

most prominent supplies already warn their consumers of the necessity of early steps for an entire reconstruction and enlargement. Discussions of this kind are therefore desirable, and the best results of experience ought to be embodied in general rules of practice, similar in method, if not in detail, to those presented for consideration.

(To be Continued.)

On Railway Accidents—their Causes and Means of Prevention; showing the bearing which existing legislation has upon them. By Mr. JAMES BRUNLEES, M. Inst. C. E.

From Newton's London Journal, May, 1862.

The author proposed to treat the subject by dealing with the facts as they were, the causes of accidents being, in nearly all cases, sufficiently apparent; he would not therefore attempt, by theory, to establish rules for their prevention. From the reports of the officers of the Board of Trade it appeared that, during the seven years from 1854 to 1860, the number of accidents amounted to 540, as the result of 1274 distinct causes. Of these accidents, 11 per cent. were attributed to the permanent way, 7 per cent. to the rolling stock, and 76 per cent. to the management, including insufficient means for securing safety, leaving only 6 per cent. as not ascertained.

The accidents due to the permanent way were then referred to in detail, and it appeared that the general defects were most evident in the system of ballasting, of joint-fishing, of turning the rails, and of fastening the chairs to the sleepers. With regard to the ballast, it was argued that it would be found economical to have at least 6 ins. or 9 ins. of rough gravel or broken stone, as a free draining bed to the sleepers and to the "top-dressing;" and that, during the months of September and October, an extra number of men should be employed to drain the ballast and beat up the road, in order that it might become consolidated before the winter's rains and frosts set in, and thus avoid the evil effects of frost on wet ballast. It was urged that the plan, now in general use, of placing the fish-joint between two sleepers, was objectionable, as the ends of the rails were unsupported except by the fish-plates, which together were frequently only equal to two-thirds of the section of the rail. It was submitted that all the joints should be fished directly over a sleeper, or that a bracket chair should be used. The practice of turning the rails was condemned, because when a rail was so much worn as to require turning, its strength was generally so reduced as to render it unfit for main line traffic. With regard to the fastenings of the chairs to the sleepers, it was urged that it was desirable that iron spikes only should be employed on the outer side of curves, or else that the chair should be partially sunk into the sleeper, to lessen the strain on the treenail. The superior economy of steeled, or partially steeled, rails, points, and crossings, was also incidentally noticed.

In reference to the accidents which had arisen from defective or neglected rolling stock, it was found that many of the fractures had

occurred during the winter months, owing, possibly, in some degree, to the rigid state of the "way" in frosty weather; whilst others were due to the use of bad iron, and some to defects either in the welding of, or in the mode of attaching the tyres of the wheels. Steel, or partially steeled, tyres, were now, to a certain extent, in use, and tyres formed of a continuous ring, or unwelded piece of metal, were also successfully employed. Several new methods of fastening the tyres had proved as fruitful of mischief as the ordinary plan of simply shrinking them on, though others had been found to be efficient; and it was said that, on some lines, the tyres had not failed to any great extent. The author hoped, that the importance both of the tyres and of the axles of wheels would lead to a useful discussion on this branch of the subject. The usual want of uniformity in the main features of the carriage portion of the rolling stock was then commented upon; and it was considered that this variety not only increased the cost of manufacture and of maintenance, but was often the cause of accidents, and frequently contributed to render them disastrous. The author thought that the carriages should be nearly uniform in size, and that the buffers should, in all cases, be the same height above the rails. The longitudinal beams should be in the same line throughout, be strong in themselves, and the framing securely braced. The present coupling in the centre should be increased in strength, and the whole attachment between the carriages should be such as to render a train in effect, as far as practicable, as one carriage, with a certain amount of flexibility; so that in the event of collision, the carriages should retain their position, instead of rising upon one another; and if an axle or a wheel broke, the crippled carriage should be partially borne up by the neighboring carriages until the train could be stopped.

On the question of management, after some remarks upon the speed of trains, it was shown that, by punctuality, both in the time of starting and in the rate of running, safety, so far as human foresight was concerned, was insured. The system of working the traffic of a railway by allowing an interval of time between the trains was deemed unsatisfactory, and far inferior to the system of an interval of space. The accidents arising from the irregularity of excursion trains were then alluded to, and it was remarked that if, during the summer and autumn, the ordinary trains were run at lower rates of fares, the traffic would be increased, as the public would feel greater security in traveling. The difficulty in running coal or mineral trains to a fixed time table might be met by a more general use of the electric telegraph, and by a better system of signaling arrangements. During the seven years, from 1854 to 1860 inclusive, 88 accidents happened from inefficient signals, of which 14 occurred in 1860. In some cases, especially at sidings, there were no signals; in others they were defective in form, or were improperly placed. It was desirable that junction signals and points should be worked simultaneously by one man, and at junctions, separate main and distance signals should be provided for each line. If the system of working the traffic by the electric telegraph was generally adopted, and the line was divided into sections, so that a

train should be prevented from entering any section until the preceding one had passed to the section in advance, collisions would be impossible, except those liable to arise from disregard of the signals, and a proper interval would be secured between the trains, in spite of unpunctuality. As the want of a means of communication between the engine-driver and the guard or conductor had frequently been experienced, and as plans were in daily use on several lines, there was no reason why it should not be adopted on all. To render it fully effective, the guard or conductor ought to start the train from each station by means of that machinery, so as to prove that it was in working order. Owing to the general high speeds and heavy trains, it was of the utmost importance that ample break power, capable of being applied in the least time, should be provided with each train. It was a question how far a regularly distributed retarding force, acting at the same moment on all the wheels, might not be preferable to a concentrated force applied at particular points. By the system of "continuous breaks," the employment of several men with each train was unnecessary. It had also another advantage—that a train was more under control, and could be stopped in a shorter distance. The negligence of servants, arising from their ignorance or inefficiency, was next adverted to, and it was thought to be due to the pay being too low to command the services of men of intelligence, steadiness, and self-reliance. Frequently they were insufficient in number, leading to overwork; and instances were on record in which engine-drivers had been employed for 17 hours daily, and in some cases for 26 and 30 hours continuously.

The author proposed leaving the bearing of existing legislation upon railways to be dealt with by Capt. Douglas Galton.* He would, however, observe, that Government interference was not likely to render railways safer, or more available to the traveler; and that it would be better to rely on the consideration and calm reflection of those immediately interested in these enterprises, especially as from the heavy expenses attendant on accidents, directors and shareholders would naturally desire to render this mode of traveling as safe as possible.

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The Economic Angles in Parallel Open-work Girders.

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(Continued from vol. xliii. p. 303.)

Let N be the number of bays into which the span s is divided by the points of concentration of the loading. Let θ represent in a general manner the angle which a brace makes with the vertical direction, and v the vertical component of the stress upon the brace.

In our last paper, we have shown that when N is of any previously assigned value, the economic values of θ , as calculated for the bracing taken alone, will also be the economic values of θ for the whole girder, that is, for the bracing and booms taken together. The question is, therefore, reduced to the determination of the economic angles for

* Captain Galton's paper will be published in the next number.