bending up from the weight which they have to carry. Sometimes insufficient rivets are used in connecting such clip angles to the floorbeams. Even when a loop hanger passes down through or around both flanges of a floorbeam and takes bearing on the bottom flange angles, if there is no tie plate or only a thin loose washer plate, these angles and washers are very often found to be insufficient.

Decay of Timber Stringers

The reduction of the strength of timber stringers due to decay is not always appreciated. That the unit stresses generally allowed for timber leave a larger factor of safety above the elastic limit than is commonly left in the case of steel members is realized. This is wise, because wood exposed as is usual on bridges, deteriorates more rapidly than steel or iron which receives reasonable care. But, regardless of the reduction of strength of individual fibers which, though not so far gone as to be called rotten, are approaching that stage, a slight loss of section in the top or bottom of a stringer reduces the strength for resistance to bending altogether out of proportion to the amount of section lost. In a timber beam 12 in. deep a loss of 1 in. in depth reduces the section 8 per cent. and the strength 16 per cent.; 2 ins. in depth reduces the section 17 per cent. and the strength 30 per cent.; 3 ins. in depth reduces the section 25 per cent. and the strength 44 per cent.; 4 ins. in depth reduces the section 33 per cent. and the strength 55 per cent.

If the decay is uneven the loss of strength is even more striking. A 12-in. stringer having full depth at one side and reduced at the other side 2 ins. has its section reduced 8 per cent. and the strength reduced 28 per cent.; 4 ins. has its section reduced 17 per cent. and the strength reduced 46 per cent.; 6 ins. has its section reduced 25 per cent. and the strength reduced 58 per cent.; 8 ins. has its section reduced 33 per cent. and the strength reduced 66 per cent.

Sound timber, notched for pipes or other obstructions, would be reduced by these ratios; but in considering decayed timber it must be remembered that there is not a sharp dividing line between sound and rotton wood. Hence it is not wise to increase the allowed unit stress in timber for the consideration of existing structures above the amounts given in the specifications, particularly as decay in timber is wont to proceed rapidly when once started. Oak, chestnut, ash, and to a less degree, spruce timber, may lose a great part of their original strength while still showing little change in their appearance.

Corrosion and Bolt Holes

Corrosion and bolt holes in flanges of rolled steel beams reduce the strength far more than is generally realized. Of course the fact is known when thought of, but it is too commonly overlooked. The following figures illustrate these cases:—

If a 12-in.-31½-in. I-beam used as a stringer has 1 hole ⅞ in. in diameter in one flange, the strength is reduced 12¼ per cent.; 1 hole ⅞ in. in diameter in each flange, the strength is reduced 14¼ per cent.; 2 holes ⅞ in. in diameter in one flange, the strength is reduced 24½ per cent.; 2 holes ⅞ in. in diameter in each flange, the strength is reduced 28½ per cent.; ⅛ in. thickness rusted from one flange, the strength is reduced 15¼ per cent.; ⅛ in. thickness rusted from each flange, the strength is reduced 19 per cent.

If a 12-in.-20½-in.-lb. channel used as a stringer has 1 hole ⅞ in. in diameter in one flange, the strength is reduced 17¾ per cent.; 1 hole ⅞ in. in diameter in each flange, the strength is reduced 21½ per cent.; ⅛ in. thickness rusted from one flange, the strength is reduced 15 per cent.; ⅛ in. thickness rusted from each flange, the strength is reduced 18¾ per cent.

Spacing of Ties

Ties should be spaced not more than 8 ins. apart in the clear (6 ins. is better), or a derailed car wheel will drop so low between the ties as to cause too great pounding. They should be notched not less than ¾ in. for the stringers and attached to them by hook-bolts or some suitable substitute at every third tie. There should be not less than 6 ins. thickness of timber above the dapping. For wide spacing of girders or stringers, or when one rail is elevated while the stringers are at the same level, deeper ties may be required.

Guard Rails

Inside guard rails are a very important adjunct to a bridge carrying a track, to prevent the wandering of a derailed car; such guard rails should be fully spliced or their efficiency will be greatly reduced. Care should be taken that bolts are so placed that neither heads nor nuts can be sheared off by a derailed car. Some engineers do not realize that outside guard timbers do not answer the same purpose; and the requirements of at least one Railroad Commission until recently called for lining angles on these timbers, apparently with this misunderstanding. A brief consideration of this subject will show the fallacy of this view; if a wheel is retarded by rubbing against the inside rail, it will tend to turn the axle a little, directing the car toward its normal location; but the retarding of a wheel by rubbing on the outside guard timber will swing it further out of line and away from its proper place. This change of direction, too, will throw it against the guard more nearly at right angles, thus making it more likely to climb the guard and leap into whatever disaster is lurking beyond.

Though the outside guard timbers are not qualified for guiding a derailed car, they do have a very important office. Without them or some substitute, the ties would be likely to become bunched; the guard timbers also help to distribute the load and reduce the danger that the ties will tip up under a derailed wheel when stringers are too closely spaced. Guard timbers should always be notched over the ties and should be bolted to at least every fourth tie. Splices should have a horizontal lap joint.

PUBLICATIONS RECEIVED

IRVING SUBWAY.—Pocket-size catalogue (No. 2-A), issued by the Irving Iron Works Co., Long Island City, New York, illustrating and describing the "Irving Subway," a fireproof, ventilating flooring for power houses, industrial plants, etc.

PUBLIC WORKS REPORT.—Report of the Minister of Public Works for the Province of Ontario for the twelve months ended October 31st, 1918; 100 pages and paper cover; 6½ by 9½ ins. Contains the reports of A. J. Halford, Engineer of Public Works; C. H. Fullerton, Superintendent of Colonization Roads; and F. R. Heakes, Provincial Architect.

EMPIRE MUNICIPAL DIRECTORY AND YEAR-BOOK.—Published by the Sanitary Publishing Co., Ltd., 8 Breams Bldgs., London, E.C., England. This directory is in its 37th year of publication. It consists of lists of local authorities and officials in the United Kingdom and all of the British dominions and colonies; 272 pages and cover, 7 by 9½ ins., cloth bound; price, $1.50 postpaid to Canada.

CERTAIN LINES IN ONTARIO AND QUEBEC.—By F. B. Reid, supervisor of levelling, Geodetic Survey of Canada. Published as Publication No. 4 of the Geodetic Survey. This pamphlet describes bench marks from Montreal to Hull, P.Q.; St. Martin Junction to Three Rivers, P.Q.; Grenville, P.Q., to Prescott, Ont.; Ivanhoe to Toronto, Ont.; Bethany to Port Hope, Ont.; Myrtle to Whitby, Ont.; North Toronto to Mimico, Ont. It also includes an index and map showing all work previously published.

THE JEFFREY CARRIER.—Cloth-bound book, 96 pages and cover, 6 by 9¼ ins., distributed gratuitously by the Jeffrey Manufacturing Co., Montreal, P.Q., and Columbus, Ohio; published in three colors on coated paper, profusely illustrated. This booklet describes the pivoted bucket conveyer and is published as catalogue No. 210. It is so full of useful data concerning carriers, has so many illustrations of various installations, and is so well printed and substantially bound, that it will prove a desirable addition to the engineer's library.