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POPULAR SCIENCE

Accelerometry and brake testing technology in the railway sector

Técnica de acelerometría y pruebas de freno en el ámbito ferroviario

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Abstract

Interview with Mr. Mariano Fernández Soler, Director of the National Centre for Railway Development and Innovation (CENADIF), in order to inquire about the methodological measurement project developed by the institution, and its impact in the field of railway operational safety.

Resumen

Entrevista al Ing. Mariano Fernández Soler, director del Centro Nacional de Desarrollo e Innovación Ferroviaria (CENADIF), con el fin de indagar sobre el proyecto metodológico de medición que desarrolla la institución, y su impacto en el campo de la seguridad operacional ferroviaria.

The National Center for Railway Development and Innovation (CENADIF) was established by the Ministry of Transport of Argentina through Resolution 289 on December 3, 2020. Its mission is to drive technological and industrial development within the railway system, with the collaboration, integration, and participation of the railway industry, jurisdictions, universities, and public and private institutions. Working directly towards fulfilling the railway policy of incorporating new technologies and services, as enshrined in Law 27132[1] for the reactivation of freight and passenger railways in Argentina.

Within its field of action, CENADIF carries out the development and homologation of products, spare parts, components, and equipment related to the railway industry in accordance with applicable technical standards. It also undertakes tasks to promote and guide scientific and technological research, establish priority plans and programs, and collaborates in the development of regulations and technical documentation[2], including methodologies, plans, and technical instructions.

The Center is currently involved in more than twenty projects, among which the programs for rolling stock development, track and signaling infrastructure, homologation of synthetic sleepers, testing of alternative energy sources such as hydrogen, and the development of measurement methodology stand out.

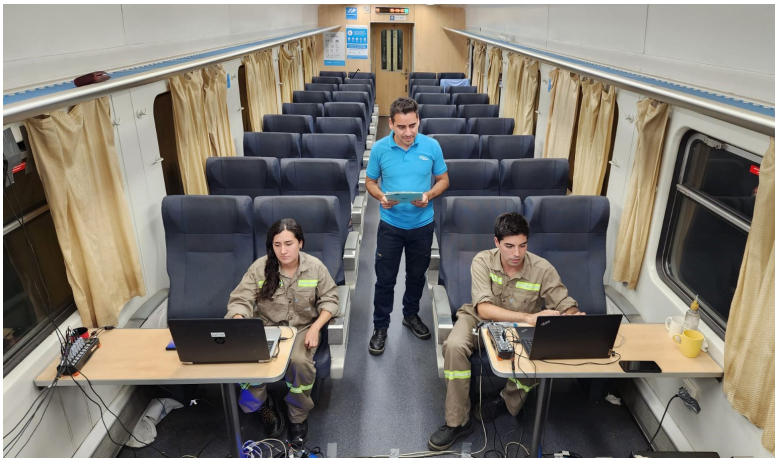
Within the last-mentioned program, the study of the accelerometry technique and brake testing is included. To learn more about this, we interviewed Mr. Mariano Fernández Soler[3], responsible for CENADIF, with an extensive background in both the public and private sectors, and expertise in railway engineering, development, and technical standards.

What applications does accelerometry have in the railway sector?

Accelerometry is a measurement technique that involves measuring accelerations using specialized sensors. It has several applications, such as measuring dynamic parameters of the rolling stock's behavior with respect to an onboard reference system. When we evaluate vertical and lateral behavior, it's because we are interested in the track-train interaction, where we observe both track irregularities and track geometry. When evaluating longitudinal behavior, one of the most important analyses we perform is brake testing.

What is the motivation for conducting brake tests? Why is measurement necessary?

There are several reasons motivating brake tests. Among them, one significant reason is the verification of a scheduled repair or a corrective intervention. Another reason is to assess if the train has the same braking performance capacity before returning it to service.



"Firstly, the advantage of conducting brake tests with suitable instruments and equipment is that the results obtained are not subject to biases and opinions but rather reflect the physical performance of the vehicles."

How can comparative values be obtained within a specific fleet?

Comparative values can be obtained through a protocol that clearly defines how tests are conducted, the steps for instrumentation, the sensors to be used, data processing procedures, variables under study, and the required conditions for the test track, among other considerations.

1. Resolution 289 of 2020 [Ministry of Transport of Argentina]. By which the National Center for Railway Development and Innovation was created. December 3, 2020. Available at: https://www.argentina.gob.ar/normativa/nacional/ resoluci%C3%B3n-289-2020-344841
2. Law 27132 of 2015. By which the policy of reactivating passenger and freight railways, the renewal and improvement of railway infrastructure, and the incorporation of technologies and services is declared of national public interest and a priority objective of the Argentine Republic. May 20, 2015. Official Gazette No. 33134. Available at: http://servicios.infoleg.gob.ar/infolegInternet/verNorma. do?id=247081
3. Industrial engineer specializing in railway engineering (UTNUBA). Interim full professor of Railway Dynamics, taught in the Railway Engineering program at the National Technological University - Haedo Regional Faculty (UTN-FRH). Manager of Innovation Management at Ferrocarriles Argentinos Sociedad del Estado (FASE) and head of the National Center for Railway Development and Innovation (CENADIF).

How can the behavior of a train be evaluated in relation to a fleet?

It can be evaluated through comparative tests among different vehicles within a fleet, carried out based on a standardized protocol. With a clear procedure, it ensures that tests are conducted identically for the same type of vehicle, and results are comparable.

What parameters of brake performance can be measured?

