ГУМАНІТАРНИЙ ФАКУЛЬТЕТ

Кафедра «Іноземні мови»

МЕТОДИЧНІ ВКАЗІВКИ

з розвитку навичок різних видів
професійно-орієнтованного читання
за темою

"КОЛІЯ ТА КОЛІЙНЕ ГОСПОДАРСТВО"

для студентів 2 курсу
будівельного факультету

(англійська мова)

Харків 2009

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Видання підготовлено відповідно до програми навчальної дисципліни і є складовою навчально-методичного комплексу дисципліни „Англійська мова”.

Дані методичні вказівки призначені для роботи з текстами за спеціальністю для студентів будівельного факультету. Тексти, які подані у методичних вказівках, знайомлять студентів з інноваціями у будівництві та обслуговуванні залізничної колії та взяті з оригінальних друкованих видань. До текстів даються детальні словники активної лексики, що полегшує роботу студентам.

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(англійська мова)

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УКРАЇНСЬКА ДЕРЖАВНА АКАДЕМІЯ ЗАЛІЗНИЧНОГО ТРАНСПОРТУ

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Методичні вказівки з розвитку навичок різних видів професійно-орієнтованного читання за темою “Колія та колійне господарство” для студентів 2 курсу будівельного факультету

(англійська мова)

Харків, 2008

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UNIT 1

BALLASTED TRACK OR SLAB TRACK

Active vocabulary

behavior – поведінка;
vehicle – транспортний засіб;
interface – поверхня розділу, межа;
traffic – Рух;
long-term – довгостроковий, тривалий;
deterioration – знос, погіршення;
to target – націлювати;
virtually – фактично;
shortcoming – недолік;
measurement – вимірювання;
granular – гранульований;
damage – ушкодження;
interaction – взаємодія;
fastening – деталь кріплення;
sleeper – шпала;
subgrade – земляне полотно, основа;
frequency – частота;
feedback – зворотній зв'язок;
excitation – збудження;
fatigue – втомленість;
wear – знос;
monitoring – контроль;
to fill the gap – заповнювати прогалину;
to affect – впливати;
piezofoil – п'єзофольга;
to validate – стверджувати;
range – діапазон;
continuum mechanics – механіка суцільних середовищ;
background – основа;
predictive – попередній;
to survey – досліджувати, вивчати;
to anchor – фіксувати, закріплювати;

slab – бетонне покриття, плита;
adjustment – вивірка;
insulation – ізоляція;
to tackle – мати справу, займатися;
harmful – шкідливий;
impending – неминучий, майбутній;
maintenance – ремонт;
reliability – надійність;
tool – інструмент;
strain sensor – тензодавач;
servo-hydrolic – сервогідравлічний.

Pre-text discussion. Have you ever heard about Eurobalt? Use the Internet or any other source of information to find out about this project. Present your report to your group-mates.

EUROBALT WILL TAP THE UNEXPLOITED POTENTIAL OF BALLASTED TRACK

Ballasted tracks have been an integral part of the railway from its earliest days. Although the dynamic behaviour of high speed rail vehicles and the rail-wheel interface is now well understood thanks to *R&D** work over the last 30 years, few theoretical models exist for the dynamic behaviour of ballasted tracks under high speed traffic.

Nor is there a model for long-term deterioration of tracks under these conditions. The European Research Project for Optimized Ballasted Tracks (Eurobalt) will put this right, giving railway engineers understanding needed to develop ballasted track for the best possible performance. Due to be completed by November 1995, the project is targeted particularly at a better understanding of ballast behaviour on high speed lines, although the benefits will be applicable to virtually all types of railway.

