Lathe machining in the era of Industry 4.0: Remanufactured lathe with integrated measurement system for CNC generation of the rolling surfaces for railway wheels

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Abstract. Many projects and researches in the field of remanufacturing of specialized lathes are presented in the specialized literature. In the process of design for remanufacturing, a great number of solutions contain different aspects and data important to consider. The paper presents important stages of theoretical and applied research regarding the modernization of a conventional lathe with two working units by adaptation of four driving chains for CNC advance/positioning movements and improvements of translation couplings, adaptation of CNC equipment for driving and measuring simulation of both wheels mounted on axle. The reduction of geometrical errors of the running profile is very important for the restoration of functional requirements and measurement of the geometric precision. The CNC capabilities of the remanufactured lathe require a database of parametric representation of profiles and rolling surfaces using CAD techniques according to international standards.

Keywords: Railway wheel profile, CNC lathe remanufacturing, Rolling surface reshaping, Wheelset.

In the interoperability Technical Specifications relating to the “rolling stock” subsystem, developed according to the Directive 2008/57/EC, there are established the parameters that are defining the wheel profile: flange height, flange thickness, width of rim-tire, running tread diameter, angle of running tread. The flange slope quota is also an important parameter because if it is too small, the wheel flange will be almost vertical, which implies that the transitions and the flange of the wheel flange will be almost vertical, which implies that the transitions and the flange contacts will occur abruptly causing high contact forces that damage both wheel and rail. All these parameters can be measured and controlled using mechanical and optical instruments.

Running tread of the railway vehicles wheels is regulated by the normative covered by national and international rules. In the Interoperability Technical Specifications relating to the “rolling stock” subsystem, developed according to the Directive 2008/57/CE, there are established the parameters of the wheel profiles. In Romania was created the profile S–78, standardized for passenger and freight wagons fitted with UIC normalized flange. Whatever form they have, profiles of the train wheels are defined by nine constructive areas. The UIC S 10-2 standard presents the main parameters that are defining the wheel profile. The running tread of a wheel tread is a straight line of external surface of flange. The designed shape of a wheel is represented by wheel profile drawing. The requirements to draw the wheel profile are described below and they are based on several parameters Sh, qR, L1, L3, etc. These parameters can be measured and controlled using mechanical and optical instruments.

For tramways or light rail systems, these parameters may have different values.

For railway transport standards and norms in the field. During the operation of the railway vehicle, the contact surfaces between the wheels and rail become worn. This wear lead to changes in wheel and rail profile, contact surface and, consequently, to instability in the movement of vehicles. Therefore, the maintenance and repair of the rolling stock are important for traffic safety and passenger comfort.

The wheels are the most loaded components of railway vehicles. They are subject of a continuous wear of a few running conditions: non-uniform loads, alteration of rail and wheel profile, temperature variations, curved paths, sudden changes, in speed, breakings, etc. In the moment that the wheels reach a critical level of wear, they must be reshaped or replaced, when the material to be removed by cutting exceeds a certain limit. Using wheels with appropriate profile reduce the risk of derailment and minimizes the dynamic interactions between the vehicle and the track, reducing noise, vibration and wear.

The main requirement of this approach is the profile processing and maintaining the contact surfaces of wheels and rails within geometric and functional parameters. Profiling and re-profiling of wheels are performed by technological processes on specialized lathes. Due to the high cost for acquisition of such a modern new machine tool, the manufacturers often have an option for the remanufacturing of an existing machine tool. Thus, there is a need for development and implementation of an automated equipment for simulation, manufacturing and measuring of wheels running profile, both static and dynamic by adding driving, command and measurement systems. The remanufacturing costs are smaller than the costs for purchasing a new machine tool. Thus, there is a need for development and implementation of an automated equipment for simulation, manufacturing and measuring of wheels running profile, both static and dynamic by adding driving, command and measurement systems.

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