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ЗАЛІЗНИЧНА КОЛІЯ ТА АВТОМОБІЛЬНІ ДОРОГИ

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FIELD TESTS OF GLUED INSULATED RAIL JOINTS WITH USAGE OF SPECIAL PLASTIC AND STEEL FISHPLATES

Purpose. The aim was to compare behavior of polymer-composite fishplated and control steel fishplated (type GTI and MTH-P) glued insulated rail joints in railway track. **Methodology.** After laboratory tests (shear tests of glue materials, 3-point-bending tests, axial pull tests), as well as field inspections, trial polymer-composite and control (steel) fishplated glued insulated rail joints were built into railway tracks with (almost) the same border conditions (rail profiles, cross section parameters, track condition, etc.). The authors summarize in this paper the results of field tests related to polymer-composite, as well as control (steel) fishplated glued insulated rail joints between 2015 and 2018 considering measured data of track geometry recording car and straightness tests. **Findings.** The investigation and diagnostics of experimental (fiber-glass reinforced fishplate) and control (steel fishplate) rail joints (straightness tests, track geometry recording car measurements) are in progress. **Originality.** The goal of the research is to investigate the application of this new type of glued insulated rail joint where the fishplates are manufactured at high pressure, regulated temperature, glass-fiber reinforced polymer composite plastic material. The usage of this kind of glued insulated rail joints is able to eliminate the electric fishplate circuit and early fatigue deflection and it can ensure the isolation of rails' ends from each other by aspect of electric conductivity. **Practical value.** The polymer-composite fishplated glued-insulated rail joints and control steel fishplated rail joints were built into the No. 1 main railway line (Kelenföld-Hegyeshalom) in Hungary at three different railway stations. The accurate time could not be determined when the polymer-composite fishplated glued-insulated rail joints reach the end of their lifetime as the result of previous research. In this article the investigation of deterioration process of glued-insulated rail joints is demonstrated.

Keywords: polymer-composite; fishplate; rail joint; railway; field test

Purpose

In this paper the authors summarize the railway measurement results related to APATECH (Russian branded) glued insulated rail joints with special fibre-glass reinforced plastic (polymer-composite) fishplates.

According to railway maintenance experiences of Hungarian Railways (MÁV) and Raaberbahn, Győr-Sopron-Ebenfurth Railway (GYSEV in Hungarian abbreviation, or ROeEE in German abbreviation), glued insulated steel fishplated joints need a lot of maintenance source due to rail deformations (especially settlements). The next problem is the false railway control signal due to rail end failures that results railway capacity restriction. Other problems are for example: glue material, endposts, rail ends, rail profile inner corner wear and plastic deformation.

In the international literature the researchers have been dealt with the following subtopics (the order does not mean the relevancy and the list was not made with the demand of fullness). In the following (in the literature review) the authors write only 'rail joints', but, of course, e.g. mechanical rail joints mainly differ from 'insulated rail joints', as well as from 'glued insulated rail joints':

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– standards and prescriptions related to design, dimensioning and structural configuration [15, 27]

– determination of general failures and failure patterns of rail joints and identification of the reason of breakdown [9, 10, 21, 24, 25, 26, 30, 37, 39, 40, 41, 46, 50, 54, 60, 66, 70],

– improvement (reinforcement) and development of rail joints (mechanical joints, insulated joints, as well as glued insulated joints) and elements of these rail joints [2, 12, 19, 21, 22, 23, 26, 28, 30, 32, 37, 40, 46, 53, 54, 58, 60, 70],

– analysis of the effect of different materials of rail endpost on carrying capacity (strength) and stiffness of rail joints [2, 16, 21, 22, 23, 26, 60],

– investigation of rail joints' in mechanical and electrical aspects [2, 8, 9, 10, 11, 12, 13, 14, 16, 19, 21, 22, 23, 24, 25, 26, 28, 29, 30, 32, 33, 34, 37, 38, 39, 46, 50, 52, 53, 54, 55, 56, 57, 58, 60, 66, 69, 70],

– examination of deformation (mainly deflection) behavior of rail joints, as well as the stress distribution in the rail head and fishplates; examination of wheel-rail contact in the aspect of stress and/or strain distribution, as well as wear behavior [2, 8, 9, 10, 12, 13, 16, 18, 19, 23, 25, 28, 30, 33, 34, 37, 38, 46, 50, 53, 54, 55, 56, 57, 58, 60, 69, 70],

– investigation of the effect of the arc shape at railhead edges on the stress distribution in the rail head [12, 57],

