not be subjected to any greater stresses during erection than they would be in a simple span of the same length resting on two piers. It was, therefore, possible to design it as economically as to weight as a well designed simple span would be. It is more important to save weight in a suspended span than in an independent simple span, because each pound in the former requires several pounds in the entire structure to carry it. The importance of economy in the suspended span of the Quebec bridge will be appreciated when it is considered that 1 lb. uniformly distributed over the trusses of the suspended span needs 3 lbs. of metal added to the bridge to carry it, making an addition of 4 lbs. in all. This accounts for curved top chords in the span in question, as well as for the use of nickel steel for the trusses thereof.

LENGTH OF ANCHOR ARMS.—It has been pointed out that the length of the anchor arms is uneconomical—that a shorter arm would have been cheaper. It must not be forgotten that a shorter anchor arm increases the pier reactions, as well as the steel in the anchorage proper. The present anchor piers are founded on rock ledges, which dip rapidly toward the river. To move them nearer to the river would have involved much more expensive foundations.

While an addition of dead load in the main span will require several times the weight of metal to carry it, an addition of dead load in the anchor arm requires no increase of metal to carry it when there is an upward or negative reaction on the anchor pier. This is explained by the fact that any load placed between the main piers or on the main spans increases all moments and shears over all the spans, while any load placed on the anchor arm, if the reaction on the anchor pier is negative, decreases that reaction and consequently the moments in the anchor arm, but has no effect whatever on the main span. For this reason carbon steel will be used mostly in the anchor arm on the new design. The carbon steel unit stresses adopted for the Quebec bridge are generally five sevenths of the nickel steel stresses, the former requiring heavier members. The additional weight in the anchor arms is a source of economy when the relative prices of carbon and nickel steel are considered.

HEIGHT OVER PIERS.—An opinion has been expressed that the height over the piers of the new Quebec bridge is not great enough for economy. Actual calculations show that for economy the height of 310 ft. in the Quebec design is too great by about 20 ft. for the K system of trussing adopted; further, that this height would have been at least 40 ft. too great for the original system of the official design. The height of the Forth bridge towers, while 26 ft. higher than the Quebec bridge, though the span is 100 ft. shorter, is no doubt economical for the form of trussing adopted for it. The economical height is not only a function of the length of the span, but also of the panel length next to the pier. This height should be such as to correspond to an inclination of the diagonals not far from 45 deg. A double intersection system, with very long panels near the pier, such as adopted in the Forth bridge, would have been economical for the Quebec bridge, except that it requires a system of secondary members or subposts, or very heavy longitudinal girders, or both, to carry the load from panel to panel. Then, too, it is well to reduce in the members the stresses due to their own weight—which in long panels become quite important. The 20 ft. excess in height of the present Quebec design over what would have been the economical height is justified by the resulting reduction in the sections of the bottom chords, which are of considerable size at best.

STRAIGHT VERSUS CURVED CHORDS.—In long cantilever spans the bottom chords of the cantilever and anchor arms should be straight when possible. With a curved chord the joints must be made at the panel points. These joints are of great importance, as has been shown in the report of the Royal Commission on the Quebec bridge disaster. They should be fully spliced to take care of secondary stresses due to deflections of the span during erection and under the action of live load. It is advisable, therefore, to place them outside of the point of connection with the diagonals and keep them clear of gusset plates. The same objection does not exist in top chords of simple spans, which are of moderate sizes, even in the longest spans known. The economy in simple spans resulting from such curved chords is worth while and quite important, while if any economy were to result from curving the bottom chord of the cantilever and anchor spans, such economy would certainly be of little importance in comparison with the resulting disadvantages. The vertical deflections from live loads are not as great in a straight chord design as in a curved chord design.

Another consideration in favor of the straight chords is that the most important, in fact the bulk, of the wind forces travel to the pier through the bottom chords of the cantilever and anchor arms and the wind bracing, or lateral system situated in their plane. The straight bottom chords carry these stresses direct to the piers without transmitting any appreciable components to the web system of the trusses. Not so with curved bottom chords. At each point where the chord's direction is changed a component stress is transmitted to the web. This means that while a pair of straight chords with its lateral system deflects under the action of the wind in the plane of the chords only, a pair of curved chords, by transmitting shear to the web members, causes the trusses to deflect, the windward truss downward, tending to flatten the curve, and the leeward truss upward, tending to make the curve more pronounced. The rigidity of the straight chord design against lateral deflection and oscillations is therefore greater than that of the curved chord design.

One of the reasons why curved bottom chords were used in the cantilever arms of the original Quebec bridge design was the fact that it was the aim of that design to provide full headroom of 150 ft. on a width of 1,000 ft. The bottom chords of the anchor arms were then made curved also for the sake of symmetry. The width on which the full headroom will be obtained has been reduced in the new design to about 760 ft., which certainly is more than ample to accommodate navigation. Only the highest vessels will be limited to this width of 760 ft., and that only at high water.

