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NEW YORK, SATURDAY, MAY 12, 1906.

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 FUEL EFFICIENCY TEST OF AUTOMOBILES.

Never before has there been held in this country an automobile contest having so many participants as had the Two-Gallon Efficiency test, conducted by the Automobile Club of America on Saturday of last week. Not only were the entries seventy-one in number, but the proportion of starters was large, there being sixty-five machines in all. The main object of the test was to determine the fuel consumption per mile of the various automobiles. First, second, and third prizes, consisting of a valuable gold punch bowl and a silver cup and medal, were awarded to the three cars that made the highest scores.

The score of each car was obtained by multiplying the total weight of the car when loaded (to which weight 800 pounds were arbitrarily added) by the distance run. Thus, in reality, the contest was placed on the ton-mile basis, which would cause the large, heavy cars to win over those of lighter weight if the former were not handicapped. This, it seemed, must be so, since ordinarily gasoline consumption does not increase directly with the weight, and a heavy car is found to be much cheaper to run per ton-mile than a light car. Despite this well-known fact, the committee in charge penalized the light cars by taking the weight of all two-cylinder machines as but 75 per cent of their actual weight, and that of the single-cylinder cars as but 70 per cent. The test favored the heavy four-cylinder cars, therefore, and it seemed well-nigh impossible that any other type of car could win. The surprising result was, however, that the winner happened to be a four-cylinder *light-weight runabout of the air-cooled type*, a car which is a distinctively American invention. This machine, weighing with driver and observer 1,500 pounds, ran from 57th Street and the East River to North Haven, Conn., a distance of 87 miles, upon two gallons of gasoline, at an average speed of 17½ miles an hour. When the fact is considered that the first 35 miles of road were in a very muddy condition, owing to a cloudburst occurring while the car was traversing them, it seems quite possible that a distance of 90 miles, or 45 miles per gallon, could have been covered had the road been dry. The automobile editor of this journal, who had the pleasure of being the observer on the winning car, believes that this distance could readily have been covered in fair weather and with dry roads, in view of the facts that the low speed had to be used on a considerable number of hills that could otherwise have been mounted on the high gear, and that the dampness of the air necessitated the opening of the needle valve of the carbureter more than is required on a pleasant day.

The car that won the second prize was likewise one of the latest types of air-cooled cars that American ingenuity has devised and perfected. The distinctive feature of this car's motor is that the cylinders are incased in aluminium jackets, through which air is forced by a powerful gear-driven blower, while in contradistinction to this system the motor of the winning runabout is cooled only by the natural draft of air as the car moves forward, the motor in this case being placed transversely at the front of the car and also being provided with auxiliary mechanically-operated exhaust valves, to aid in the quick expulsion of the burnt gases. The needle valve of the carbureter also can be adjusted from the driver's seat. This is a very good feature, that is found on scarcely any other make of car. Both of these machines are familiar to our readers from descriptions published in our automobile number of January 13 and previously. A car of the same make as the winner holds the transcontinental record, which was made in less than 33 days.

The car which obtained third place was a well-known French make of 4-cylinder water-cooled machine. This car had a score of 180,642, as against the 200,100 of the winner and the 194,953 of the second car. It weighed 3,110 pounds, and covered 46.2 miles, while the second car weighed 3,270 pounds, and made 47.9 miles. The cost of running per ton-mile of the first six cars, figured with fuel at 20 cents per gallon, is 0.613, 0.517, 0.556, 0.559, 0.500, and 0.640 of a cent respectively. The fourth machine was a large French car with a record for fuel economy; the fifth was an 18-passenger bus; and the sixth a light tonneau having the same make and size of engine as the winner. A one-cylinder buckboard made 101.6 miles, and a single-cylinder tonneau carrying four people, 56.8.

PREVENTION AND MASTERY OF DISEASE.

It is probable that most of us have heard more or less about the remarkable success which attended the efforts of the Japanese to prevent and control disease among their armies in Manchuria; but it has remained for Major Louis L. Seaman to place the full facts before the world in a work to which he has given the appropriate title "Real Triumph of Japan." The high reputation of Major Seaman as an army surgeon, and the fact that his assertions are based upon personal observation during his presence with the armies in Manchuria, place the statements contained in his work, extraordinary though they be, beyond all question as to their veracity and accuracy.

