred. These tests thoroughly verified the correctness of the accepted formula, and the latter has since been used universally in determining the dimensions of compression members necessary to carry any given load. This formula was used in designing the chords of the Quebec bridge. They were designed to carry, under the most severe conditions of full live load and maximum wind strain, a stress of 24,000 pounds on each square inch of metal. This is two-thirds of the elastic limit, or the limit at which the metal would begin to stretch. At the time of failure, this member was carrying only about 16,000 pounds per square inch, or less than one-half the elastic limit. Evidently, when compression members are built up according to the present methods, in sizes such as those in the Quebec bridge, there is a failure of the separate pieces to act together as a whole, and present that resistance to buckling which members built up in the same way have invariably presented when constructed in smaller sizes for bridges of less dimension.

Obviously, if confidence in future bridges of great span such as this is to be restored, the first step to be taken is to determine with absolute certainty why the failure occurred; and the best way to do this would be to build a compression member which is an exact duplicate of this one, and subject it to gradually increasing loads, until both the elastic limit and the ultimate point of failure have been passed. To do this would, of course, involve the construction of an exceedingly costly testing plant; but in view of the doubt which has been cast upon American principles as applied to the design of bridges of great span, not even this expense should be spared in an effort to get at the true conditions.

It is too early to predict that, as the result of these investigations, we may be led to adopt the circular sections (by far the most effective form for long compression members) used by the late Sir Benjamin Baker for the Forth bridge, but we do believe that in future bridges of this size, the ratio of diameter to length of compression members will be greatly increased, and continuous cover plates will be used in place of the present open lattice-work reinforcement.

SUCCESSFUL FLIGHT OF AN AEROPLANE CONSTRUCTED AFTER LANGLEY'S MODEL.

Spurred on by the success of the Wright brothers in this country, and by the fact that these gentlemen have made a trip to France with the purpose of selling their aeroplane, a number of the well-known French experimenters have been making every effort to fly with a heavier-than-air machine. In a competition of models held last June in France, several models on the following-plane type, such as was first built and used successfully by the late Prof. Langley, made the best performances. Since then, M. Louis Bleriot has constructed and experimented with a full-sized machine of this type with quite remarkable results. A complete description of Bleriot's work will be found in the current SUPPLEMENT. Suffice it to say that with a machine having only about 215 square feet of supporting surface and weighing, all told, 617 pounds, he succeeded in flying a distance of 870 feet in two successive jumps of 401 and 469 feet, separated by a space of 39 feet, throughout which he touched the ground. His machine developed a speed of over thirty miles an hour. Its movement in a vertical plane was controlled by a horizontal rudder at the front end, this rudder being operated by a movable seat mounted on rollers, which was moved forward or backward similarly to the seat of a racing scull. The most notable part of this intrepid aviator's performance was the making of a turn at the end of the field over which he was experimenting, and landing with the wind at a speed of over thirty miles an hour without damaging his machine. This was a splendid demonstration of the inherent stability of the Langley-type machine, and complete proof that had Prof. Langley ever been able to successfully launch his machine, it would have made a successful flight. One of the most remarkable points to be noted with regard to M. Bleriot's performance is the fact that he had a motor of only about 20 horse-power, and each square foot of supporting surface was required to carry 2.8 pounds. One and one-half to two pounds per square foot is generally considered to be a good load for a machine of this type. Coming as it does at the moment of completion of the aeronautic trophy offered by this journal in commemoration of Langley and his machine, M. Bleriot's performance should put at rest all question as to the value of the type of machine proposed and successfully experimented with on a small scale by the late Curator of the Smithsonian Institution.

THE EVOLUTION OF MATTER.

The discovery of radium rays and other radiations has resulted during the last few years in a revolution, not only in the field of experimental physics, but of natural philosophy generally. Such fundamental laws as the laws of the conservation of energy and matter have lost a great part of their old prestige, and are far from occupying their former position as pillars of natural philosophy.

While the atom until recent years was considered as indestructible, radiation phenomena have shown that not only "radio-active" substances, but all bodies generally give out continually a stream of minute particles. These particles, which are thrown off by the atom at an enormous speed, possess the properties of rendering the air conductive of electricity, penetrating any obstacles on their way, and undergoing a deflection under the influence of magnetic or electric fields.

That these phenomena are common to all bodies has been first recognized by Dr. Gustave le Bon, who in a treatise recently published* deals with the significance and consequences of these theories.

For the old axiom, "Nothing is created, nothing is lost," Dr. Le Bon substitutes the principle, "nothing is created, all is lost." He considers radio-active phenomena as evidence of a permanent vanishing of matter and a gradual decay and transformation of it into an immaterial state, while passing through a number of intermediary conditions; the immaterial state corresponding to what is called ether. Ether and matter appear to him to represent things of the same order, the different forms of energy, namely, electricity, heat, light, matter, etc., being manifestations of one identical thing, differentiated by the stability and nature of its equilibria.

The products of this decomposing of atoms, according to recent researches, form substances intermediary by their properties between ponderable bodies and imponderable ether, that is, between two worlds which science has so far kept strictly separated. While matter was once considered inert, it now appears as an enormous reservoir of energy (inter-atomic energy), which it is able to give out without deriving anything from outside.

This inter-atomic energy manifested during the decay and disintegration of matter would result in most of the forces of the universe. The only essential difference between force and matter would be that the latter is a stable form of inter-atomic energy, while the former is unstable. By the dissociation of atoms, the stable form of energy called matter would be transformed into its unstable forms—electricity, light, heat, etc.

The idea recently suggested that a transmutation of atoms, according to the dreams of alchemists, some day might become quite practicable, is obviously in agreement with these theories. In fact, according to Le Bon, the law of evolution, which according to Darwin is true of living beings, would be applicable also to the simple chemical bodies or elements, chemical species being as far from invariable as living species.

The practical interest attaching to the doctrine of the permanent decay of matter, due to its transformation into energy, will be fully appreciated only when a process for accelerating the disintegration of bodies has been found. When this has been achieved, a prac-

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* L'Evolution de la Matière, Ernest Flammarion, pub., Paris.