While a number of scientific papers and monographs on the dynamic behaviour of track are available, nearly all of them consider ballast and its performance as something of a “black hole” and the parameters responsible for the long-term behaviour of

ballasted track are completely unknown.
There are six main reasons of this unsatisfactory situation:
Experimental shortcomings. Investigations on ballast and ballasted track in the laboratory cannot easily reproduce the conditions that prevail in the field; further, actual track measurements are often difficult to interpret as no consistent theory is available.
Modelling. Ballast is a granular material, which until now could not be satisfactorily described and modelled as a continuous material; this means that neither a model for the dynamic behaviour nor for the damage mechanisms of ballast exists.
Component interaction. The various dynamic interactions between high speed trains, rails, fastenings, sleepers, ballast and subgrade are one of the most difficult areas of railway dynamics. New concepts and international cooperation are needed to investigate interaction in the low frequency (0 to 100 Hz) and high frequency (100 to 5000 Hz) ranges.
Feedback effect. Under high speed traffic conditions a long term feedback effect between the deterioration of ballast and rail fastenings and modifications to the rail surface – partly responsible for dynamic excitation – is expected to appear. Progress will be made easier once this has been identified.
Damage modelling. Considerations of other forms of deterioration of ballasted tracks, such as rail fatigue and wear, component deterioration, and sleeper deterioration.
Monitoring. Systems aimed at predicting the deterioration of track geometry are currently available, but none permit the long term monitoring of ballasted track because significant parameters and consistent theory on which to base efficient monitoring do not exist.

I N N O V A T I O N A N D R E S E A R C H

The Eurobalt project aims to fill the gaps in railway engineers' knowledge of ballast and the phenomena which affect it. There will be five main axis of research.
New experimental methods, including the piezofoil technique, will be used to identify properly the parameters needed for modelling tasks and to validate models of dynamic behaviour in the whole frequency range.
A theoretical model of ballast will be formulated – this is really at

the core of the Eurobalt project. Continuum mechanics and other approaches suited to the description of granulated will be considered, and these may be some extent be combined to form the theoretical background of predictive models for ballast dynamics and deterioration.

Existing models of dynamic interaction between vehicle and track in the low and high frequency ranges will be developed to match the special requirements of the project; later they will be integrated into the global modelling of ballasted track.

Dynamic models and predictive models will be assembled to form a combined model for dynamic analysis and prediction of long term deterioration of ballasted tracks.

Monitoring methods based on the concepts in the models will be developed; dynamic responses will be surveyed by a vehicles-based system, while track-based monitoring will survey the dynamic inputs caused by specific vehicles, so helping to identify those responsible for major deterioration of the ballasted track.

A I M S A N D E X P E C T A T I O N S.

Track can be laid in several different ways, but the interface is always necessary to distribute loads and anchor the track. Until now, ballasted track has been the most common and cost-effective type of permanent way. The main alternative is the continuous slab, but its use is generally restricted to tunnels and a few other applications – although it has been widely adopted on Japan's Shinkansen.

Slab track has a much higher first cost, roughly four times that of ballasted track, and it is more difficult to make geometric adjustments. It is sometimes difficult to match the slab with the subgrade, and there may be an increase in noise and vibration levels, which requires special insulation measures. The fatigue behaviour of slab track at very high speeds is an area requiring more investigation, which makes some railways reluctant to use it.

Our theoretical knowledge of ballasted track is just about sufficient to predict long-term interaction with trains and subgrade, but this is a far cry from the detailed information that is needed to exploit the design of ballasted track to its fullest extent. Thus dynamic phenomena may appear on very high speed lines that may lead to operational restrictions.

Eurobalt tackles all these problems. Based on continuum mechanical investigation, a theoretical and computerised model of the complete ballasted track, including interaction with train and subgrade, will be established and validated against laboratory and field experiments.
The model will be able to predict dynamic phenomena as well as long term deterioration of the ballasted track. Later it will be used to optimize train design in relation to the infrastructure by identifying the relevant parameters so that harmful dynamic stresses and wear of the track can be reduced.
Based on the knowledge acquired during the modelling phase, a monitoring system embracing track and vehicles will be developed to allow automated and cost-effective diagnosis of problems. The monitoring process will also be used to give timely notice of impending maintenance needs.
Models to be developed and the proposed monitoring techniques will improve maintainability and reliability of high speed ballasted tracks and allow better use of ballast materials to reduce noise and vibration from high speed trains. Although ballast is a quite common material, the theoretical work and experiments will need to be carried out to a high level of scientific competence.
The models and monitoring systems will the tools that railways and their suppliers need to allow commercial speeds to be raised towards 350 or even 400 km/h. At the same time they will increase reliability and improve the cost-effectiveness of high speed operations. Optimizing the vehicle-track system using these tools will be the result of a competitive approach which could start to generate practical results within two or three years of completion of the research.