It is shown by Longman's Tables that for nearly two centuries past, in wars that extended over any great period of time, on an average at least four men have perished from disease to every one who has died of wounds. In the late Boer war 8,221 officers and men were sent home on account of wounds, while 63,644 were invalided home by disease. Major Seaman quotes from Vital Statistics for 1898, in which the Surgeon-General of our army shows that while deaths from battle casualties were 293, those from disease amounted to 3,681, or 14 from disease to 1 from casualty. These surprising figures are compared with the record made by the Japanese. The Japanese statistics show that from February, 1904, to May, 1905, although 52,946 were killed or died from wounds, only 11,992 died from various diseases. That is to say, only one died from sickness to every four and one-half men who died in battle or from wounds.

This complete reversal of the statistics of the two leading nations of western civilization constitutes, according to Major Seaman, the real triumph of Japan; for it is a fact that in their war with China only ten years before, the Japanese lost about the same average as that which prevailed during our own civil war, namely, three from disease to one from bullets. In that war they realized that disease was even more fatal than the enemy's weapons, and in the intervening years they set out to master the invisible foe with a success to which the statistics, as above given, bear eloquent testimony. These results were obtained by careful study of military sanitation and hygiene, and by a most thorough bacteriological examination of the water along the line of march and in the vicinity of the camps. The water-testing outfit formed part of every sanitary detachment, and every foraging and scouting department was accompanied by a medical officer, who made an examination of the water to be used by the troops. In view of the extraordinary facts developed as the result of Major Seaman's investigation, it is not putting the case too strongly to say that, as matters now stand, the medical corps has as much, if not more, to do with the winning of campaigns and the mitigation of the horrors of war as any other department of the army.

FIREPROOF QUALITIES OF REINFORCED CONCRETE.

In a recent issue we drew attention to the fact that, because of its strength, resiliency, and monolithic or one-piece construction, reinforced concrete was admirably adapted to resist the shock of earthquakes, and we strongly recommended the system for the rebuilding of San Francisco. We now wish to emphasize the fact that armored concrete is equally well adapted to resist the fierce heat of such a conflagration as that which completed the ruin of the city. Mention should first be made, however, of certain additional facts which have come to light regarding the behavior of reinforced concrete buildings that were exposed to the most destructive shocks of the earthquake. The first case is that of the bell tower of the Mills Seminary, which, although it is some 75 to 80 feet in height, was not even cracked by the severe shaking to which it was subjected. The other two instances are to be found in Stanford University, where the Museum Building and Roble Hall, both built of reinforced concrete, are standing practically intact amid the widespread ruin, and in some cases the absolute demolition, of the other buildings of the University, all of which were massively constructed with a special view to withstanding earthquake shock. Two wings built of brick had been added to the Museum Building since its completion. These were thrown down, while the concrete structure passed through the ordeal satisfactorily. Roble Hall is built with concrete walls and floors of wood. The only damage to this building was due to the falling of a chimney, which broke through the floors, killing one of the inmates.

As to the ability of reinforced concrete to stand the test of fire, although there are no advices at hand to show that any such construction was put to severe fire test in San Francisco, enough has been learned in experimental tests made for building departments, and particularly in an exceedingly fierce fire which occurred to a concrete building in Bayonne, N. J., three or four years ago, to render it certain that buildings of this type would have passed through even the San Francisco ordeal satisfactorily.

One of the most conclusive tests by fire, loading, and water was that made last year by the Bureau of Buildings of New York city of a reinforced concrete floor, carried on two reinforced concrete girders, supported by four columns. The purpose of the test was to determine the effect of a continuous fire below the floor of four hours at an average temperature of 1,700 deg. F., the floor carrying a load of 150 pounds per square foot. At the end of four hours, the red-hot floor was to be subjected to a stream of cold water for five minutes, and then the upper side of the floor was to be flooded at low pressure. As the result of the test there was some flaking of the surface of the concrete, which did no material damage to the building. A stream of water knocked off the concrete from the bottom at one of the girders at the center, exposing the metal rods for a few feet, and there were some slight cracks of no material significance. With the exception of these defects, the whole floor system, in spite of the severe ordeal through which it passed, was found to be in excellent condition. The test was carried out under Prof. Ira H. Woolson, of Columbia University, and on the satisfactory results achieved the system received the approval of the Bureau of Buildings of the City of New York, for whom the test was made.

