1.10.23. APPLICATION OF SATELLITE GLOBAL POSITIONING TECHNOLOGIES FOR MANAGEMENT OF TRACK INFRASTRUCTURE NDT/TD

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Introduction of global navigation satellite technologies based on GLONASS/GPS systems [1] is one of the most rapidly developing trends in the area of implementation of comprehensive safety systems and monitoring track infrastructure. This includes detection and control of potentially hazardous natural and man-induced processes, engineering and geodetic support of design, railway construction and operation, and development of precision positioning systems for High-Speed and express lines.

Innovative theoretical research in the areas of non-destructive testing and technical diagnostics (NDT and TD) of track infrastructure in Russia also rely on cutting-edge navigation satellite systems.

The diagnostic complex INTEGRAL being manufactured by TVEMA Group enables logging 117 parameters of track infrastructure condition. However, any of these parameters, even measured at highest possible precision, becomes senseless without valid referencing to the track path length. Precision positioning is of paramount importance from the traffic safety viewpoint.

Although the main task being implemented by our experts, that is, enhancement of the precision of referencing measured parameters to the track path coordinate, is induced by a vital engineering problem, we believe this issue to be of the most general nature and to be an incentive for development of the existing information processing stochastic-based techniques.

For example, quite a few domestic and overseas research and industrial institutions involved in satellite navigation focused on the approach of integration of navigation systems [2, 3]. GNSS/INS integration is the synthesis of the two distinct systems, Inertial Navigation System (INS) and Global Navigation Satellite System (GNSS), which combines the merits of both systems while compensating their individual drawbacks.

The solution of high integration of gimballess INS, GLONASS/GPS receiver, and path/speed sensor (PSS) is implemented at INTEGRAL according to an original algorithm. Combining their data enables mutual corrections of the readings of these devices, hereby enhancing the accuracy of referencing measured parameters and detected defects to the track path coordinate.

Gimballess Inertial Navigation System (GINS) embodying the inertial navigation principle is a single integrated unit comprising fiber-optic (laser) gyroscopes (FOG), micro-electro-mechanical systems (MEMS), accelerometers, and an evaluator. The basic difference of a GINS from other (gimbal) INS types is a simple design related to the absence of gyro-stabilized gimbal platforms. This feature provides a compact design possessing serious advantages in production and operation.

Being an NDT instrument, GINS installed at the diagnostic complex INTEGRAL enables efficient and accurate measurement of track geometry (level, lining, sagging, twist, bend curvature, longitudinal/lateral track positioning, etc.) via no-chord point technique at speeds commensurate with those stipulated for ordinary trains, without breaking a traffic schedule. According to the original algorithm, the GINS output is permanently referenced to GNSS readings. Thereby application of navigation satellite technologies directly affects the precision of track parameters measuring.

The synergistic mix of INTEGRAL diagnostic instrumentation essentially comprises an integrates onboard navigation system capable of reliable determining of coordinates and travel path of the diagnostic complex irrespectively of GLONASS/GPS signal reception conditions (under bridges, in tunnels, in woodlands, in tower-house city areas, etc.).

The priority trends of development of navigation satellite technologies in the area of organization and carrying out NDT/TD work at the Russian railways are as follows:

– control of diagnostic rolling stock positioning in the aspect of general traffic management and dispatching providing integration of the navigational information into the common informational space of OJSC RZD;

– control of diagnostic rolling stock positioning (including geometry carts) with the purpose of locating teams working on the track, and for the sake of enhancing the reliability of control results and eliminating the adverse effects of the human factor;

– monitoring of steady track infrastructure facilities' positioning;

– creation and actualization of electronic digital maps of the track and the infrastructure basing on the satellite-assisted coordinates for using in onboard engine safety systems.

The key issue for successful application of satellite technologies at the railways is creating a unified system of digital coordinate description of the track and the infrastructure facilities; this is a prerequisite for the most efficient application of integrated GINS/GNSS/PSS navigation systems similar to the one installed at the diagnostic complex INTEGRAL.

References:

1. **Satellite-assisted** technologies at Russian railways (in Russian; Спутниковые технологии на железных дорогах России / Под ред. В.И. Якунина. Серия: Инновационные технологии на железнодорожном транспорте. Изд-во: Дизайн. Информация. Картография, 2008. – 2-е изд. 136 с.)

2. **http://ifen.bauv.unibw-muenchen.de/institute/research.htm.**

3. **http://www.novatel.com/products/span.htm.**