******R&D* – Research and Development Department.

Exercise 1

Answer the following questions.

1 What has been an integral part of railways from its earliest days? 2 What is Eurobalt? 3 What does it deal with? 4 Explain the expression “unsatisfactory situation”, mentioned in the text. 5 How

many reasons of this situation are there? 6 What is the Eurobalt project aimed at? 7 What are the main axes of research? Explain. 8 What is the main alternative of ballasted track? 9 What makes some railways reluctant to use slab track? 10 Why are models and monitoring techniques necessary? Prove.

Exercise 2

Give English equivalents to the following Ukrainian word-combinations.

Недосліджена територія; динамічна поведінка високошвидкісних транспортних засобів; тривале погіршення колії; умови, які переважують у колії; гранульований матеріал; механізми пошкодження; взаємодія компонентів; ефект зворотного зв'язку; заповнювати пропуск; техніка п'єзофольги; механіка суцільних середовищ; основні та попередні моделі; мати справу з проблемами; поліпшити надійність високошвидкісних колій.

Exercise 3

Work in pairs. Make up dialogues on the following topics:

a) Discuss the problems, over the solution of which the programme "Eurobalt" is working.

b) You are the representatives of the Berlin Technical University and the Kharkov State Academy of Railway Transport working within the framework of the project "Eurobalt". Discuss the ways of elimination of "black holes" in ballast studying and also the ways of railway research and its improvement.

Exercise 4

Crossword. Find the hidden word. Words can be arranged in any direction, except biasly.

1	Транспортний засіб (v…..)	7	Шпала (s…..)
2	рух (t…..)	8	Втомленість (f……)
3	Поверхня розділу (i…..)	9	Знос (w…..)
4	Недостаток (s…...)	10	Фіксувати (f…..)
5	Деталь кріплення (f…..)	11	Ремонт (m…..)

6 Ушкодження (d…..)

12 Інструмент (t…..)

13 Плита (s……)

V	L	E	S	T	E	G	A	M	A
E	C	F	A	E	N	I	N	G	D
H	I	R	T	I	S	E	P	A	N
H	S	A	F	N	L	E	E	R	C
O	C	I	F	T	W	E	A	R	H
R	T	C	O	E	T	M	G	I	O
G	N	I	M	R	O	A	U	T	R
S	B	U	S	F	O	I	E	A	F
L	G	R	A	A	L	N	T	E	N
A	B	E	D	C	E	E	C	N	A

Exercise 5
Write an annotation to the text.

UNIT 2

FLOATING SLAB TRACK

Active vocabulary

wear and tear – знос, амортизація, зношування;
floating – наплавний (метод будівництва), висячий (пальовий фундамент), такий, що сам установлюється;
adjacent – розташований поруч, сусідній (*to*);
springs – пружина, ресора;
firm – кріпкий, міцний, твердий;
trough – улоговина, канава;
substructure – базис, основа, підвалини, фундамент;
helical spring – гвинтова пружина;
matting – матування, підстилка;
affect – завдавати шкоди;
dismantle – демонтувати.

Pre-text discussion. What do you know about Light Rail Vehicles? Look through the text and try to understand what country is spoken about in the text? Have you ever heard about floating slab tracks? Look for some information about it in the Internet.

