tions up to the point of fracture, the following inferences may be at once drawn: (a) The increment of deflection diminishes and therefore the coefficient of elasticity increases with the elimination of the moisture from the beam. (b) The increments of deflection are much more uniform in amount in the case of kiln-dried beams.

It is, of course, impossible to maintain a beam in a kiln-dried state As soon as it is exposed to the atmosphere, it at once commences to absorb moisture, and the absorption continues until there is an equilibrium between the hygrometric conditions of the beam and atmosphere. The beam is then in its normal state, and the experiments indicate that the increments of deflection, corresponding to this state, are approximately uniform. The rate of absorption depends essentially upon the nature of the timber, and proceeds more slowly as the density increases. The weight of a central 2-inch slab of beam 30 (Spruce), increased 3.6 per cent. in 24 days, and 8.5 per cent. in 47 days. The influence of moisture on the deflection of a beam was well illustrated in the case of 15 inch x 6 inch Douglas fir beam on 186 inch centres. On June 15th, 1895, it was placed in position and was loaded with a weight of 1,000 lbs. at the centre, producing a deflection of .071 inch. The daily observations, extending over several months, showed a continually increasing deflection, until, by the evaporation of the moisture, the beam had attained its normal state. The average deflection now remained constant, varying, for example, between .09 inch on August 24th, and .082 inch on September 2nd, the greater deflection of course corresponding to an increase of moisture in the atmosphere. On the 4th of September, the load was increased to 2,000 lbs., which produced a deflection of .127 inch. This load remained on the beam until January 8th, 1896, the deflection during the same period varying between .129 inch and .114 inch.

Of 20 non-kiln dried beams, 11 failed by crippling on the compression side, 6 failed by longitudinal shear, and 3 hemlock beams only failed by the fracture on the tension side. The experiments on the direct tensile and compressive strength of the timbers show that this is precisely what might be expected to take place. In every case the direct tensile strength is very much greater than the direct compressive strength, and failure by crippling is likely to take place under a load much less than the material could bear in tension. Under all circumstances, therefore, in practice, it is advisable to place a beam so that the portion of the timber which is strongest and in the best condition should be in compression Again, the experiments conclusively show that kiln-drying enormously increases the direct compressive strength, but greatly diminishes the shearing strength, while the direct tensile strength does not appear to be much affected, although in the majority of cases it was diminished, and sometimes considerably. The large increase of strength in compression due to kiln-drying might have been naturally expected, as in the process of drying the walls of the cells are stiffened and hardened, and thus become better able to resist a compressive force. The walls, however, are at the same time much more brittle, and it is possible that a sudden blow might cause the failure of a kiln-dried column, which would have remained uninjured had the moisture not been eliminated. It may also be of interest to note that in the re-tests of specimens after the injured portion had been removed, the compressive strength was, almost without exception, increased. Hence, by kiln-drying a beam its compressive strength is made to approximate more closely to its tensile strength, and its transverse strength is consequently sometimes considerably increased. It must be remembered, however, that this kiln-drying invariably largely diminishes the shearing strength, and therefore proportionately increases the tendency to shear longitudinally. Thus, of the nine kiln-dried beams in the preceding tables, only one failed by crippling while four failed by fracture on the tensile side and four failed by longitudinal shear. Indeed, generally speaking, kiln-dried beams will fail either by a tensile fracture or by a longitudinal shear, and this result has been further verified by experiments subsequent to those referred to in the present paper.

In practice, of course, beams cannot be maintained in a kiln-dried state, but they rapidly pass into the normal state. The question of how far it is desirable to eliminate the moisture depends essentially on the balance to be maintained between the tensile, shearing and compressive strengths, and a beam should always be placed so as to exert its relative strength to the best advantage. Kiln-drying, unless some special method of prevention is adopted, develops shakes in the timber and causes existing shakes to become more pronounced. Some of these shakes often extend to a great depth and run the whole length of the beam, so that it not infrequently happens that only a slight layer is left to hold the beam together. Such a beam, although otherwise sound and clear, offers very little resistance to longitudinal shear, and might more justly be regarded as being made up of two or more superposed beams.

When this paper was read by Prof. Bovey before the Canadian Society of Civil Engineers, the following discussion ensued:

Prof. Bovey replying to a question stated that the direct tensile strength of timber is much greater in every case than the direct compressive strength, for instance, if 10 represented the tensile strength, 5 would represent the compressive, and for that reason, as his experiments showed, it was always best and safer to put the best side of the timber in compression.

Mr. Peterson replied that while Prof. Bovey's tests indicated that the failure usually took place on the compression side he found that in actual practice the timber invariably failed on the tension side, therefore, he maintained, the direct compressive strength of timber is greater than the direct tensile strength.

Prof. Smith said incipient failure having occurred on the compressive side the neutral axis shifts its position and throws an additional strain in tension.

Prof. Bovey.—A beam which had apparently failed on the tension side, had in reality been first weakened by crippling in compression (which is not always visible), and this threw an additional strain on the tension side, which thereupon ruptured first. No two pieces of timber give the same results, they vary greatly, e g, if you can cut a piece of timber into three parts longitudinally you will find they vary largely, as far as strength is concerned.

Mr. Irwin pointed out that after a timber had failed the part injured in compression would return so as to escape observation easily, whereas an actual rupture gradually took place on the tension side.

Mr Peterson said, speaking of bridge trusses, that he had never known the top chord to fail, and that it was not nearly so liable to do so as the bottom chord, therefore it does not coincide with the experiment made.

Prof. Bovey replied that the cases of a bridge truss and a beam of timber were not parallel, and that the top chord of a bridge truss was subject to direct compressive strains very different to those in a beam under the load.

Mr Duggan remarked that a bridge truss never failed in the solid, but only in the joints, these being the weakest points.