The top chord of the Quebec bridge cantilever and anchor arms is straight. The Forth bridge cantilever arms have straight top chords also. While there was good reason for making the Forth bridge top chord straight, there was no serious reason, beyond a slight increase in vertical rigidity, for making it straight at Quebec. The two trusses on the Forth bridge are in planes inclined toward each other at the top. The two top chords are parallel. Had they been made curved they could not have been parallel, since they must necessarily be situated in the inclined planes of the trusses. The appearance of tension chords having a greater distance apart at the centre of the arm than at either end would have been very bad. But there is no such reason at Quebec. The trusses are in vertical planes and the top chords could have been curved without serious inconvenience, but also without any advantage. The board considered that, aside from the additional vertical stiffness, a straight chord will present an appearance of strength which a curved chord would not do.

The foregoing is the first part of a paper read by Mr. Modjeski before the Franklin Institute in Philadelphia. It will be continued in the next issue.

Birthdays of Transportation Men in November.

Many happy returns of the day to —

F. W. Alexander, A.M. Can. Soc. C.E., Division Engineer, Alberta Division, C.P.R., Calgary, born at Fredericton Jct., N.B., Nov. 22, 1878.

J. O. Apps, General Baggage Agent, C.P.R., Montreal, born at Tara, Ont., Nov. 9, 1877.

A. B. Atwater, Assistant to President, lines west of Detroit and St. Clair Rivers, G.T.R., Detroit, Mich., born at Sheffield, Ohio, Nov., 1845.

G. B. Burchell, ex-General Manager, Maritime Coal Ry. and Power Co., Montreal, born at Sydney, N.S., Nov. 1, 1877.

J. R. Cameron, Assistant General Manager, Canadian Northern Ry., Winnipeg, born at Truro, N.S., Nov. 5, 1865.

L. D. Chetham, City Passenger Agent, C.P.R., and District Passenger Agent, Esquimalt and Nanaimo Ry., Victoria, born at Matlock, Eng., Nov. 5, 1869.

F. H. Clendenning, District Freight Agent, B.C. Coast Service and Trans-Pacific Steamships, C.P.R., Vancouver, B.C., born at Montreal, Nov. 9, 1881.

F. Conway, City Freight and Passenger Agent, C.P.R., Kingston, Ont., born at Ernestown, Ont., Nov. 19, 1850.

A. S. Cook, Inspecting Engineer, National Transcontinental Ry., Ottawa, born at Penobsquis, N.B., Nov. 20, 1873.

W. L. Crighton, Advertising Agent, Canadian Government Railways, Moncton, N.B., born at Derby, Eng., Nov. 9, 1871.

W. B. Cronk, ex-General Superintendent, National Transcontinental Ry., Montreal, born at Footville, Wis., Nov. 11, 1862.

W. Downie, General Superintendent, Atlantic Division, C.P.R., St. John, N.B. (on leave), born at Rock Currie, Ireland, Nov. 12, 1850.

Jos. Dubrule, jr., Manager, Canadian Pacific Car and Passenger Transfer Co., and President, Prescott and Ogdensburg Ferry Co., Ltd., Prescott, Ont., born at Spencerville, Ont., Nov. 14, 1872.

R. L. Fairbairn, General Passenger Agent, Canadian Northern Ry., Toronto, born at Stillwater, Minn., Nov. 24, 1880.

P. J. Flynn, Terminals Manager, Winnipeg Joint Terminals, C.N.R., G.T. Pacific Ry. and National Transcontinental Ry., born at Fishers, N.Y., Nov. 22, 1872.

Grant Hall, General Manager, Western Lines, C.P.R., Winnipeg, born at Montreal, Nov. 27, 1863.

John L. Hodgson, Master Car Builder, G.T. Pacific Ry., Transcona, Man., born at Simcoe, Ont., Nov. 15, 1858.

W. M. Hood, Travelling Passenger Agent, Canadian Northern Ry., and Canadian Northern Steamships, Ltd., Toronto, born at Harrow, Ont., Nov. 25, 1872.

W. E. Ladley, Superintendent of Motive Power, Reid Newfoundland Co., St. John's, Nfld., born at Leeds, Eng., Nov., 1875.

J. McGillivray, General Manager, Inverness Ry. and Coal Co., Inverness, N.S., born at Nairn, Scotland, Nov. 13, 1867.

J. McMillan, General Superintendent of Telegraphs, Western Lines, C.P.R., Winnipeg, born at Liverpool, Eng., Nov. 2, 1866.

T. E. Martin, Local Freight Agent, C.P.R., Quebec, Que., born at Beauharnois, Que., Nov. 23, 1852.

A. S. Munro, Commercial Agent, G.T.R., London, Ont., born at Hamilton, Ont., Nov. 10, 1880.

C. Murphy, General Superintendent, Mani-