SLAB TRACK HITS THE RIGHT NOTE IN BASLE

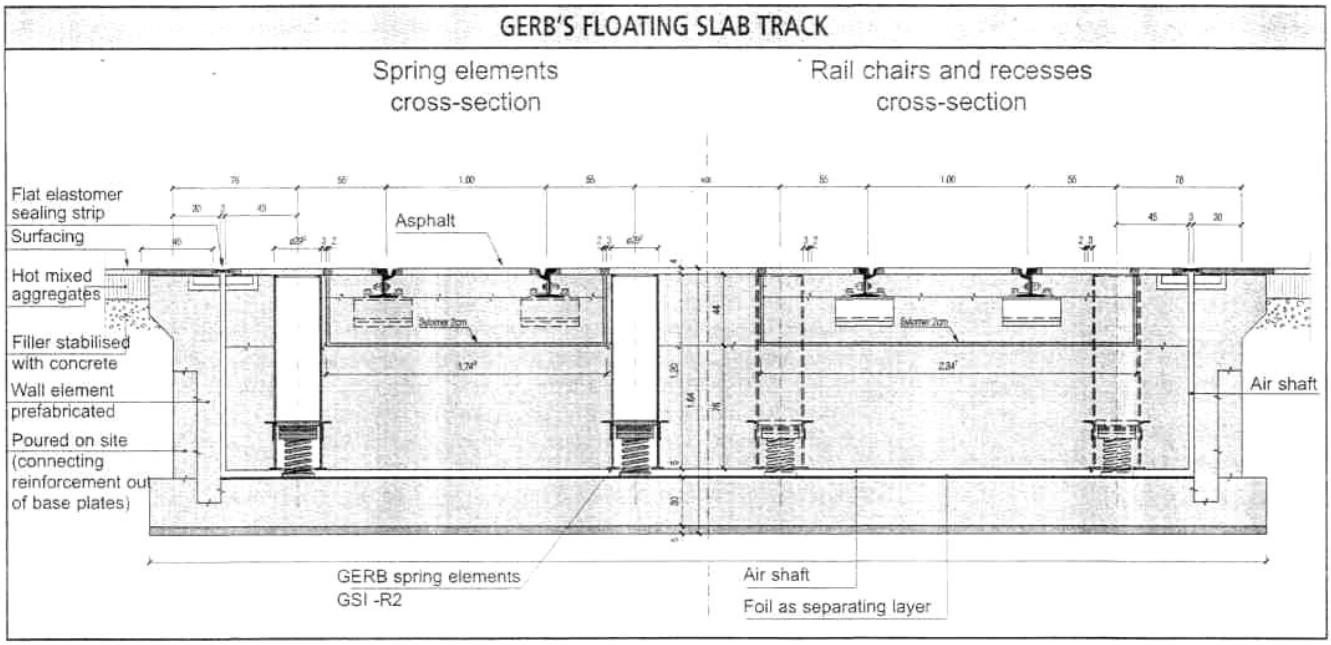
The Steinenberg in Basle is one of the most heavily-used sections of the city's light rail network, with LRVs passing at intervals of one to two minutes. Because of the wear and tear on the rails and the consequent risk of broken rails, the city council has been aware for some time that the track on the Steinenberg and on Theaterstrasse would have to be totally replaced. At the same time it decided to install a floating slab track system at the T-shaped junction of the two streets to cut noise and vibration, which has been a problem for the adjacent concert hall, the Stadt-casino, for many years.

Gerb's[*] basic floating slab track is like a bridge supported by springs embedded in a firm base that isolates the rails from the substructure. The system can be adapted according to local needs. Rails are fixed to a concrete slab or ballasted trough which is isolated from the substructure by individual elements containing highly elastic helical steel springs. The springs form an elastic interface with the slab, effectively isolating the dynamic forces. The entire system is 1.64m deep and is built up in several stages.

In Basle, a total of 750 steel cylinders were installed to house the steel springs on the concrete slab that forms the foundation. Concrete was then poured in four stages, with the foundations for the rails being separated from the rest by a layer of special matting, so that any future work on the rails can be carried out without affecting the rest of the structure.

The springs are designed to last 25 years, which is about the same

time as the new rails. Unfortunately, because of space limitations, visual examination of the spring elements is not possible, so it is proposed to dismantle some of them from time to time to monitor their efficiency.



With these measures, the noise in the concert hall should be reduced by 20-25dB, which will bring it down to a level experts say is acceptable. The previous level was around 46dB. The authorities in Basle selected this option as being the best system available today. The alternative would have been a simpler system only 900mm deep, which although cheaper would only have reduced noise levels by 10 to 15dB.

GERB* - In 1908 William Gerb established a company for vibration isolation and noise control of heavy machinery. Since that time the business of vibration isolation as well as vibration control has been continuously developed into several directions. Today the **GERB Group** consists of the following companies:

- **GERB Vibration Control Systems** has become one of the leading companies in vibration control of machinery, equipment, structures and trackbeds,

- **GERB Engineering** provides consultation, engineering and design for machine foundations and for buildings for the purpose of vibration control.