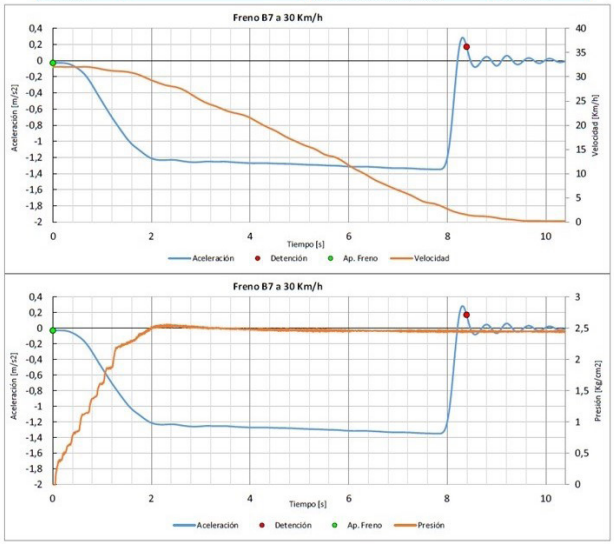
You can measure all magnitudes related to the dynamics during the braking process, such as accelerations, stopping distances, instantaneous speed, cylinder and pipe pressures, actuation mechanisms, and the temperature of linings and discs

What analysis can be derived from the measured data?

You can analyze the braking distances of train formations, the operation of the electrodynamic system, whether the pression in the pipe or cylinder application pressures are within the correct values, and more. Additionally, it is possible to evaluate whether the friction coefficients of brake shoes or pads from a specific manufacturer are comparable to the originals, providing a basis for homologation or certification.

DATOS DEL ENSAYO	
Fecha	5/10/2021
Registro	0007
Línea	Roca
Ramal	Const. - La Plata
Material Rodante	EMU CSR Zhuzhou
Zona de pruebas	Villa Elisa - La Plata
Condición de freno	B7
Velocidad Objetivo	30 [Km/h]
Conjugación de freno	EDB OFF
Observaciones	

DATOS DEL PROCESAMIENTO	
Velocidad en la aplicación	32,04 [Km/h]
Tiempo de detención (t_{sf})	8,39 [s]
Tiempo de respuesta equivalente (t_{re})	N/A
Distancia de detención (S_d)	44,62 [m]
Tiempo de alzada de aceleración (t_{ja})	N/A
Desaceleración eficaz (a_e)	1,15 [m/s2]
Desaceleración media (a_m)	1,06 [m/s2]
Tiempo de alzada de presión en cilindro (t_{ac})	1,58 [s]
Presión media en cilindro (P_m)	2,25 [kg/cm2]
Presión estabilizada en cilindro (P_e)	2,44 [kg/cm2]

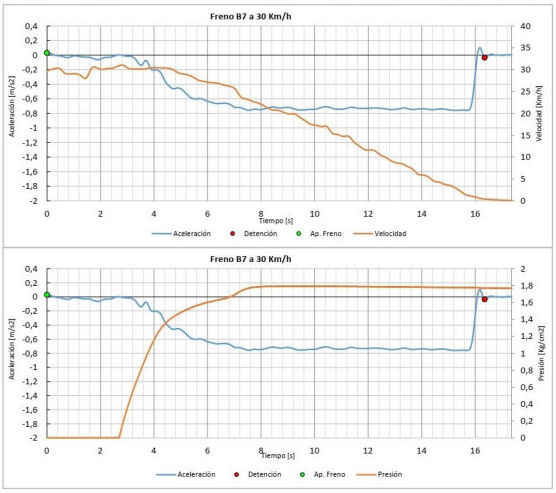


What can be done with the information obtained?

Expected operating parameters can be established to make future comparisons of each of the units with themselves and in relation to the fleet over their lifespan. For this, it is essential to use dynamics descriptors, such as braking distances or stabilized accelerations, and have a large number of recorded tests, so that a statistical analysis of the fleets can be outlined.

DATOS DEL ENSAYO	
Fecha	7/12/2022
Registro	0023
Línea	Roca
Ramal	Const. - A. Korn
Material Rodante	EMU Toshiba
Zona de pruebas	KORN - ADROGUÉ
Condición de freno	B7
Velocidad Objetivo	30 [Km/h]
Conjugación de freno	EDB OFF
Observaciones	

DATOS DEL PROCESAMIENTO	
Velocidad en la aplicación	30,00 [Km/h]
Tiempo de detención (t_{sf})	16,35 [s]
Tiempo de respuesta equivalente (t_{re})	N/A
Distancia de detención (S_d)	89,41 [m]
Tiempo de alzada de aceleración (t_{ja})	N/A
Desaceleración eficaz (a_e)	0,59 [m/s2]
Desaceleración media (a_m)	0,51 [m/s2]
Tiempo de alzada de presión en cilindro (t_{ac})	6,84 [s]
Presión media en cilindro (P_m)	1,35 [kg/cm2]
Presión estabilizada en cilindro (P_e)	1,77 [kg/cm2]



"The analysis of the integral behavior of the braking system is of significant relevance in the safety of railways since the data obtained can be applied to preventive maintenance tasks."

How can this information impact the railway safety field?

Firstly, the advantage of conducting brake tests with suitable instruments and equipment is that the results obtained are not subject to biases and opinions but reflect the physical performance of the vehicles. This data can be used in the development of preventive maintenance plans for rolling stock, especially concerning the effectiveness of brakes and their wear.

Another important aspect to highlight is that brake tests and trials can lead to an effective process for the certification and approval of modern brake systems, brake pads, and shoes.

In general terms, the analysis of the integral behavior of the braking system has significant relevance in the safety of railways since the data obtained can be applied to preventive maintenance tasks for both rolling stock and track infrastructure. The latter point is still under analysis.