– analysis of sleeper settlement and stress distribution on the contact surface between sleepers and ballast bed, considering the usage of geosynthetic reinforcement solutions or without them [1, 9, 10, 19, 34, 36, 39, 46, 54, 58, 64],

– investigation of support properties of rail joints and rail tracks as well as ballast deformation [1, 35, 36, 37, 46, 60, 64],

– investigation of glue material quality adequacy related to glued insulated rail joints [52, 53, 66, 67],

– analysis of the quantity of glue material between fishplates and rail web due to assembly process, as well as the effect of the glue surface patterns on carrying capacity (strength) of rail joints [52, 53, 66, 67],

– investigation of epoxy de-bonding phenomena [52, 53, 66],

– examination of the effect of the angle between the rail longitudinal axis and rail joint cut (endpost) (i.e. square and inclined rail joints) on the mechanical behavior of the rail joint [8, 11, 12, 13, 18, 37, 38, 58, 68],

– analysis of the effect of the size of the endpost [19, 21, 22, 23, 26, 57, 58],

– investigation of lipping (and/or ratchetting) at the contact lines between rail ends and endpost elements [25, 26, 28],

– analysis of electric arc burning at insulated rail joints in high-speed railway stations [17],

– investigation of dynamic effect in railway tracks due to railway vehicles with or without under sleeper pads [35],

– investigation of speed-dependency of stresses arising in rail joints' elements [39],

– analysis of detecting method of missing and/or loose screws in the rail joints [41],

– development of special measurement techniques for determination of faults (electrical and/or mechanical) in rail joints [2, 7, 13, 26, 41, 49, 55, 56, 59, 66],

– development of defect-based condition assessment methods [20],

– investigation of dynamic effects due to rail joints on railway vehicles and railway track elements [9, 10, 11, 24, 32, 33, 34, 41, 50, 51, 55, 60, 61, 62, 65, 69, 70],

– considering dynamic effects of railway vehicles on railway tracks as well as measurement of equivalent conicity [3, 4, 6],

– investigation of calculation and evaluation techniques of railway track geometry measurement data made by track geometry recording cars in the aspect of real chord values [5].

Foreign research teams worked the methodologies below:

– numerical analysis with finite element method (FEM), static and dynamic approaches [10, 12, 13, 16, 25, 30, 37, 38, 46, 50, 53, 54, 60, 69, 70],

– laboratory tests [2, 13, 21, 22, 23, 25, 26, 28, 40, 52, 54, 55, 56, 66, 67],

– field (in-situ) tests [2, 9, 10, 11, 18, 24, 32, 34, 35, 39, 41, 52, 53, 54, 55, 58, 59, 61],

– image analysis supplemented with Wavelet calculation method,

– calculations based on mathematical and physical theories, i.e. MATLAB [17],

– mathematical calculation of deterioration and maintenance theories [42, 43, 44, 45, 51],

– IoT (internet of things) techniques,

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– electrical measurement methods [14, 29],

– signal processing for non-destructive testing of railway tracks [59],

– mathematical (statistical) regression analysis and artificial intelligence, as well as artificial neural networks [42, 43, 44, 45].

There are some interesting results from the international literature review:

– significant part of the rail joints' failure is related to reduced moment of inertia of the fishplate pair (compared to parent rail section) [54], as well as increased stress values in the rail head that can lead to plastic deformation, lipping in the rail steel material [25, 26, 28],

– the maintenance cost of rail joints is enormous, it is very significant aspect because the avoiding of insulated rail joints from the CWR tracks is very complicated [54],

– it is very important to choose adequate glue material for glued insulated rail joints [2, 16, 21, 22, 23, 26, 60], respectively the endposts' material and thickness [19, 21, 22, 23, 26, 57, 58],

– modified railhead geometry (longitudinal section, i.e. arch shape) is able to ensure reduced stresses and higher life-time for rail joints [12, 57],

– lipping phenomena in the rail head near the endpost can be hindered by higher rail steel grade or modified-treated steel materials in the rail head [26, 28, 40],

– external reinforcement methods are able to ensure higher bending stiffness for fishplated rail joints [54],

– the usage of inclined (30° and 45°) rail joints helps with reducing vertical displacement, noise and vibration compared to square ones [11, 12, 18],

– it has to be mentioned that the railway operation practice verified that inclined rail joints are not adequate (i.e. they are not better than square ones) [68],

– importance of glue patterns (as well as the quantity of glue material between fishplates and rail web) [52, 53, 66, 67],

