

particular interest. Furthermore, it has not been able to confer with the subcommittee of the American Railway Association on marking, packing and handling of freight, nor with the patron of the suggestion, in con-

ference with whom it is believed a better plan of investigation and course of procedure may be outlined. It is, therefore, the intention of your committee to go into this matter carefully during the coming year.

Report of Committee on Car Construction.

The Master Car Builders' Committee, W. F. Keisel, Jr., Assistant Mechanical Engineer, Pennsylvania Rd., chairman, and of which H. H. Vaughan, Assistant to Vice President, C. P. R., is a member, reported in part as follows:

CENTRE SILLS FOR EXISTING CARS.—To the Arbitration Committee, the following amendment to rule 43 is recommended: "Existing steel or steel underframe cars, which have less strength than specified below, should be classified with wooden cars, and subject to the same rules for combination defects. Area of centre sills not less than 16 sq. in. Ratio of stress to end load not more than 0.09. The length of centre or draft sill members between braces to be not more than 20 d, where d is the depth of the member, measured in the direction in which buckling might take place."

To explain the above we would state that the basis of strength in rule given above is threefold. 1, a minimum section area of centre or draft sills; 2, maximum ratio of stress to strain, and, 3, maximum ratio of length to depth of unsupported members of underframe. The section area given should obtain throughout the length of the sills lying between points where impact takes place. If impact takes place between the coupler horn and end sill, the full length of the centre sills must be considered. If, on the other hand, impact takes place between rear followers, the part of centre sills between these followers should be considered, and the centre sills from the rear followers to the end sill may be lighter. The rivet area holding the back follower stops to the center sills should not be less than 12 sq. ins.

"In determining the ratio of stress to end strain, the distance between the neutral axis of any member of the car and the centre line of strain should be taken as a lever arm, through which bending effect is added to direct tension or compression. A formula for the ratio of stress to end strain is

$$\frac{1}{A} \frac{X}{SM}$$

— plus —, in which A represents area in sq. ins., X represents lever arm in ins., and SM represents section modulus of section.

"The length of centre or draft sill between adjacent tie plates or braces, or the length of any part of any centre sill or draft sill between adjacent supports or braces, must not be more than 20 times the measurement across the section of member under consideration. The measurement across the section referred to must be taken whichever way the member is weaker, which, of course, will be the direction in which the member will buckle if overstrained. As an example: Centre sills consisting of channels tied only at the top by floor plates, and having flanges 2½ ins. wide, may have the bottom flanges braced only at intervals of 8 ft. According to the rule given above, these bottom flanges should have braces at intervals of not more than 20 times 2½ ins., or 50 ins. Such car will, therefore, require an additional brace for anchorage about half way between the existing anchorages."

CENTRE SILLS FOR NEW CARS.—To furnish maximum revenue returns, the money expended for first cost, repairs, and dead weight hauled should be a minimum. It was suggested that two standards for centre sill area be adopted—one for cars in general service, and one for heavy service;

but as both kinds will be hauled in the same trains, this is not practical. Minimum centre sill areas, between points of impact, on existing cars, may vary up to 55 sq. ins. Service experience demonstrates that the cars having minimum centre sill strength are crippled in acting as cushions for the stronger cars. This makes it desirable to aim at uniformity of centre sill strength for all cars in the train. Designs of cars which do not go into general service in interchange may be considered only from their own load carrying standpoint, without regard to train strains; but those used in interchange must be considered from both standpoints. For the latter, your committee recommends the following as minimum design requirements to produce cars giving maximum returns for money expended: Area of centre sills: 24 sq. ins., min. Ratio of stress to end load: 0.06, max. Length of centre or draft sill members between braces: 20 d, max., where d is the depth of the member, measured in the direction in which buckling might take place.

