A2M01: Committee on Railroad Track Structure System Design
Chairman: Thomas P. Smithberger

Railroad Track Structure System Design

THOMAS P. SMITHBERGER, *HDR Engineering, Inc.*
DAVID C. KELLY, *Illinois Central Railroad*
ALFRED E. SHAW, JR., *Shaw Engineering*

In the new millennium, designs for improved railroad track structure systems will increasingly be needed to ensure system safety, reliability, and profitability as the railroads strive to compete with other transportation modes for the movement of freight and passengers. Design improvements will be focused primarily on accommodating increased vehicle weights, faster operating speeds, and reduced track maintenance cycles.

History supports this prediction. Design maximum axle loadings have increased over time, from 30 kips in 1880 to 50 kips in 1906 to 80 kips today (*1*) (1 kip = 1,000 lbs). Furthermore, the Association of American Railroads predicts that annual railroad train miles will grow from approximately 500 million in 1997 to more than 600 million by 2002, an increase of approximately 20 million train miles per year (*2*). [A corresponding growth in annual railroad tonnage, measured in million gross tons (MGT), will also occur.] A reemergence of passenger rail, operating jointly on trackage with freight traffic, will be part of this train-mile (and MGT) increase. Continued growth of commuter rail traffic around major urban areas, coupled with the proposed development of incremental high-speed intercity passenger rail corridors, will add to the total rail traffic on the U.S. railroad network.

Innovative designs will be required to support this growth, both by increasing capacity in a cost-effective manner and by improving the performance of existing track. New track concepts, different from the standard rail and cross-tie structure commonly used, will need to be investigated as appropriate. In all of these efforts, it will be necessary to take a systems approach to the design. Such an approach recognizes that the track and the vehicles operating on it must be viewed as a system, and that the design of one element has a direct impact on the performance of the others. Historically, a systems approach has not been taken; track engineers have designed track, signal engineers have designed signals, and mechanical engineers have designed cars and locomotives. In the future, both the track and mechanical engineers will need to consider the wheel–rail interface and vehicle–track interactions in their respective designs. Evidence of this need is seen in several areas:

- The Federal Railroad Administration's (FRA) recently revised Track Safety Standards establish vehicle–track interaction limits for the qualification and operation of high-speed service.
- Ongoing vehicle–track systems research at the Transportation Technology Center's Facility for Accelerated Service Testing in Pueblo, Colorado, has resulted in the design of improved suspension trucks that reduce wheel/rail forces while decreasing fuel consumption.

- The evaluation of track components throughout the industry is increasingly being based on their effect on vehicle performance, in addition to the performance of the components themselves.

The results of these research initiatives and field tests must be formulated into recommended design requirements and published for the industry in the American Railway Engineering and Maintenance of Way Association (AREMA) *Manual for Railway Engineering*. In addition, strong relationships must be fostered among the railroads, the Transportation Research Board, AREMA, FRA, and research facilities (both academic and commercial) so that the results of research can be formulated into practical designs that will be useful to the industry, and so that future research efforts will be targeted to areas of need.

Finally, the railroads, TRB, and AREMA must lead and collaborate on training for the development of future railway engineering professionals. Previously, the railroads provided a large proportion of such training in-house to their engineering staff. Now that the railroads are outsourcing more of their design work to supplement core in-house design capabilities, training in railway engineering must increasingly be provided by companies doing work for the railroads and by primary railway engineering professional organizations, such as TRB and AREMA.

TECHNOLOGY AND INFORMATION GAPS

Technological advances are needed in a number of specific areas to advance the state of the art in railway design:

- An efficient, accurate, and cost-effective method for measuring rail stresses in track and monitoring the change in those stresses over time for better design and maintenance of continuous welded rail trackage.
- Technology to detect and locate rail breaks along a railway system other than by using the present-day signal system.
- Innovative and economical turnout and railroad crossing designs. Research might focus on improving the individual components of current turnouts and crossings (e.g., frogs, switch points, stock rails, guard rails, ties, and fastenings), improving turnout geometry, or developing totally new turnout and crossing system designs.
- Research leading to economical recommended practices for track transition designs at highway–rail crossings, turnouts, crossing diamonds, tunnels, bridges, and other locations where there is a significant change in track modulus. (Some initial research and testing of highway–rail crossing transition designs has been funded by FRA.)
- Testing of various concrete slab track systems with direct rail fixation to evaluate their economic and long-term performance in heavy-axle and high-speed-rail applications.
- Additional research on railway track substructure to develop improved designs that will support future heavy-axle loads in a cost-effective manner. For this research, a systematic approach, considering the moduli of the various materials involved (e.g., soils, ballasts, concrete, wood) and optimizing their interaction for distributing axle loadings to the substructure, should be considered. Key results of this research should be practices and techniques that railway engineers can apply in their everyday work in a scientific manner.
- Research directed to the evaluation of longitudinal rail stresses on long bridges and viaducts. Recommended design practice for the industry should result from this research.

- Design of economical alternatives to the solid sawn wood tie, including an associated rail fastening system. One such alternative is a tie that performs in a manner similar to that of the standard wood tie and cut spike system for use in spot tie replacements.

CHALLENGES

A shared vision for the future of railway design needs to be developed so that all organizations involved will be moving forward efficiently in the same direction to advance the state of the art of the industry. The responsibility for developing such a vision falls primarily on the railroads, in partnership with organizations such as TRB and AREMA.

Another area of major concern is the adequacy of future funding for railroad research. Presently, the railroads and FRA provide the majority of such funds. In addition, the railroads, TRB rail committees, and AREMA committees use highway and other, more heavily funded, transportation research as it might be applicable to railroad engineering. As the railroads continue to strive for adequate profitability and FRA competes with other agencies for federal funds, there are no assurances that adequate railroad research dollars will be available in the next century to help implement industry’s future vision.

As the nation’s tonnage leader in hauling freight, the railroads must remain in good condition. A return to the railroad bankruptcies of the 1970s, when track mainlines were frequently under slow orders, should not be a vision for the 21st century. As railroads subsequently returned to profitability, the national track infrastructure continued to improve, with a focus on and funding for maintenance and innovations. This progress can continue through the 21st century with the leadership and support of the organizations involved.

REFERENCES

1. American Railway Engineering and Maintenance of Way Association (AREMA). *Manual for Railway Engineering.* Washington, D.C., 1998.
2. Sweedler, B.M. Toward a Safer Future: National Transportation Safety Board Priorities. *TR News*, No. 201, March-April 1999, pp.3–6.