– the support geometry influences the arising stress-strain state in the rail joint elements [35, 37, 46, 60],

– a lot of methods were developed that are adequate for detection faults and stress-strain state in the rail joints (i.e. for example: ultrasonic test, acousto-elastic method, neutron diffraction method, X-ray measurements, usage of optical fibre Bragg grating sensors) [2, 7, 13, 26, 41, 49, 55, 56, 59, 66],

– additional dynamic effect due to rail joints can lead to faster deterioration process [9, 10, 11, 24, 32, 33, 34, 41, 50, 51, 55, 58, 60, 61, 69, 70],

– the geometrical deterioration process of railway track as well as rail joints can be determined by up-to-date methods, e.g. analysis of measured data of railway track geometry recording cars using with artificial intelligence, artificial neural networks, etc. [42, 43, 44, 45],

– unequal elasticity of the subrail base as well as quasi-static calculation method can be considered during railway superstructure calculations [1, 36],

– dynamic effects of railway vehicles on railway tracks can be measured by railway track geometry recording car (e.g. type Plasser&Theurer EM 250, etc.), values of velocity, accelerations in different directions are able to be measured, derivatives of measures values can be calculated, in this way the occurent geometrical problems of rail joints are able to be determined and localized [3, 4, 6, 62, 65].

The authors investigated and made diagnostics of experimental fibre-glass reinforced fishplated and designated for inspection control steel fishplated rail joints. The process of the railway investigation was the following:

– the locations designations where the polymer-composite fishplated glued insulated joints and the assigned steel fishplated insulated railway joints were built in railway track,

– analyzing of the track geometry recording car measurements (only evaluation of longitudinal settlement data),

– to performing the straightness tests, which were measured in the guiding edge and the running surface of railhead.

The aim is to compare behavior of polymer-composite fishplated and control steel fishplated (type GTI and MTH-P) glued insulated rail joints in railway track and determining the time course of the deterioration process. The authors' future task is to investigate and make diagnostics of experimental (fibre-glass reinforced fishplate) and control (steel fishplate) rail joints from straightness tests and track geometry recording car measurements and determine the state change of the joints.

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Methodology

The prior field survey, the polymer-composite fishplated glued insulated rail joints for field tests were manufactured by 'A' type glue material (after laboratory shear tests of glue materials, 3-point-bending tests, axial pull tests). The polymer-composite joints and the assigned control joints (for comparison) were built-in the track in three different places, with three different rail profiles, in three different speeds [15, 27]. The three different places and those specifications where the polymer-composite fishplated glued insulated rail joints and the control steel fishplated glued insulated rail joints were built into the railway track are the followings.

Biatorbágy railway station:

– Polymer-composite fishplated experimental insulated rail joint: 60 rail system, left transitive main track in 296+42 section, V=140 km/h. Installation date: 13-09-2016.

– Control GTI steel fishplated insulated rail joint: 60 rail system, left transitive main track in 295+36 section (between the No. 4 and No. 8 turnouts), V=140 km/h. Installation date: 22-06-2016

Tatabánya railway station:

– Polymer-composite fishplated experimental glued insulated rail joint: 54 rail system, right transitive main track in 711+68 section, V=120 km/h. Installation date: 30-08-2016

– Control MTH-P steel fishplated insulated rail joint: 54 rail system, right transitive main track in 702+80 section, V=120 km/h. Installation date: 06-05-2016.

Lébény-Mosonszentmiklós railway station:

– Polymer-composite fishplated experimental insulated rail joint: 60 rail system, right transitive main track between the No. 2 and No. 8 turnouts in 1598+55.80 section, V=160 km/h. Glued ballast bed, installation date: 26. 09 2016.

– Control MTH-P steel fishplated glued insulated rail joint: 60 rail system, left transitive main track between the No. 6 and No. 12 turnouts in 1598+97 section, V=160 km/h. Glued ballast bed, installation date: 27-9-2016.

Track geometry measurements (evaluation of longitudinal settlement data):

– The railway track geometry data – which is measured by FMK-004 and FMK-007 geometry recording car – and the rolling stock data were given by MÁV Central Rail And Track Inspection Ltd. and MÁV Ltd. for the time period between years 2015-2018. All three locations are on the Kelenföld-Hegyeshalom railway line, which is part of the trans-European rail freight network. That is why the FMK-007 geometry recording car does measurements on this railway line with undistorted measurement result in D1 wavelength range. During the procedure the original chord measurements are calculated by the system, it does not include any characteristic features (distortion) of any wrap arrangement, it filters out the wavelength of less than 3 meter or more than 25 meter wavelengths. In order to evaluate the change of the condition of the track, the data of the longitudinal settlement were mainly taken into account for the evaluation of the track geometric data (glued-insulated rail joints were in a straight track, so the «direction» parameter can be neglected, and the twist parameter could have been examined for too short base lengths, so it is neglected, too.