GERB is a global company, having companies, offices and manufacturing facilities in several locations around the world. The company's headquarter is located in Berlin, Germany.

Exercise 1
Answer the following questions.

1 Why is the Steineberg one of the most heavily-used sections of the city's light rail network? 2 Why would the track on the Steinenberg and on Theaterstrasse have to be totally replaced? 3 Why has it been the problem for the adjacent concert hall for many years? 4 What is Gerb's basic floating slab track like? 5 How is a concrete slab isolated from the structure? 6 How deep is the entire system? 7 What and how many stages does it need to be built? 8 What is the life time of the springs? 9 What is it proposed to do to monitor the efficiency of the springs and why? 10 What level of noise in the concert hall is acceptable according to the experts? 11 What would have been the alternative to this system?

Exercise 2

Translate the following words and word combinations from Ukrainian into English.

Найбільш напружена секція, мережа міського легкого метро, знос, система з наплавним бетонним колійним покриттям, скоротити шум та вібрацію, вмуровані у тверду основу пружини, згідно з місцевими потребами, бути ізольованим від основи, розміщувати гвинтові сталеві пружини, еластична межа, будувати за декілька стадій, не завдвючи шкоди структурі, ізолювати динамічні сили, візуальне обстеження, прийнятний рівень.

Exercise 3

Find pairs of synonyms among the words given below.

Substructure, deterioration, foundation, interface, fasten, solid, embedded, take to pieces, fix, install, examination, set into, have an effect on, adjacent, plate, trough, slab, trench, mount, affect, dismantle, investigation, firm, neighboring, wear and tear, boundary.

Exercise 4

Translate the parts of the sentences written in Ukrainian into English.

1 The Steinenberg in Basle is one of (*найбільш напружених*) sections of the city's (*мереж легкого метро*). 2 Because of the (*знос*) on the rails and the consequent risk of broken rails, the city

council decided to install a (*систему з наплавним бетонним колійним покриттям*) at the T-shaped junction of the two streets. 3 This would cut (*шум та вібрацію*), which has been a problem for the *(розташованого поруч)* concert hall, the Stadt-casino, for many years. 4 Gerb's basic floating slab track (*нагадує собою міст*) supported by (*пружинами, які вмуровані у тверду основу*). 5 Rails (*прікріплени до бетонного покриття*) or ballasted trough which is (*ізольовано від основи*) by individual elements containing (*високо еластичні сталеві гвинтові пружини*). 6 The springs form an (*еластичну межу*) with the slab. 7 A total of 750 steel cylinders were installed (*для розміщення сталевих пружин*) on the concrete slab that forms the foundation. 8 The foundations for the rails are separated from the rest by (*шаром спеціальної прокладки*). 9 Because of space limitations, (*візуальне обстеження*) of the spring elements is not possible. 10 It is proposed to (*демонтувати*) some of them from time to time (*для перевірки їхньої ефективності*).

Exercise 5
Project.

- **Do you agree that vibration and noise have always been the problem for houses, theatres and concert halls, adjacent to tram lines, Underground lines etc? Think, where in Kharkiv would you build a floating slab track system and why?**
- **Imagine yourself being a leading expert in constructing track systems. Write your comment with the estimation of such a phenomenon as a floating slab track.**

UNIT 3

ASPHALT TRACKBEDS AS AN ALTERNATIVE TO THE CONVENTIONAL SUB-BALLAST

Active vocabulary

to reap benefits – отримувати вигоду;
trackbed – основа залізничної колії;
hot-mix asphalt – гаряча асфальтова суміш;

sub-ballast – площадка основна, підбаласт;
geotextile – геотекстильний матеріал;
layer – шар;
waterproof – водостійкий;
to anticipate – передбачувати;
marginal – крайній, узбіччя;
to divert – відводити;
ditch – канава;
confinement – утримання, герметизація;
resilient – еластичний, пружний;
stiffness – твердість;
joint – стик;
excessive – надмірний;
extention – залізнична вітка;
exposed – відкритий, незахищений;
prior – перед;
hardpan – основа;
commuter line – приміська лінія;
sustain – підтримувати;
predominance – переважання;
turnout (switch) – стрілка;
crossover – залізничний стрілочний з'їзд;
crossing diamond – глуха хрестовина;
single - track main line – одноколійна магістраль;
adjacent – сусідній, примикаючий;
compacted – утрамбований;
paving equipment – обладнання для мостіння вулиць.

