1. Introduction

The social development involves traffic capacity improvement. To improve the traffic capacity it is necessary to use better logistics and better technical parameters of rail construction. The most frequently constructions problems effect traffic failures. The new, reliable and powerful technical solutions are basic requirement for traffic railway improvement.

One of the modern solutions started to develop in about ten years ago. The non ballasted track was created as one reliable alternative to standard superstructures. The advantages of stiff railway construction are: longer lifetime, lower maintenance requirements etc. This construction is suitable for high-speed train sets. The disadvantages are higher construction costs and higher costs for reconstructions.

2. History

The past experiences showed that the ballast becomes the critical element of the standard superstructure when it is using for high-speed railways. That is the reason why later constructers had started use alternative materials for example concrete or asphalt with lower plastic deformation for the same loads. The first experimental constructions without ballast and with alternative materials were built in 20-th years of previous century. The rapid development of the non ballasted track construction was in Shinkasen (Japan) in 1960 – 1980. In these cases the non ballasted track was used for whole rail distance. Only the experimental parts of the railway track were built in Europe in the same time. The great progress was reached in Germany. The development and real practical application were slow and it was slower in other European countries.

Nowadays the Asian countries starting to develop and use the non ballasted tracks mainly in rapidly grooving China.
3. Structural principles

The non ballasted track structure must be able to carry the static and dynamic loads due to train vehicle. It is necessary to carry the load without damage of structural elements. The long lifetime is another important attribute (about 60 years). Because of long lifetime it is necessary to make the quality and bearing fundament layer for slab track rail without ground freezing and subsoil settlement. The requirement of stiffness in the system wheel – rail is provided with elastic plates under rail and under clip plate which are created from the materials with specific elastic properties.

The principle is based on all layers stiffness change in vertical direction.

\[ E_1 > E_2 > E_3 > E_4 \]  \hspace{1cm} (1)

The non ballasted track on the underground layer consists of:

- rail
- rail fastening
- sleeper
- concrete or asphalt bearing layer
- hydraulic fasten bearing layer
- ground freezing resistant layer
- underlying ground

4. The non ballast track structural types

More structural types developed during times. Nowadays the non ballasted tracks can be sectionalized on several types which are shown in the Fig. 2. [1]
5. Testing

It is necessary to test the properties of the new structural element which is putting into operation. Also it is important to evaluate if the member fulfilling the properties. German railways have the most experiences in Europe region. Next part describes only German tests for rail structural members. The non ballasted track structures are tested in laboratories. The real models 1:1 are creating for this purpose. It is necessary to make the tests by accredited laboratories. The extensive methodology was developed in Technical University in München (Prüfamt für Bau von Landverkehrswegen der Technischen Universität München).[1]

Followed tests are specified:
- the stiffness characteristics of the elastic layer (c_v = 22,5 kN/mm²) by temperatures from -30 till 50 °C and stable behavior test by 30 Hz frequency forcing which correspond high-speed traffic.
- horizontal direction forces effect by oblique force 150 kN which in long time loading process cannot effects more than 8 mm rail head distance change.
- transversal movement resistance test.
- fatigue test of the large dimensional element of the non ballasted track with superelevation 180 mm loaded by force 250 kN at least 3 millions loading cycles by various temperatures.
- durability test of the large dimensional element with asphalt load bearing layer with temperature 36 °C loaded with force 250 kN in at least 5 days.
- transversal resistance investigation, corresponding to the shift 2 mm, which must be at least 15 kN/m.
- Elevation test – one supporting point must have resistance more than 15 kN.

Fig. 3 Large dimensional measuring laboratory -company BWG, (Werk Brandenburg)
6. Conclusions

Many technical solutions were developed during times. Many of them didn’t find application for the practical use and many of them were not convenient. All nonsuccesses were particular successes too. The new vision for the real behavior of structure was obtained. In order to develop new structural solutions a many full-scale tests on models in laboratories and in real conditions have to be done. But there are many costs for development of structures.

The new methods of computer modeling are one of the modern effective solutions for this problem. The most important for computer modeling are experiences with structural modeling and loading simulations. Not at least experimental results and past knowledge create next field which can be useful as a theoretical background.

References


Summary

The social development involves traffic capacity improvement. To improve the traffic capacity it is necessary to use better technical parameters of rail construction. One of the modern solutions started to develop in about ten years ago. The non ballasted track was created as one reliable alternative to standard superstructures. Many technical solutions were developed during times. Many of them didn’t find application for the practical use and many of them were not convenient. All nonsuccesses were particular successes too. The new methods of computer modeling are one of the modern effective solutions for this problem.