But the most severe test, the one which is generally accepted by engineers and architects as proving on a large scale the fire-resisting qualities of reinforced concrete, was the fierce fire which burnt out the mill of the Pacific Coast Borax Company at Bayonne, N. J., on the night of April 6, 1902. The building, which measured 200 feet by 250 feet, was four stories high in the main portion, and the remainder consisted of a single-story wing. The fire, which started from the bursting of an oil main and was fed by a large amount of inflammable material, was an exceedingly hot one; as was proved by the amount of fused cast iron from the machinery and copper from the dynamos and motors, which was found on the various concrete floors (themselves intact) after the conflagration. Everything that the building contained was completely burnt up, and nothing but the monolithic concrete structure remained. This was found to be in absolutely perfect condition, so much so that the building was put in first-class shape at a cost of less than one thousand dollars. Evidence of the ability of such a structure to pass through a severe fire test, and yet maintain its integrity, was found in the fact that although the heat must have exceeded 2,000 degrees, the side walls, four stories high and 200 feet long, without any cross walls to tie them, were found, at the conclusion of the fire, to be absolutely in line, both vertically and horizontally.

The question of the extensive use of reinforced concrete in the rebuilding of San Francisco is greatly dependent upon the attitude which may be taken by the San Francisco labor unions, which hitherto have opposed the system so vigorously and successfully, that of late but little of it has been used. We note, however, from press dispatches, that the unions have signified their intention to suspend all restrictions which might hinder the rapid rebuilding of San Francisco, and it is to be hoped that this conciliatory and humane attitude will be extended to cover the important question of constructive materials.

THE GOVERNMENT AS A CEMENT MANUFACTURER.

The government wants Portland cement, and wants it badly. With twenty-four big irrigation projects under construction, requiring hundreds of thousands of barrels of cement, the engineers are finding it next to impossible to obtain anything like the quantity needed. The unprecedented demand for this commodity all over the West has already overtaxed the capacity of the mills, and almost without exception the government's requests for bids are turned down. Apparently no manufacturers west of the Mississippi are able to supply new orders. In reply to inquiries from the government they state that owing to the unusual demand, new orders cannot be accepted for several months to come. Recently proposals were requested from eight manufacturers and dealers in cement for 2,000 barrels required on an Idaho project. Only one proposal was received, and that was at a rate fifty per cent higher than the firm would have sold a few months ago. Still later invitations for bids for several thousand barrels were sent to twenty-three dealers. Again but one firm submitted a bid, and this was nearly sixty per cent higher than the normal profitable rate of sale by this firm. Other attempts to purchase cement have been similarly unsuccessful.

The Reclamation Service is gravely concerned. It

has let contracts for structures involving millions of dollars, and a failure to secure cement as needed, entering as it does so largely in the work, will be disastrous. Owing to the inaccessibility of many of the government works, the transportation of cement is difficult and costly. This was particularly the case in Salt River Valley in Arizona, where the great distance from existing mills and the expensive wagon haul made the cost prohibitive. After making thorough investigation of the cost of bringing in cement for the Roosevelt Dam and other structures, the government erected its own mill, and for several months past has been turning out daily hundreds of barrels of first-class cement at a price far below the cost of cement shipped in. It is known that materials required for manufacturing cement of good quality exist near several of the other projects, and private parties should embrace the opportunity to go into the business. From the present outlook, however, the government seems to have a choice of shipping from the far eastern seaboard or from Europe, or of manufacturing its own cement.

SOME FEATURES OF THE GREAT EARTHQUAKE.

BY H. A. CRAFTS.

I was afforded an excellent opportunity to observe the effects of the great California earthquake of April 18, 1906, being in San José at the time of the shock Then, in about an hour, I left for San Francisco over the Southern Pacific Coast line, which traverses the west shore of San Francisco Bay from Palo Alto on the south to the center of the city on the north.

At San Bruno, fifteen miles south of San Francisco, the train was halted on account of damaged track, and the great majority of the passengers started on afoot. As for myself, I walked about twelve miles, when I was overtaken by the train which had finally managed to creep across the shaken track and proceed on its way.

I then went as far as the Valencia Street station, in the southern quarter of San Francisco. At that point I ascertained that it would be impossible to get through the city and across the bay to Oakland; and having started for the last-named point to learn the fate of my family, I concluded to turn back and proceed to San José, or wait at some small town on the peninsula until such time as I could make my way *via* San Francisco.

I walked back some five miles, and then took a train back to San José, arriving there at six o'clock P. M., just twelve hours from the time of my departure. Meantime I had traveled fifty miles of the worst-affected territory and returned.

I am of the opinion that when the relative force of the earthquake has been approximately measured, it will be found that the point of greatest energy was in the vicinity of San José. I am quite sure from my personal observations that the shock at San José was much more severe than that at San Francisco.