In all sites where the polymer-composite fishplated and control steel fishplated rail joints were built into the track, the data per 25 centimeter have been filtered from the middle of the joints to 100-100 meters in both directions. After the measured values were represented along the sections for both rails in 200 meter length (between years 2015-2018) and shifting the measurement data line along the longitudinal section, which shown in Figure 1.

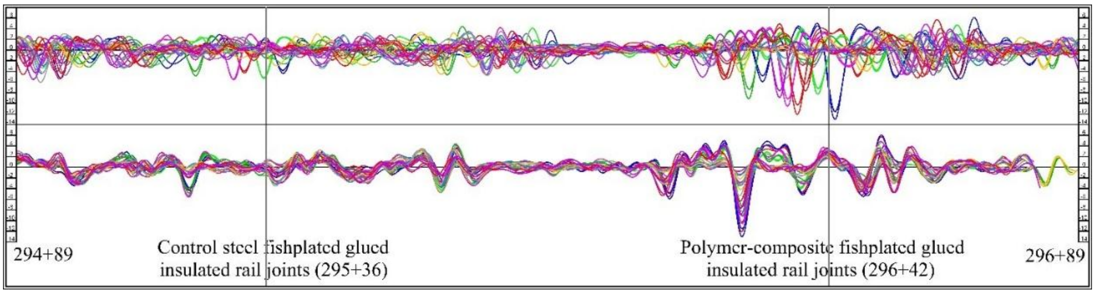

Fig. 1. The original and corrected settlement data at Biatorbágy railway station

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The measurement data of 2017 December was selected for the reference point (each dataset was corrected according to the selected base measurement). It was necessary to offset the data along the length profile because the satellite positioning is not always turned on in the geometry recording car or the accuracy is not adequate, so the sections may slip (shown in Fig. 1 below picture). Then the shifted measurement data lines along the longitudinal section were narrowed down (decreased) to 30 meter length. In this way only the analysis of the surroundings of the joints is important, and the evaluation with a rating of 200 meters does not give a true picture of the change of state of the designated control rail joints and the polymer-composite fishplated rail joints. The percentage distribution of the number of errors were examined in 30 meter long section for both of rails, separately, and the absolute value of average of the parameters regarding to both rails. The resulting values have been collected in at 15%, 50% and 85% by measurement intervals ($i_{15\%}$, $i_{50\%}$, $i_{85\%}$ Vaszary status characteristic number with the following relation), and using the below formula a condition character can be determined [47, 48]:

$$I = i_{15\%}^2 + i_{50\%}^2 + i_{85\%}^2$$

These «I» condition characteristic numbers were represented in a graph (Fig 2.) which are shown the current condition parameters of polymer-composite fishplated glued insulated and control steel fishplated glued insulated rail joints.

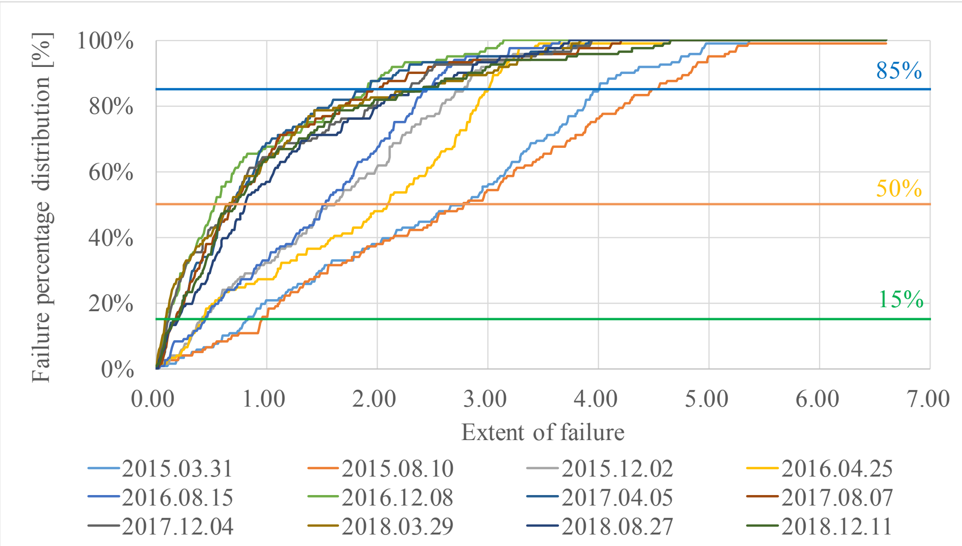

Fig. 2. The «I» condition characteristic numbers of polymer-composite fishplated glued insulated joint on left rail at Biatorbágy

