
SUMMARY

Shape, dimensional, and surface analysis of the innovative technology for combined automotive hubs with rolling bearings

The dissertation presents a comprehensive analysis and development of a new technology for manufacturing third-generation composite bearing hubs, covering both design and technological aspects, with particular emphasis on issues related to manufacturing tolerances and longitudinal clearance optimisation. The introductory part characterises successive generations of bearing hubs, discussing their design evolution, technological solutions and the economic and operational benefits resulting from their use. The impact of these solutions on improving assembly processes and reducing the risk of failure under operating conditions is also presented.

The rest of the paper presents the current state of knowledge in the theory and practice of dimensional chains, along with deterministic and probabilistic calculation methods, taking into account the principles of full and partial interchangeability at a specified level of probability of meeting design requirements. Methods for testing the capabilities of measuring instruments and machines are also discussed, highlighting their importance for process stability and product quality.

Against this background, the main objective and specific objectives of the work were formulated, followed by a detailed analysis of the hub design drawing, identifying the critical dimensions affecting longitudinal clearance. A mathematical model of the longitudinal clearance dimension chain was developed, allowing the determination of the coefficients of influence of individual links on the clearance value and the determination of tolerances for full and partial interchangeability variants. The results obtained were compared with the tolerances adopted in the technical documentation, which made it possible to identify potential opportunities for dimensional optimisation in terms of quality and production costs.

The following chapters are devoted to a detailed description of the technological process of hub production, including the selection of materials, machining, heat treatment and abrasive operations, as well as the assembly process. The machining parameters and the selection of measuring tools ensuring the control of critical dimensions were taken into account. Particular attention was paid to the production stages that have a direct impact on the longitudinal clearance value. The capabilities of the machines and measuring instruments were tested, and the measurement uncertainty budget was analysed.

The results of longitudinal clearance measurements in the manufactured hubs were subjected to statistical analysis, confirming the ability of the process to meet

the design requirements and the correctness of the adopted technological assumptions. In summary, it was demonstrated that extending the tolerance ranges of third-generation bearing hub components eliminated the time-consuming process of selecting components, which simplified the manufacturing process and reduced assembly costs by 8%.