Проведено оцінку напруженого стану залізничної конструкції типу Multiplate MP 150 із врахуванням ступеню ущільнення ґрунтової засипки. Встановлено, що у початковий період експлуатації металева гофрована конструкція є нестійкою проти утворення пластичного шарніра, коли ґрунтова засипка ще не досягла нормативного ступеню ущільнення. З метою недопущення розвитку залишкових деформацій металевої гофрованої труби необхідний технічний нагляд за трубою протягом року експлуатації

Ключові слова: залишкова деформація, несуча здатність, гофрована конструкція, модуль пружності, нерівність на залізничній колії

Проведена оценка напряженного состояния железнодорожной конструкции типа Multiplate MP 150 с учетом степени уплотнения грунтовой засыпки. Установлено, что в начальный период эксплуатации металлическая гофрированная конструкция является неустойчивой против образования пластического шарнира, когда грунтовая засыпка еще не достигла нормативного степени уплотнения. С целью недопущения развития остаточных деформаций металлической гофрированной трубы необходим технический надзор за трубой в течение года эксплуатации

Ключевые слова: остаточная деформация, несущая способность, гофрированная конструкция, модуль упругости, неравенство на железнодорожном пути

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ESTIMATION OF CARRYING CAPACITY OF METALLIC CORRUGATED STRUCTURES OF THE TYPE MULTIPLATE MP 150 DURING INTERACTION WITH BACKFILL SOIL

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1. Introduction

It is accepted at present to assess performance of corrugated metal pipes for residual deformations by applying the criterion of relative vertical and horizontal deformations, relative to the diameter of the pipe. As indicated in refs [1, 2], residual vertical deformation of pipes must not exceed 3.0 % over operation time.

Technical observations of relative deformations of metal pipe at the section from Vadul-Siret to the state border on the Lviv railroad (Ukraine) [3] showed that relative deformations of the pipe are accumulated during initial period of pipe operation. However, the residual deformations decreased in one year of pipe operation. This is connected to the self-compaction of soil under its own weight and the weight of the railroad load.

In order to determine the actual location of the rail track in the profile, over the pipe and adjacent structures, and to control the position of pipe design, instrumental measurements were performed that involved geodetic instruments

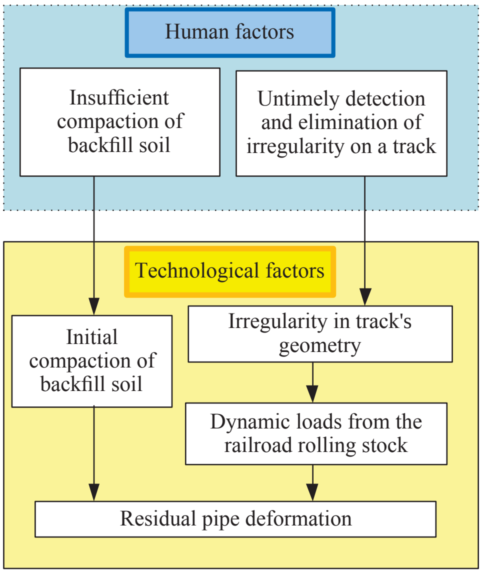

Fig. 10. Mechanism of occurrence of railroad track deformation and metallic pipe deformation

6. Discussion of results of the study into carrying capacity of a metallic corrugated pipe of the type Multiplate MP 150

The experience of building metallic corrugated structures demonstrates that it is impossible to ensure perfect symmetry of the structure's model, soil compaction, and the character of loading during operation. The structures considered are very sensitive to asymmetrical loads, which is why during operation one may expect asymmetrical deformation. Given this, it should be recommended that special attention during construction of such structures be paid to the homogeneity of the backfill soil and a symmetrical compression degree.

When the designed backfill soil compaction of 97 % by Proctor criterion is fulfilled, the strength criterion and permissible vertical deformations of a metallic corrugated structure are ensured. This is due to the fact that the side walls of a metallic pipe demonstrate a sufficient resistance against horizontal deformations. However, when the backfill soil compaction is below 90 %, test for the formation of a plastic hinge in a metallic pipe is not effective.

As regards the influence of a track irregularity and a degree of compaction on the bearing capacity of a metallic corrugated structure, it can be stated that both factors exert a significant impact. The lowest value for bearing capacity is characteristic for the initial period of operation, immediately after construction. However, provided a timely elimination of an irregularity on the railroad track, even at insufficient compaction of backfill soil, the reserve of carrying capacity is 58 %. Whereas at a normal degree of compaction, the margin factor is about 80 %. If an irregularity in the railroad track upper structure exceeds the normative values, it leads to a rapid growth in the dynamic load from the rolling stock and, consequently, to a decrease in carrying capacity. It should be noted that even when an irregularity exceeds the standards, it is possible to ensure stable work of the pipe if backfill soil has a sufficient degree of compaction.

At the same time, a significant shortcoming in the criterion of relative deformations is the influence of design diameter of the pipe, since a given criterion is unified for all possible ranges of metallic corrugated pipes. Therefore, the absolute value of pipe deformations can be different in each particular case. Thus, relative deformation is not applicable when estimating position of the track. Along with it, absolute deformations must be accounted for. Therefore, in the further research it is necessary to estimate the stressed-strained state taking into considerations the absolute deformations of a metallic pipe. This is due to the fact that the horizontal deformations of the pipe's cross section have no influence on the horizontal deformations of the track upper structure and on the dynamic loads from the rolling stock.

5. Conclusions

1. At the initial stage of operation of a metallic corrugated pipe it is necessary to improve the level of technological control over a change in the vertical and horizontal diameters of the pipe because the backfill soil has not yet reached the standard degree of compaction of 97 %. With an increase in the degree of backfill soil compaction *RP* from 85 % to 97 %, the modulus of deformation of backfill soil increases threefold.

2. The study conducted shows that carrying capacity of a structure depends on two interconnected factors, specifically the magnitude of an irregularity on the railroad track and the degree of compaction of backfill soil. An increase in the degree of compaction of backfill soil leads to a decrease in the stresses in a metallic pipe by almost half. The stresses grow much faster with an increase in the irregularity on the railroad track. Numerical computations have shown that the equivalent stresses exceed the permissible magnitude of 235 MPa when the degree of compaction of backfill soil is below 90 % and the development of operational irregularity on the track. It poses a threat of the metal of a corrugated pipe entering a plastic state. In the combined effect of both reasons, more important is the degree of compaction of backfill soil whose share accounts for 42 %, with the proportion of an irregularity development making up 22 %.

3. The examined metallic structure under standard operation conditions has a large reserve of carrying capacity, which amounts to 80 %. However, these structures, despite their high initial strength margin, are sensitive to an increase in external dynamic loads due to the emergence of an irregularity on the railroad track.

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