Straightness tests

The straightness tests were made by MÁV-THERMIT Ltd. During the straightness measurement the device is placed on the rail head, and it measured the roughness of the guiding edge and the running surface of railhead on 1.0-meter base length.

After measurement the results were calculated with the «Min-Max Absolute» value (this is the highest difference between the minimum and maximum values), the «Average» values and the «Deviation» values of the guiding edge and the running surface of railhead, after it the change of data has been observed. Then the measurement results have been investigated related to the area below the curves (integer), and the areas have been compared and depicted in graph depending on the rolling gross tons.

Findings

The authors conceive statements about the condition changes of the surroundings of the measured railway joints.

During the evaluation of longitudinal settlement values the data per 25 centimeter have been

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filtered and were shifted along the longitudinal section to 30 meter basis length. The percentage distribution of the number of errors were examined in 30 meter long section for both of rails, separately, and the absolute value of average of the parameters regarding to both rails, and the calculated condition characteristic numbers were represented in a graph. The results obtained are as follows.

At Biatorbágy railway station: in both cases the values of condition parameters of fishplated rail joints were slightly increased since they were built into track, but this is not significant. This state change of polymer-composite fishplated joint is shown in Fig. 3.

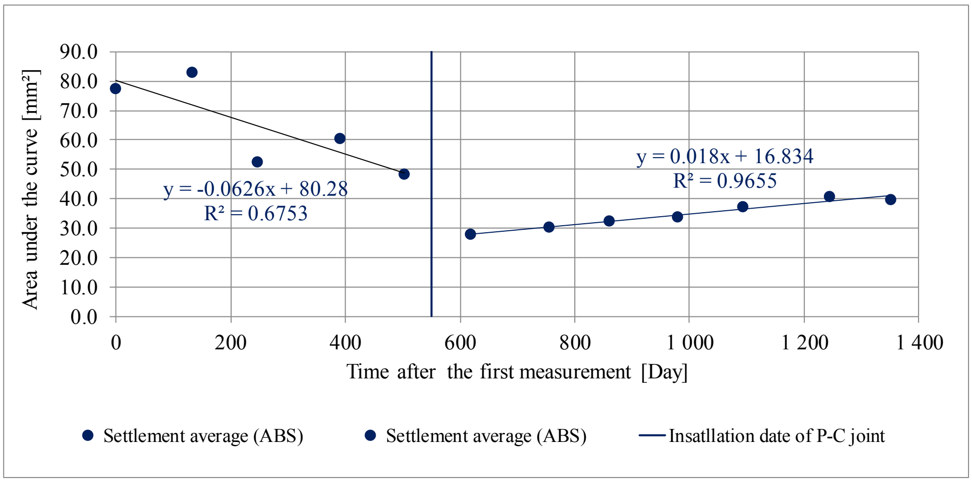

Fig. 3. Are under the curve on 30 meter (at Biatorbágy, Polymer-composite fishplated experimental insulated rail joint on left transitive main track).

At Tatabánya railway station: after the change, the condition of polymer-composite fishplated rail joint and the control fishplated rail joint were slightly deteriorated, the values of condition parameters «move» in parallel in both cases, but there were tamping work with Mechanised Maintenance Train (MMT) in the track. The time interval is too short before the MMT, and therefore the deterioration of the track was not able to be determined precisely.

