three-quarter inch bolts to hold the bottom chord tension member of a 75-foot span.

Another case was that of an eminent chief engineer of a railroad who once tried to change the plan of a through Howe truss into a Deck Howe truss by turning it upside down, not realizing that the bottom chord of a Howe truss is always in tension whether the load is applied at the bottom chord or the top chord. If he had stopped to think, he would have realized that when he stepped on a beam he would put a tension strain in the bottom and compression in the top, and that if he had suspended himself from the bottom of the beam he would have caused the same strains, as the beam would still deflect downwards, not upwards. Instances like these are enough to make the novice go slow; and yet, many such have occurred. As to who was responsible for the Quebec catastrophe is of chief interest to the people who have to pay the loss, for there was absolutely no criminal intent, for it is inconceivable that a single man connected with that concern would have for an instant risked all those lives had he thought he was doing so. It is simply a case of erroneous judgment, or want of judgment, with terrible loss of life and money, and it is pitiful to see the effect on the survivors, who will never recover from the blow.

The Canadian Government Commissioners who have just been taking testimony in New York have had some light thrown on the subject by the evidence of Mr. Theodore Cooper, the consulting engineer of the Quebec Bridge Company.

MR. COOPER'S SALARY.

Mr. Cooper, a venerable man of 70, is one of the pioneers in steel bridge building and none have done better work or held a higher respect in the profession. According to his testimony he was engaged as consulting engineer for the Quebec bridge at $7,500 a year, but as the company did not seem able to raise that amount he agreed to accept $4,000 a year, which was paid him and nothing more, and as the chief engineer was not a bridge engineer, the consulting engineer had to act as chief engineer also, and though he drew attention to the fact that he should be remunerated for the extra work and expense he never was, and as his office expenses, etc., amounted to about $4,000 a year he was actually consulting engineer for that project for some seven or eight years without remuneration. Owing to ill health he has been unable to go to Quebec for several years and he has testified that he had not done much actual designing for some twenty years past. One might infer from his testimony that he had had so many "scraps" about other questions of design, that he had entirely overlooked the faulty cross-section of the main compression members.

After referring to the bottom chord section No. 9 west, which was undoubtedly the first to fall, and which was known to be out of line and in a dangerous condition, Mr. Cooper was asked:

"Do you think that at a moderate expense the ribs could have been made absolutely safe?"

He answered, "I do. I believe if prompt action had been taken to protect chord 9 west from further deflection, which could have been done by the employment of three hours' work and $100 worth of timber and bolts, the deflects and deficiencies which we now recognize in the compression chords and members, could, at a later date, have been corrected and the bridge could have been made perfectly safe and sufficient for its intended purpose."

And yet there was no one on the site in authority, who realized the danger except one inspector who had to take a trip to New York to try to have the defect remedied—and about twenty-four hours after he left Quebec the bridge was in the river. The whole testimony is well worth reading, being absolutely candid, concealing nothing, evading nothing.

It shows the folly of attempting important work without time for thorough study and without the requisite number of trained men on the job, with sufficient judgment to act in emergencies and with ample power to enforce obedience.

It is a well known fact that many financiers and promoters will pay hundreds of thousands of dollars to contractors sooner than a few thousands to an engineer for saving the hundreds of thousands.

Mr. Cooper refers to the fact that consulting engineers cannot afford to keep a staff to do all this designing. They certainly could not, if their fees, as in this case, only covered their expenses. But there are plenty of engineers who can make general designs very reasonably which would cover all essential points, leaving drawing of the shop plans covering, rivet spacing, etc., to the bridge contractor, as these can be easily checked.

HOW SPECIFICATIONS ARE CUT.

The writer once had to report on the plans submitted by some seven or eight contractors for the largest cantilever, at that time, proposed on this continent and he was surprised to see what poor designs could be gotten up, according to the same specification, in order to reduce the cost of the bridge to a minimum.

This does not mean that contractors are dishonest, but that to get a job on competitive plans they have to sail as close to the wind as they *consider* safe and when they have the job every minor employee thinks that he is doing his employer a benefit by cutting out as much expense as possible.

Whereas the independent engineer knows that he is doing his client an injury if he cuts the cost at expense of a safe or durable structure.

There is one thing, however, that the majority of Canadians and Americans are anxious for, and that is to see the Canadian Government build a fine looking cantilever bridge on the same piers but on entirely different lines—as none of us enjoy having Europe sneer at us and say we can't 'touch' the Forth bridge—for we can certainly build a much finer looking structure, of a more economical design, and that too, without making any new tests of material or shapes or calling for any further knowledge of bridge construction than plenty of our Canadian and American engineers have possessed for many years.

Power House Built Entirely Under Water

A SUBAQUEOUS power plant has recently been completed about fifteen miles below Baltimore on the Patapsco river. It is built within a dam and is entirely under water. It is the first of its kind ever built and cost much less than it would have if built in any other known way. The dam is 220 ft. long, 40 ft. thick at the base and 26½ ft. high. The spillway is 168 feet long, but at present only 108 feet of this distance is used for housing the power plant. The dam is reinforced concrete, the shell being 18 inches thick at the bottom and tapering to 10 inches at the top.

The apron extends only half way down from the crown, the remaining downstream portion being entirely open and provided with windows by means of which the interior is lighted. The shape of the apron is such that the water is thrown some little distance away from the windows.

The part used by the power house is fitted with a false ceiling hung five feet from the inside of the dam so as to protect the apparatus from any water that might leak through the outer shell of the dam. The dam is built of a fine and rich mixture, which was laid very wet. Aside from this, no precautions were taken to eliminate water.

The water is led to the turbines through steel pipes passing through the upstream spillway shell and discharged by draft tubes into the base of the dam, dropping into a well sunk some three feet below the river bed. The water passes thence by way of a channel constructed in the dam. The intake is 5½ feet below the crest of the spillway so that the trash racks are kept clear of driftwood, etc.