There is no point that apparently received so severe a shock as San José and some of the smaller towns next north of it on the peninsula, excepting Santa Rosa, and that town is almost exactly the same distance north of San Francisco as San José is south. Thus San Francisco might be taken as the center of the disturbance, with a constantly-increasing force both north and south for distances of fifty miles, from whence outward the force constantly diminished.

Now as to the disturbance in an easterly and westerly direction: The next day I took a train for Oakland, on the east side of the bay, and was surprised to observe that that strip of country had been far less affected than the strip that I had traversed the day before. There were a few chimneys down along the route, and when I reached my home in Fruitvale, a suburb of Oakland on the southeast, there was hardly any evidence that an earthquake had struck the section the day before.

Of course, the effect westward of San Francisco could not be judged, because there is the boundless Pacific; and if there were any upheaval at all, it came in the shape of a tidal wave, and I have yet to hear that any such phenomenon occurred in that direction. Eastward still of Oakland there was a constantly diminishing tremor. Stockton, sixty miles inland from the Golden Gate, reported but a comparatively slight disturbance. So there is the approximate area of the great terrestrial disturbance.

Now as to local effects. At the time of the shock I was in bed in a small room in the rear of the second floor of a large square-frame dwelling on North Third Street, San José. I had wakened some fifteen minutes before, and was trying to get one more nap before arising. Suddenly I was aroused from a half-slumber by the sound of a rush and a roar outside, and in a second the whole house was swaying from side to side and straining in every part.

Then there was a momentary lull, after which came the supreme shock. The house appeared to heave up and down and sway from side to side at the same time, just as if it had been suddenly cast upon a rolling sea. The terrible force appeared to gain strength continually, and it seemed as if the whole structure would be wrenched in pieces and flung to the ground in a heap of ruins. In the meantime the roar outside had become almost deafening, and this was punctuated with crash after crash of falling buildings in distant parts of the town.

Then all was calm, and that calm was almost as terrifying as the storm that had just ended, for who could tell what was coming?

Upon rising I found my washstand, which had stood back against the east wall of the room, moved out from the wall at its south end about a foot, while all around the carpet was drenched with water that had been spilled from a large ewer that had stood in a bowl upon the washstand.

Hastily dressing, I went into the street. The sky above was perfectly clear and the sun was just rising. The air was balmy, and not a breeze stirred the leaves upon the trees. Looking up and down the streets, a gray dust could be seen rising, not only from the earth itself, but from the wreckage that strewed the whole city.

I turned the next corner going west, and came suddenly to a large square two-story frame dwelling, that had had its back broken at the second floor joist and had yawed off to one side, the first story meantime half collapsing and the upper story resting upon it intact. Hovering around its portals were some half dozen half-clad, distracted women, and I heard one of them remark that they had all got out alive, and that there had been eight persons in the house at the time of the shock.

That was a sample of some of the work done in San José. I did not remain to inspect the town, but hurried to the train. When I returned in the evening, a friend told me that San José was a wreck. This should be qualified, however. There was hardly a building in town that did not show some effects of the earthquake. Not one chimney in a hundred was standing. The business part had been more badly damaged than the residence part; hardly a front was intact, while many buildings had entirely collapsed. About thirty persons had been killed, including several entire families.

I took the 6:10 train for San Francisco, and it was a continuous succession of wreckage all the way up the track. There are about a dozen fair-sized towns between San José and San Francisco, including Santa Clara, Palo Alto, Redwood City, and San Mateo. Santa Clara was hit fully as hard as San José, but no one was killed. At Palo Alto the buildings of the Leland Stanford, Jr., University were badly wrecked, At Redwood City the new courthouse was about ruined.

Either coming or going I caught glimpses along the principal business streets of these towns, and there were regular windrows of ruins stretching up either side of the streets as far as there were any buildings of a considerable size.

The railroad as far as San Bruno was in fairly good condition, but it must be remembered that it is built over a very low and level tract of country, with no filled grades to speak of. But north of San Bruno there are several arms of the bay marsh lands reaching up into the peninsula, and across these the railroad company was compelled to construct grades that vary from four to ten feet in height above the marsh level.

Here it was that the earthquake put in some of its heavy licks. The earth embankments were sunk and cracked and the track twisted into serpentine shape for long distances.

And presently we came to the great cemeteries where the dead of San Francisco have been buried for fifty years. Thousands of headstones and monuments were overturned, and the elaborate gateways wrecked in various ways. Here I had a talk with a railroad employe who lives in the vicinity. He informed me that when the shock came, he was on his way to the small station to draw a pail of water. The motion of the earth was so violent that he was thrown off his balance, and he fell to the ground.