BOX CAR END, DESIGN AND STRENGTH.—When existing box car ends need renewal they should be reinforced between corner posts with the equivalent of two steel braces, each having a section modulus of 4, or more. These braces may be applied vertically, horizontally or diagonally. New cars should have steel plate ends ¼ in. thick, reinforced between corner posts with the equivalent of either two vertical steel braces with a total section modulus of not less than 9; or one vertical and two diagonal steel braces with a total section modulus of not less than 10; or three horizontal steel braces with a total section modulus not less than 10. New cars may have the following alternative arrangement: Three or more steel braces, two of which run diagonally, with a total section modulus of not less than 12½, and wood lining 1¾ in. thick. To concentrate strength at a point near floor line on the vertical centre line of car, diagonal braces should extend from the centre sills to the side plates, and not from the bottom corner to the ridge. The attachments for the braces and the members to which they are attached must be sufficiently strong to realize the full strength of the braces. Hardwood or yellow pine may be considered equivalent to the steel members, if the section modulus is four times as great. Wooden posts and braces should be set in metal pockets not less than 1½ in. deep, and must be held in place by adequate tie rods. Lining at car ends should be supported at intervals not greater than 30 times the thickness.

Two 4 by 3 in. Z bars, 12.4 lb. per ft., have a total section modulus of 9.34; two 5 in. I beams, 9.75 lb. per ft., 9.6; three 4 in. I beams, 9.5 lb. per ft., 10.2; and three 3 in. Z bars, 14.2 lb. per ft., 10.3.

Types of end similar to VanDorn ends, made of ¼ in. plate, or Murphy ends, with the lower half made of ¼ in. corrugated plate, and the upper half with 3-16 in. corrugated plate, may be substituted for those described.

CAR DOORS AND FASTENINGS.—Attention has been directed to non-uniformity of doors and fastenings, and ease with which some cars can be entered without breaking the seal. It was also stated that if car is equipped with a board roof only, this is

partly removed and afterward replaced, and should there be a tin roof underneath, this is cut and bent back sufficiently for a man to enter. After pilferage is committed he returns through the opening, replaces the metal and boards, and an ordinary inspection does not detect how entrance was effected. Attention has also been directed to the large percentage of defective doors, which have to be cleated to hold them in proper position.

Your committee feels that one of the most important parts of the car door proposition, at present, is to reinforce the doors and door fastenings on some existing box cars in the least expensive manner that will make them safe and serviceable. In many cases this does not require new doors, but only additional fittings or reinforcements. For this reason it is thought advisable to make one recommendation to cover the betterment of existing construction, and another to cover all new construction. On account of the patent situation, your committee does not feel that it is feasible to present full detailed designs of doors and fastenings without eliminating some of the best known construction, and, therefore, prefers to present its recommendations in specification form, as follows:

Specifications for reinforcing existing doors:—The necessary additional number of bottom door guides should be provided to make four on each side of the car—one adjacent to each door post, one in the middle of the doorway, and the other between the back door post and the open door stop, located approximately as shown in the illustration, and similar in design, with particular reference to the height of lip, which should be 1¾ in. If the design of the door is such that the removal of the door guide next to the door post would permit the door to be pulled away from the car, then this door guide should be of such design that it cannot be removed when the door is closed.

Doors should be reinforced against bulging by the equivalent of two 1½ by 1½ by 3-16 in. angles extending horizontally the full width of the door, one located approximately 12 ins. from the top of the door, and the other approximately 12 ins. from the bottom of the door, and fastened with ¾ in. carriage bolts.

The door hasp fastener should be at least 24 ins. long, fastened with not less than five ¾ in. bolts with the nuts on the inside of the door. The door hasp fastener should be of such design that the hasp cannot be removed without removing the bolts from the fastener.

The closed door stop should have two or more lips extending at least 1½ in. over the door to support the door against bulging outward. Where all wood closed door stops are used, they should be strengthened against splitting, and should have at least two metal reinforcing brackets similar to closed door stop casting shown in the illustration.

Open door stops, if of wood, should extend the full height of the door and be strengthened against splitting.

SPECIFICATIONS FOR COMPLETE new doors for existing cars or for new construction.—The upper door track should be continuous, and strong enough so that it will not sag, securely fastened to the car with ½ in. bolts, or ¾ in. rivets not less than six in number, and so designed that it will continuously support the door against outward pressure independent of any action of the door hangers, and will also keep out rain and snow, proper flashing, if necessary, to be provided over the door track. The design of track and hangers should be such that when the door is being opened or closed it cannot lift up and bind against the track.