RAILROAD TRACK THEORY and PRACTICE

MATERIAL PROPERTIES, CROSS-SECTIONS, WELDING, AND TREATMENT

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Foreword to the English Edition

Railroad Track, first published in West Germany, provides information on high-performance track with the lowest possible maintenance costs. The material was developed jointly by the German Federal Railroad (DB), technical universities, scientific enterprises, and relevant industries. Advanced theory has always been rapidly put into practice by the German Federal Railroad. Consequently this volume, in which International Railway Association (UIC) regulations have been taken into account, provides data about the relationship between track and vehicles as well as the practical application of knowledge on the construction and maintenance of track.

International enterprises that manufacture and use track materials and track machinery have frequently complained that the English and French summaries of chapters in the original German edition—and the multilingual captions for the figures—were insufficient to allow the book to be consulted as a technical reference source in those two languages.

Thanks to the initiative of Mr. Romolo Panetti, president of Speno International SA of Geneva, an English-language edition of this work can now be issued. I wish to express my appreciation to the translator, Walter Grant, for the care and precision with which he prepared the English text. May I also express my thanks to Dr.-Ing. Lothar Fendrich of Hamburg, my colleague for many years, for his critical review of track terminology following his stay in the United States.

I hope that the present English edition will clarify to a wide circle of readers the advantages of low-maintenance track. The German Federal Railroad has found that the track described here has proven itself in excellent fashion for many years under extremely severe conditions, as regards both its individual components and its total design. The maintenance methods adapted to this type of track have proved themselves economical.

Fritz Fastenrath

Oldenburg
Federal Republic of Germany
February, 1980

Foreword to the First Edition

Under competitive pressure, railroad companies have tried for years to improve the services they offer by increasing the speed of passenger and freight traffic. Furthermore, the industry wishes to increase the load volume of railway vehicles in freight transport and to permit axle loads exceeding 20 tons. An existing railway network cannot be quickly converted to offering services which require higher physical forces. Consequently, railroad engineers were faced with the problem of acquiring an increased scientific understanding of the interaction between the vehicle and the rail, and of drawing from this understanding the constructive consequences for the vehicle and the track. Such research has been pursued jointly by construction and mechanical engineers from the railroads as well as by the collaborating industries. Their findings can be utilized both for newly constructed lines and for the reorganization of existing railway networks.

While unsatisfactory vehicles can be withdrawn from traffic, an improperly functioning track has a deleterious effect on the entire operating capability of a line until the next track renewal. Because the track requires heavy investment, careful choice of all the track materials and its subsequent proper maintenance are particularly significant.

Our purpose is to give students, planners, builders, and supervisors in the railway field an insight into the requirements of "rail constructs" and into the resulting consequences for construction and economical maintenance. Following the general introduction, twelve papers treat component areas. The authors of these papers have made fresh and decisive contributions in their areas of expertise. The overall framework is delineated in such a manner that the reader can gain a perspective on the problematics of track through the example of its most important component, the rail. Repetition of some factual matters in the various papers was consciously accepted in order to facilitate the reader's understanding of the sometimes multiple interrelationships.

Ties, rail fastenings, switches, ballast, and subsoil are mentioned only to the extent that references to special construction and behavior characteristics appear important, when such characteristics must be taken into account in laying a low-maintenance track.

Despite their heavy professional commitments, the authors have made these excellent papers available to me. I wish here to express my sincere

thanks to them. By painstakingly detailed work the publisher has succeeded in making the various individual papers uniform and in clearly reproducing the many figures and tables. Finally, I wish to especially thank my colleague, Dipl.-Ing. Lothar Fendrich, for his collaboration; as a committed track engineer he was ready, in the interest of the cause, to relieve me by taking over numerous tasks so that the book could appear at the present time.

Fritz Fastenrath

Oldenburg (Oldb)
October 1977

Preface

The development of railroads is the development of their technical components—vehicles, drives, operating controls, and track. Rails form an essential component of the track, supporting and guiding the railroad vehicle.

The history of rails is closely connected with the spread of railway traffic and the development of manufacturing methods. Stephenson's first locomotives ran on mushroom-shaped and fishbellied rails with a weight of 12 kg per meter; these rails were fabricated of brittle cast iron. Broad-base rails with a weight per meter of up to 70 kg are available for today's heavy and fast traffic. These rails are fabricated from ingot steel, which provides favorable preconditions for fabricating rails in the desired quality.

One-hundred and fifty years of experience, studies, and experiments, not excluding some reversals, separate these very different rails. These years were marked by more and more advanced insights concerning materials, the suitable distribution of materials in the rail cross-section, and the weight of the rail. During the second half of the previous century more than 100 rail shapes could be found in European railways. In contrast, the International Railway Association (UIC) has at the present time introduced a uniform UIC 60 rail with a weight of 60 kg per meter.

Within these 150 years of rail history the last two and one-half decades play a special role. Continuously welded rail was developed, where the rail must assume not only the stresses resulting from the support and guidance of the vehicle but also longitudinal forces resulting from temperature fluctuations. In addition, axle loads and line loads were increased due to the concentration of traffic flow. Speed was increased. Finally, manual track maintenance gave way to general mechanization of track construction work. All these factors necessitated penetrating studies in science and practice. The developmental surge of the last ten years has been especially strong and conspicuous. It has yielded a contemporary state of knowledge which even has the capability of dealing with tomorrow's possible developments, and which will consequently retain its validity for a longer period of time.

The present book, *Railroad Track,* consequently appears at the right time. It expresses the views of those experts who have successfully concerned themselves during the most recent stage of developments with op-

timization of the track, and consequently also of the rail, in theory, in the laboratory, and in practice. It should be especially emphasized that mutual relationships and dependencies are clearly indicated among the component problems under consideration, such as safety versus derailment at every speed actually occurring in practice, quiet running of vehicles, low wear, and maximum lifetime with minimum plant and maintenance costs.

This new knowledge is reflected in the individual reports contained in this book. It represents the knowledge, experience, and investigations not only of one railroad but is based on the common work and similar insights of all the European railroads. It is to the credit of the International Railway Association to have intensively and systematically furthered collaboration, specifically in the track area. Thus the present publication concerning railway track can also claim an international status.

The papers were selected with great expert knowledge and care—and for this special thanks is due to the editor. They were selected so that all persons responsible for designing and maintaining track can obtain from these papers the important basic principles underlying their tasks. Rail manufacturers and acceptance officers will find data concerning suitable materials and manufacturing methods, data of particular importance to them. The planner is provided with references which he must take into account in designing a rail plan, references which are based on rails and switches. The track engineer obtains guidelines for the practical aspects of track layout and welding. Track management is apprised of possibilities for improved economy.

The relationships between vehicle and track or, expressed more precisely, between the wheel and the rail, are elucidated. These relationships provide important information for the vehicle constructor. By appropriately designing the railway vehicle he can make a contribution toward keeping the stress on the rail and track within bounds.

Finally it should be pointed out that the present publication is significant for training future generations of engineers in the colleges; both teachers and researchers will find here valuable stimuli for their work.

Railroad Track deserves a wide readership among domestic and foreign experts. Hopefully these publications will serve further progress and help to secure a healthy future development of railways within the framework of traffic as a whole.

The authors deserve thanks for the effort and care which they have expended to present complicated problems precisely and intelligently.

Frankfurt, October 1977

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