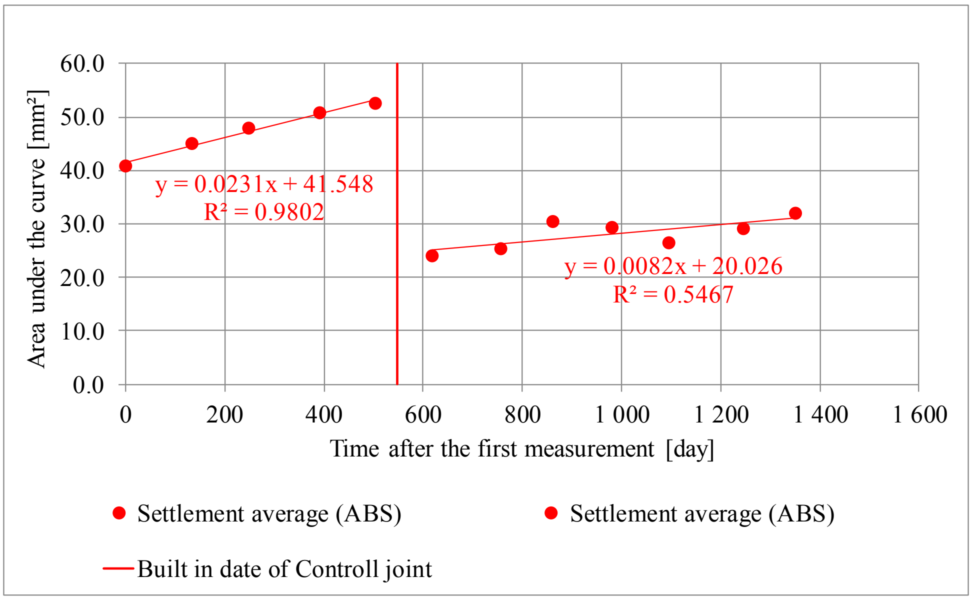

Fig. 4. Area-based evaluation at Control MTH-P steel fishplated insulated rail joint: 60 rail system, left transitive main track (Lébény-Mosonszentmiklós)

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At Lébény-Mosonszentmiklós railway station: there was not significant change in this track, the track geometry values of the track are close to invariable, and the tangent of the trend line slightly increases. It should not be forgotten that these evaluations do not give an accurate assessment about the condition of the track because the ballast bed was glued (ballast bonding process holds ballast substrate together in many areas wherever this is required), so there can be much smaller vertical movements in these trial railway tracks.

For evaluation of railhead straightness tests the measurement results have been investigated related to the area below the curves (integer), and the areas have been compared and depicted in graph depending on the rolling gross tons in case of the roughness of the guiding edge and the running surface of railhead. The evaluation of results was rated according to the current condition of the investigated sites.

At Biatorbágy railway station: the area under the curve (integer) is increased as a function of through-rolled gross tons in case of polymer-composite fishplated joints in both rails, in case of control fisplated rail joints there are not any significant changes. The tangent of the graph depicted in case of polymer-composite fishplated rail joints was increased, in case of the control fisplated rail joints is constant.

At Tatabánya railway station: the area under the curve (integer) is slightly increased as a function of through-rolled gross tons, resulting in higher deflection values, but in the case of control rail joints, the tangent of the graph depicted is not significant while very small deterioration is appreciable in case of the current condition of polymer-composite fishplated glued insulated rail joints in both rails. Fig. 5. shows the condition parameters of polymer-composite and control steel fishplated joints at Tatabánya. (It has to be mentioned that the control rail joints at 702+80 section were replaced to new ones at 07-07-2018 because of the run-down state, which can be seen in Fig. 5 with significant low (i.e. approx. excellent) values related to 900 days.)

At Lébény-Mosonszentmiklós railway station: the area under the curve (integer) is does not change, the tangent of the graph depicted is nearly constant.

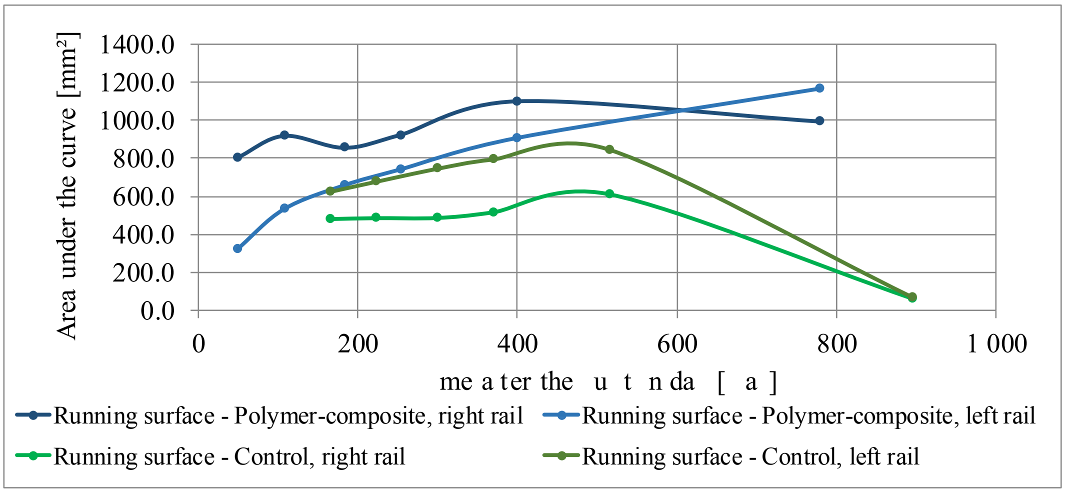

Fig. 5. Change of condition of PC and Control joints on running surface at Tatabánya