Pre-text discussion. What do you know about Hot-Mix Asphalt? Do you have any information about it? Think about the advantages of using this technique.

RAIL REAPS BENEFITS FROM ASPHALT TRACKBEDS

Since the early 1980s, the United States railway industry has been selectively utilising hot-mix asphalt (HMA) – a material similar to a typical highway pavement – in the track structure as a support mat in place of the conventional all-granular sub-ballast and/or geotextile. The common term for HMA application is "underlayment" since it is placed as a mat, normally 125 to 200 mm thick, within the track structure between the ballast and new subgrade or existing roadbed.

Its primary use is for rehabilitating existing lines, particularly at special track-work sites, where conventional all-granular systems have not performed satisfactory. In recent years HMA also has gained acceptance for numerous large new construction projects. These decisions were based on anticipated geotechnical problems if conventional all-granular trackbeds were utilised or as a means of maximising the long-term performance of the trackbeds and life of the track components.

The main benefits of HMA are:

~ a strengthened track support layer below the ballast to distribute reduced pressures uniformly to the roadbed (subgrade)

~ a waterproofing layer and confinement to the underlying roadbed to provide consistent load carrying capability for track structures even on roadbeds of marginal quality

~ an impermeable layer to divert water to side ditches and virtually eliminate roadbed (subgrade) moisture fluctuations which effectively improves and maintains underlying support

~ a consistently high level of confinement for the ballast so it can develop high shear strength and uniform pressure distribution

~a resilient layer between the ballast and roadbed to reduce the likelihood of subgrade pumping without substantially increasing track stiffness, and

~ an all-weather, uniformly-stable surface for placing the ballast and track superstructure.

Track sites which benefit most from HMA underlayment are those having high volumes of heavy freight traffic or high speed passenger traffic where one or more of the following conditions exist or are anticipated:

~ difficulty in establishing and maintaining a sufficiently strong and stable hardpan to support the ballast and track adequately

~ difficulty in establishing and maintaining proper surface drainage
~ difficulty in lowering the ground water table to prevent weakening of track structure, and

~ abnormally high impact stresses at joints, special trackworks, bridge and tunnel approaches or open track where track stiffness changes abruptly.

Areas where these conditions exist are likely to show rapid track contamination, excessive wear of track components, and reduction in geometric parameters. Maintenance costs become excessive to sustain safe line speeds, or slow orders must be imposed which reduce operating efficiency.

The construction of new lines and extensions, and new classification and intermodal yards represent ideal conditions for HMA since the exposed subgrade is available for placing the mat with conventional high way asphalt paving and spreading equipment prior to placing ballast and track. These are normally large paving projects.

For existing lines, using present technology, the track must first be removed and the underlying material excavated to the desired grade. Efforts continue to develop equipment to place HMA under a raised track in conjunction with operation so that the track will not have to be removed.

The depth of excavation will vary depending on the replacement thickness of the HMA mat and ballast layer, the depth of the existing hardpan (if one exists) and the desired track raise (if any). The depth of the excavation below the bottom of existing sleepers will equal the sum of the HMA and ballast thickness minus the amount of the track raise. It is not desirable to excavate into the hardpan area to achieve the depth. It is acceptable to use less ballast thickness or raise the track where possible to minimise the excavation depth where the hardpan would be disturbed.

Santa Fe Railway in the Kansas and Oklahoma areas, and a predecessor line to CSX Transportation, L&N Railroad/Seaboard System, in the Kentucky area, were the initial railways to become heavily involved with using HMA underlayment. These initial installations were made during early 1980s. These two railways

have placed several hundred HMA underlayments in the ensuing years and the numbers continue to increase each year.