He said, however, that he was not very badly scared until he looked over into the cemeteries, and there saw "all the gravestones dancing a jig," to use the man's own language.

Now let us refer briefly to the various topographical characteristics of this region: San José stands about midway east and west in the upper end of the Santa Clara Valley. About twelve miles east stands the inner coast range, and about the same distance to the west stands the Santa Cruz or outer coast range. Neither of these ranges was badly shaken. San José stands about ten miles south of the southern extremity of the bay of San Francisco and upon a level plain composed of an alluvial soil.

The peninsular towns mentioned are at about the same level, but the outer coast range swings eastward, so that the valley land narrows down rapidly as one goes north.

The district traversed on the east side of the bay is also at about the same level, and forms a comparatively narrow strip of land between the bay and the inner coast range.

Some might say that the terrible peninsula was the point of greatest insecurity, but San José, quite a distance south of the base of that arm of land and in the midst of a landlocked valley, got just as bad a shaking as did the peninsula.

THE ADVANTAGES AND LIMITATIONS OF REINFORCED CONCRETE.

A paper read by Mr. Charles S. Hill before the Association of Portland Cement Manufacturers so admirably reviews the merits and defects of reinforced concrete that it may not be deemed amiss to summarize it here.

The capacity of resistance to tension of concrete, says Mr. Hill, is much less than the ultimate compressive resistance; when a concrete beam, for example, is subjected to transverse loading, it fails by tearing apart on the tension side. The purpose of the combination of concrete and steel known as reinforced concrete is to supply the deficiency of tensile strength in concrete—to make possible the construction of a beam or other member almost entirely of concrete, but which shall, by having imbedded in it steel rods of desired shape and suitable cross-sectional area in proper positions, possess a high capacity to take tensile stresses. The fundamental theory of the combination is that the disposition of the concrete and the steel in the section is such that the two elements act as a single unit, all stresses being divided between the concrete and the steel where the latter occurs.

Actual construction of reinforced concrete falls somewhat short of reaching this theoretical perfection; it is not possible to distribute the steel perfectly through the concrete nor is it possible to secure that absolute adhesion between the concrete and steel which is necessary to perfect transmission of the stresses from one material to the other. These defects have to be allowed for in practical design; they may be reduced to quite minute proportions by good design and good workmanship, and they may be so accentuated by poor design and poor workmanship that a weak and dangerous material results.

Premising reasonably good design and workmanship, the claims which reinforced concrete presents as a structural material are sound and important. The compressive resistance of concrete is about ten times its tensile resistance, while steel has about the same strength in tension as in compression. Volume for volume, steel costs about fifty times as much as concrete. For the same sectional areas, steel will support in compression thirty times more load than concrete, and in tension three hundred times the load concrete will carry. Therefore, for duty under compression only, concrete will carry a given load at six-tenths of the cost required to support it with steel. On the other hand, to support a given load by concrete in tension would cost about six times as much as to support it with steel. If, then, the various members of a structure are so designed that all the compression stresses are resisted by concrete and steel is introduced to resist the tensile stresses, each material will be serving the purpose for which it is cheapest and best adapted and one of the principles of economic design will be fulfilled. This is the economic claim which reinforced concrete presents as a structural material.

Other important advantages secured in the combination of concrete and imbedded steel are: that the protection of the metal elements from corrosion is practically perfect; that the fire and heat resisting qualities of a masonry structure are secured at about the cost of a more or less temporary unprotected steel structure. That concrete is an almost perfect protection of steel from corrosion, is a fact almost beyond reasonable dispute. Both theory and the evidence of actual experience support this statement. It is to be noted, however, that concrete, to be effective in preventing rusting, must be dense, without voids and cracks, and in close contact with the metal at all points. The fire-resisting qualities of concrete have been subjects of much dispute. Theoretically, concrete being a hydrated compound should disintegrate with the expulsion of the water of hydration by heat. Practically, however, such disintegration must be very slow because of the high temperature required to drive off the water and because of the poor heat conductivity of the material. To set against whatever weakness concrete may have in the respect mentioned, we have the indisputable evidence that concrete structures have met the requirements of the most severe municipal fire tests and have successfully withstood the attacks of actual conflagration.

The rapid growth of reinforced concrete in public favor has been little short of marvelous. It is now used for nearly every form of structure for which timber, steel, or masonry is suitable. Indeed, its greatest evil is that it has been crowded into uses for which there is small warrant for its adoption as compared

(*Continued on page* 387.)