Originality and practical value

The role of the rail connections (rail joints) is to ensure the continuity of rails without vertical and horizontal 'step', as well as directional break [63]. Rail connections are the weak points of the track, because their fish-plates can compensate only the 60% of the moment of inertia of the rail. Wheel, during through-rolling (passing) the gap between the rail ends, hits the following (forthcoming) rail end, which is disadvantageous for the whole railway super- and substructure as well as the railway vehicle, too. Dynamic effects are much higher in case of vertical and horizontal step connections than in case of 0 'controlled' one [27].

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Requirements to rail connections are the followings [31]:

– to bear vertical and horizontal dynamic loadings at the discontinuity of rail, and avoid or limit (maximize) the vertical and horizontal step between rail ends;

– to ensure longitudinal motion of rail ends due to dilatation force without structural damages;

– it should consist of few particles, and its assembly and its components' (parts') exchange should be quick and easy;

– to fit to traffic control system, and fit the railway safety rules.

Insulated joints are special types of fishplate joints, where the rail ends are insulated from each other, in this way metallic connection can arise neither at the rail ends, nor via fishplates. It can be applied in suspended and supported joints depending on their type in case of value of sleeper space and wheel load prescribed by manufacturer. High tensile strength bolts with great forces are used to press fishplates and rail together. In this way high friction force can be achieved, it causes that the high tensile forces cannot open the rail connection. Plastic profile lining (plate) is built between rail ends. Insulated joints can be produced in plant as prefabricated elements with given length rails, as well as on the field, where they are assembled.

Conclusions

All of the experimental polymer-composite bonded-insulated rail joints in more than 2 years after their installation (the 4-5 mm gap opening in the winter of 2016/2017 at the Lébény-Mosonszentmiklós bindings and the related precautions, as well as the increased track supervision and speed limitation, they were canceled in February 2017) they were carrying the rolled 20-25 million gross tons without any problems, and it is still possible to keep in track of these stages/sections.

Except for the special case of glued ballast site at Lébény-Mosonszentmiklós railway station, where the level of the tracks is almost «set» for both the experimental and the control rail alignment, the deterioration trends in the other two locations in some of cases differed significantly the glued-insulated joints from the steel fishplated glued insulated rail joints. Cannot be released relationship or mathematically correlation about the status parameter between the elapsed time from the built-in date and the through-rolled gross tons. In addition to deterioration trends, the measurement data series also showed improvement trends. During the evaluation of the straightness data, it was concluded that the area of the glued-insulated joints in measuring the tread and the surface of the guide surface, the area below the rail ends ±0.5 m (interpreted lengthwise) varies linearly as a function of the rolled gross tons. The authors tried to find correlation between the measurement of the straightness data on the running surface and the data of the measuring geometry recording car at 25 cm per settlement data witch evaluating on area precept. Unfortunately, there was no correlation between the two evaluation methods witch is resulting from the short length of the joints.

The statement which based on the results of the authors's track geometry analysis between 2015-2018, the authors found that – although there were no structural and geometric problems, signal and interlocking interruptions during the three-year observation period, or any other situation with glued-insulated rail joints – the glued insulated rail joints with Apatech branded, nevertheless, the polymer-composite fishplates – on the basis of the laboratory tests and railway track measurements – are not a general solution for replacing the steel fishplated glued insulated rail joints in the CWR railway tracks.

The authors think that not only static but dynamic railway track measurements of glued insulated rail joints as well as their assessment can be a very interested research direction in the future.

