Potential of the Superspeed Transportation System Transrapid in Future Application, Technical Innovations, Economic Feasibility

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Abstract
The development of the Transrapid System has been based on the objectives and requirements to meet market needs and customer expectations. Further improvement of competitiveness is ensured by the WEP, the further development program, financed by the Ministry of Transportation of the Federal Republic of Germany. The expected progress is described by examples such as
- contactless onboard powersupply
- safe-life design
- non-abrasive gliding system.

Introduction
Precondition of a successful world wide application of the Transrapid System is continuous improvement of the attractiveness for the user as well as the continuous improvement of the economical efficiency for the investor/ operator.

The challenging basic objectives are
- all safety measures, which contribute efficiently to the reductions of risks have to be applied
- compatibility for multi-modal solutions have to be ensured
- the attractiveness has to be improved by continuous quality enhancements
- investment costs and maintenance expenditures have to be reduced

Quality reports of the operation at the Emsland Test Facility and the Shanghai Maglev line as well as innovations in the field of electronics and synthetic materials and innovative production techniques were taken into consideration to define an ambitious work scheme for the further development, the so-called WEP-Program, financed by the Ministry of Transportation of the Federal Republic of Germany. In the following paragraphs, major items which demonstrate the progress already achieved or to be expected in near future are discussed.

1. Guideway Technology

Two items related to the interaction with the vehicle are of major importance within the optimization of the guideway technology
• Minimization of requirements resulting from vehicle guideway dynamics
• Simplification of the guideway design.

1.1 Minimization of requirements

To ensure crash worthiness in case of small obstacles on the guideway, up to date the nose structure of the vehicle generation TR08 has a clearance of approx. 50 mm to the upper surface of the guideway. Main purpose of the small clearance is the protection of the support skids by the nose structure. The evaluation of structural vibrations and aerodynamics at the TVE have shown that caused by the clearance of only 50 mm the longitudinal gaps between girders should be closed in order to reduce dynamic loads on the vehicle structure and to avoid higher noise levels inside and outside the vehicle. Elastic components are required for a pressure sealed design with the result of considerable additional investment and expenditures for maintenance. Parameter variations have shown, that the gaps between girders can be tolerated, if an increased clearance of at least 150 mm between vehicle and guideway surface can be realized. Precondition is, that the crashworthiness of the support skids will be ensured by an improved design of their structure and fixation at the levitation frame. The respective redesign has been carried out successfully.

1.2 Simplification of guideway equipment

ThyssenKrupp Transrapid developed a motor winding for the synchronous long stator with an optimized grounding system. [2] The experience gained with several types was taken into account, resulting in a robust design which guarantees that the current capacity is much higher than the operational loads. Therefore very high values of reliability over the entire life time can be expected. In addition the working time for installing the motor winding into the stator packs has been speed shortened by redesigned mounting vehicles. [3] The applicable mounting speed has been increased by approx. a factor of 2.5. By using as many standard components as possible the costs have been reduced, the reliability and maintainability of the mounting vehicle were markedly increased, the handling clearly simplified. The new concept was completely verified during the LSW-motor cable mounting program in Shanghai, and the specified performance and parameters were fully reached. For further application routes these results lead not only to a considerable reduction of the production costs of the motor winding itself, but also enable a considerable reduction of the time of construction of the entire guideway. Reason is that the mounting of the motor winding is the final activity for the completion of the guideway. Economically this is a valuable contribution to the reduction of investment and financing cost prior to revenue service.

1.3 Simplification of the guideway structure

Transrapid vehicles are levitated by electromagnets arranged in a redundant configuration in levitation frames. However, in the very unlikely case of both levitation magnets being deactivated at the same time, the levitation is partially ensured with mechanical support. This is realized by gliding of support skids on the gliding strip of the guideway. According to the requirements of a safe-life design of the vehicles (mission fulfillment defined by travelling from station A to Station B without a break down within the life time of the system) the gliding system must function safely at least over a distance of about 200 km at speeds up to 500 km/h. To ensure this function a steel surface as gliding strip was required due to previous
experience. ThyssenKrupp Transrapid developed a gliding system consisting of support skids equipped with gliding elements made of carbon fiber reinforced carbon and a gliding surface consisting of a priming coat and a multilayer polyurethane based upper coat which is applicable in special configurations on steel as well as on concrete. [1]

The outstanding features are

- "non-abrasive" gliding elements (wear less than 0.01 mm/km)
- wear of the coating system less than 5 μm per support skid crossing
- friction coefficient 0.1 to 0.4 (depending on speed)
- gliding distance more than 300 km

Especially in case of the application of innovative materials and production techniques for concrete girders this gliding system does not require an accurate mounted gliding rail made of steel but only a concrete surface parallel to the functional surface of the stator packs. This simplification enables the application of a cost effective production technique of the concrete girders and the fitting of stator packs and guidance rails. Results are considerably lower production costs and maintenance expenditure of the concrete guideway.

2. The new Vehicle Generation Transrapid 09

The system requirement specification defined by Deutsche Bahn AG, Bayerische Magnetbahnvorbereitungsgesellschaft mbH and Transrapid International GmbH & Co KG is of binding character for the aims and activities of the further development program "WEP". Main targets and contents are

- Reduction of investment costs and maintenance expenditures
- Higher transport capacity per vehicle
- Reduction of noise emission
- Improvement of the robustness of operation to achieve highest availability.

The following items are activities to meet the above mentioned requirements by an optimization of the Transrapid vehicle technology.

- Increased clearance between upper guideway surface and vehicle and crashworthiness of the support skids results in
  - lower noise emission
  - improved behavior under wintry conditions
  - lower guideway investment cost and maintenance expenditures

- Contactless onboard power supply (Fig. 1) results in
  - lower noise emission
  - longer life span of the energy transmission system
  - improved behavior under wintry conditions
  - lower maintenance expenditures
Modernization of electric components results in
- higher reliability of electronic and electric units
- lower maintenance expenditures

Increased transport capacity (Fig. 2) (3-section vehicle with 140 seats, 74 m² standing room, 6 luggage container) results in
- lower energy consumption per passenger km
- lower investment cost

Fig. 1: Transrapid 09 - Contactless onboard power supply

Fig. 2: Transrapid 09 Nose section

Source: DB AG, Alcan, ThyssenKrupp TKT-TR
The respective development activities led to a new generation of Transrapid vehicles the Transrapid 09. The prototype is already under construction and will be put into operation in 2006 at the Emsland Test Facility in northern Germany. An extensive verification test program is planned in order to demonstrate the improvements.

3. Conclusion and outlook

The new vehicle generation TR09 in combination with the optimized guideway enable high travelling speeds, safety and availability and environmental friendliness as well as high transport volumes, short headways, excellent ride comfort and economic efficiency in accordance with the requirements of an application for long distance as well as for local and regional public transport. The contactless levitation, the direct conversion of electric energy into linear movement, the safe-live function are realized dominantly by electronic and electric components having a high potential of further innovations. These are the convincing arguments of the competitiveness of the Transrapid now and in the future.

Fig. 3: New vehicle generation TR09

References:
“Characteristics and Verification of the New Concrete Gliding Strip for Transrapid Guideway”

“Transrapid Motor Winding with Optimized Grounding System”

“Motor Cable Mounting Technology”