Railways which have become heavily involved in recent years include the Massachusetts Bay Transportation Authority with hundreds of installations on commuter lines in the Boston area and the Kansas City Terminal Railway. Countless other railroads, including Class 1st, regionals, and short lines, have varying numbers of installations.

The majority of installations involve the rehabilitation of short trackbed sections which have historically required substantial maintenance. The predominance of these are at special trackworks – highway crossings, turnouts (switches), railway crossings and crossovers, and bridge and tunnel approaches. Several large classification, automobile-unloading, intermodal, and bulk intermodal distribution yards have had HMA underlayment utilised to various extents.

CSX Transportation is currently adding the second track to its single-track main line between Greenwich, Ohio and Gary, Indiana. The capacity improvement project involves building 165km of new track on an adjacent roadbed from which the track had been removed several years ago. Each of the 108 public highway at-grade crossings along this rout are being built with an HMA underlayment.

The basic design is for a 125mm-thick, 3.6m-wide compacted layer of HMA extending 7.5m beyond the crossing area. The ballast thickness is a nominal 200mm. Various types of crossing surfaces are being installed depending on highway traffic requirements. In addition, all new railway crossing diamonds will have HMA underlayment. The specified thickness is 200mm for normal roadbed support conditions and 300mm for unusually poor roadbed conditions.

Exercise 1

Answer the following questions.

1 What do railways reap benefits from? 2 What is HMA? Explain. 3 Since when have the United States railway industry been utilising HMA? 4 What is its primary use? 5 Where has HMA gained acceptance in recent years? 6 What are the main benefits of HMA?

7 What track sites benefit most from an HMA underlayment? 8 What does the depth of the excavation depend on? 9 What is specified thickness of HMA underlayment for normal roadbed support conditions and for poor roadbed support conditions?

Exercise 2
Give English equivalents to the following Ukrainian word-combinations.
Гаряча асфальтова суміш; отримувати вигоду; підтримуючий шар; водостійкий шар; відводити воду до бокових канав; еластичний шар; попереджувати послаблення структури шляху; ціни на ремонт; магістраль; залізнична вітка; обладнання для мостіння вулиць; приміська лінія; залізничний стрілочний з'їзд; одноколійна залізнична лінія; утрамбований шар; глуха хрестовина.

Exercise 3 In right column find Ukrainian equivalent to the corresponding English word in left column.

1 sub-ballast	1 бокова канава
2 trackbed	2 ціни на ремонт
3 support layer	3 гаряча асфальтова суміш
4 waterproofing layer	4 приміська лінія
5 maintenance costs	5 утрамбований шар
6 extension	6 еластичний шар
7 commuter line	7 одноколійна магістраль
8 to divert water	8 водостійкий шар
9 HMA	9 підбаласт
10 crossover	10 залізнична вітка
11 paving equipment	11 відводити воду
12 compacted layer	12 підтримувати шар
13 single-track main line	13 обладнання для мостіння вулиць
14 side ditch	14 залізничний стрілочний з'їзд

15 основа залізничної колії
16 глуха хрестовина

Exercise 4
Work in pairs.

a) Your organization offers the project of a new railway line construction. You are a chief engineer of this organization and you are to make a report about the developments your organization is going to apply while constructing this line. (Combine the information from the previous units and the given text.)

b) Discuss with your colleagues the advantages of HMA and benefits you can reap from its utilisation.

Exercise 5
Write an annotation to the text.

UNIT 4

NEW WAYS OF KEEPING THE TRACK IN GOOD ORDER

Active vocabulary

tamping – трамбування / підбиття баласту;
sophisticated – складний, удосконалений;
armoury – арсенал;
contractor – підрядник, контрактор;
reinforcement – зміцнення, армування;
enhance – підвищувати, покращувати;
deterioration – знос;
settlement – осідання грунту;
downfeed – подача вниз;
burden – тягар, вантаж;

complement – комплект;
alter – змінювати;
tailored – нестандартний, спеціальний, замовлений;
visco-elastic – в'язкопружний;
exposed – відкритий, незахищений;
rheology – реологія (наука про текучість речовини);
perceive – сприймати, розуміти;
fix – кріпити, закріплювати;
reluctance – небажання;
speculative – теоретичний, гіпотетичний;
void former – утворювач порожнин;
resilient – пружний, еластичний;
boots – кожух, чохол, башмак;
earth leakage current – струм витоку на землю;
pre-coated – попередньо покриті / грунтовані / оброблені;
microcellular – мікропористий;
slip forming – зведення за допомогою рухомої опалубки (ковзного опалублення) при негативній температурі;
pad – прокладка, подушка;
grout – заливати рідким розчином; цементувати;
lend itself well – ідеально підходить;
grooved rail – жолобчаста рейка.