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ПОЛЬОВІ ВИПРОБУВАННЯ КЛЕЙОВИХ ІЗОЛЬОВАНИХ РЕЙКОВИХ СТИКІВ З ВИКОРИСТАННЯМ СКЛОПЛАСТИКОВИХ І СТАЛЕВИХ РЕЙКОВИХ НАКЛАДОК

Мета. Основною метою статті є порівняння поведінки клейових ізольованих рейкових стиків з полімерно-композиційними й контрольними сталевими рейковими накладками (типу GTI і MTH–P). **Методика**. Після проведення лабораторних випробувань (на зрушення клейових матеріалів, на триточковий згин, на осьовий розтяг), а також польових перевірок клейові ізольовані рейкові стики з тестованими полімерно-композиційними й контрольними сталевими накладками були вбудовані в залізничні колії з (майже) однаковими граничними умовами (рейкові профілі, параметри поперечного перерізу, стан колії й т. д.). Підсумовано результати польових випробувань клейових ізольованих рейкових стиків з полімерно-композиційними, а також контрольними сталевими накладками за період з 2015 до 2018 року з урахуванням виміряних даних колієвимірювача геометрії колії та випробувань на прямолінійність. **Результати**. Проведено дослідження й діагностику експериментальних (із накладками зі склопластику) й контрольних (із накладками зі сталі) рейкових стиків (тести на прямолінійність, вимірювання геометрії колії за допомогою колієвимірювача). **Наукова новизна**. Застосування нового типу клейових ізольованих рейкових стиків із накладками, виготовленими з полімерно-композиційного пластику під високим тиском із регульованою температурою, дозволяє усунути виникнення електричного кола на накладках і передчасний утомний вигин, а також може ізолювати кінці рейок із точки зору електропровідності. **Практична значимість**. Клейові ізольовані рейкові стики з полімерно-композиційними й контрольними сталевими накладками були вбудовані в залізничну магістраль № 1 (Келенфельд–Хед'єшалом) в Угорщині на трьох різних залізничних станціях. Точний час, коли клейові ізольовані рейкові стики з полімерно-композиційними накладками досягають кінця свого терміну служби, за результатами попередніх досліджень визначити неможливо. У цій статті описано дослідження процесу зношення клейових ізольованих рейкових стиків.

Ключові слова: полімер-композит; накладки; рейковий стик; залізниця; польові випробування

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ПОЛЕВЫЕ ИСПЫТАНИЯ КЛЕЕВЫХ ИЗОЛИРОВАННЫХ РЕЛЬСОВЫХ СТЫКОВ С ИСПОЛЬЗОВАНИЕМ СТЕКЛОПЛАСТИКОВЫХ И СТАЛЬНЫХ РЕЛЬСОВЫХ НАКЛАДОК

Цель. Основной целью данной статьи является сравнение поведения клеевых изолированных рельсовых стыков с полимерно-композиционными и контрольными стальными рельсовыми накладками (типа GTI и MTH–P). **Методика.** После проведения лабораторных испытаний (на сдвиг клеевых материалов, на трехточечный изгиб, на осевое растяжение), а также полевых проверок клеевые изолированные рельсовые стыки с тестируемыми полимерно-композиционными и контрольными стальными накладками были встроены в железнодорожные пути с (почти) одинаковыми граничными условиями (рельсовые профили, параметры поперечного сечения, состояние пути и т. д.). Авторы суммировали результаты полевых испытаний клеевых изолированных рельсовых стыков с полимерно-композиционными, а также контрольными стальными накладками за период с 2015 по 2018 г. с учетом полученных данных путеизмерителя геометрии пути и ис-

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пытаний на прямолинейность. **Результаты.** Проведены исследования и диагностика экспериментальных (с накладками из стеклопластика) и контрольных (с накладками из стали) рельсовых стыков (тесты на прямолинейность, измерения геометрии пути с помощью путеизмерителя). **Научная новизна.** Применение нового типа клеевых изолированных рельсовых стыков с накладками, изготовленными из полимерно-композиционного пластика под высоким давлением с регулируемой температурой, позволяет устранить возникновение электрической цепи на накладках и преждевременный усталостный изгиб, а также может изолировать концы рельсов с точки зрения электропроводимости. **Практическая значимость.** Клеевые изолированные рельсовые стыки с полимерно-композиционными и контрольными стальными накладками были встроены в железнодорожную магистраль № 1 (Келенфельд–Хедьешалом) в Венгрии на трех различных железнодорожных станциях. Точное время, когда клеевые изолированные рельсовые стыки с полимерно-композиционными накладками достигают конца своего срока службы, по результататам предыдущих исследований, определить невозможно. В данной статье описано исследование процесса износа клеевых изолированных рельсовых стыков.

Ключевые слова: полимер-композит; накладки; рельсовый стык; железная дорога; полевые испытания

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