Pre-text discussion. What is tamping? How is it done? What are the advantages and disadvantages of conventional track and slab track?

EMBEDDED RAIL SLAB TRACK OFFERS TAMPING ADVANTAGES

SIMPLE ballasted track needs continuous investment in sophisticated equipment, processes, manpower, and skills in order to maintain track quality to modern standards. It is no longer possible to maintain a track manually.

Tamping machines, ballast cleaning machines and track relaying

equipment are all part of the armoury of a modern railway maintenance contractor.
Massive capital investment in equipment, high skill levels, and a programme of regular repeated interventions are required to keep this simple track, which has changed very little during the past 150 years, in good order. Is there a better way? There are two of them.

The first uses polymer reinforcement within the ballast layer to improve its performance and longevity. This has the potential to reduce long-term maintenance costs and enhance safety by allowing the railway operator to employ a more limited complement of track machinery more efficiently.

The second is a ballastless track form to change the nature of maintenance required to maintain the quality of a railway system.

Deterioration of track geometry, mainly by settlement of the substructure, is the main cause of the need for track maintenance. In such a case the track geometry will need to be restored by tamping. However, tamping causes further ballast breakdown due to the downfeed and squeezing action. Repeated tamping as part of the maintenance cycle will eventually lead to loss of strength and stiffness in the ballast when fine material generated from ballast breakdown reaches a critical level, and when water fails to drain properly from the ballast. At this stage, the track needs to be maintained either by ballast cleaning or ballast renewal.

Two strategies could be adopted to reduce the burden of maintaining ballast: improve the ballast to improve its performance and longevity, and adopt an alternative ballastless slab track.

The option to improve ballast has some attraction because it can be applied to upgrade and improve existing track. Slab track would be more appropriate for a new track or a major upgrade project, and might also be a better choice for the railway that does not yet have a full complement of track machinery.

An interesting approach to ballast improvement using a polymer reinforcement technique to modify the behaviour of the ballast has been demonstrated in Britain. The *XiTrack** GeoComposite treatment modifies ballast behaviour to enhance the track support stiffness and strength to a desired level, without altering the other beneficial properties of ballast, such as free drainage.

XiTrack uses a tailored visco-elastic polymer applied to the exposed top surface of the ballast, which cures as it penetrates into the ballast to form a three-dimensional reinforcing cage down to a specified depth determined by the polymer rheology. Treated track retains its geometry for longer and delivers significant reductions in maintenance.

Slab track is perceived as being significantly more costly than ballasted track (i.e. it is more expensive to install). Studies into the initial and life-cycle costs of slab track give estimates of 1.3 to 1.5 times ballasted track initial cost with maintenance costs reduced by between 30 and 80%. Most studies use data for slab track for which the rail fixing is based on adapting existing rail fastenings to fix the rail directly to an embedded sleeper or block that is subsequently incorporated into the slab track. Such a system is complex to construct and fails to eliminate a significant inspection and maintenance of the rail fixings.

Embedded rail offers an alternative approach.

Despite evidence that slab track using embedded rail technology can be cheaper than the ballasted option, there is a reluctance to adopt embedded rail. This may be because the higher first cost of current technologies is known while the reduction in through-life costs is still speculative.

Embedded rail technology has undergone an evolutionary process, with each step improving the efficiency of material use and reducing cost. Some of the most recent solutions can now meet the goal of low first cost and can be considered as a real alternative to conventional track.

Early systems simply fixed rails in troughs or channels by pouring liquid polymer around them. These were then enhanced by the addition of void formers to reduce the amount of polymer needed to fix the rail. Further improvements have come through the use of resilient blocks fixed around the rail or by close-fitting elastomer boots.

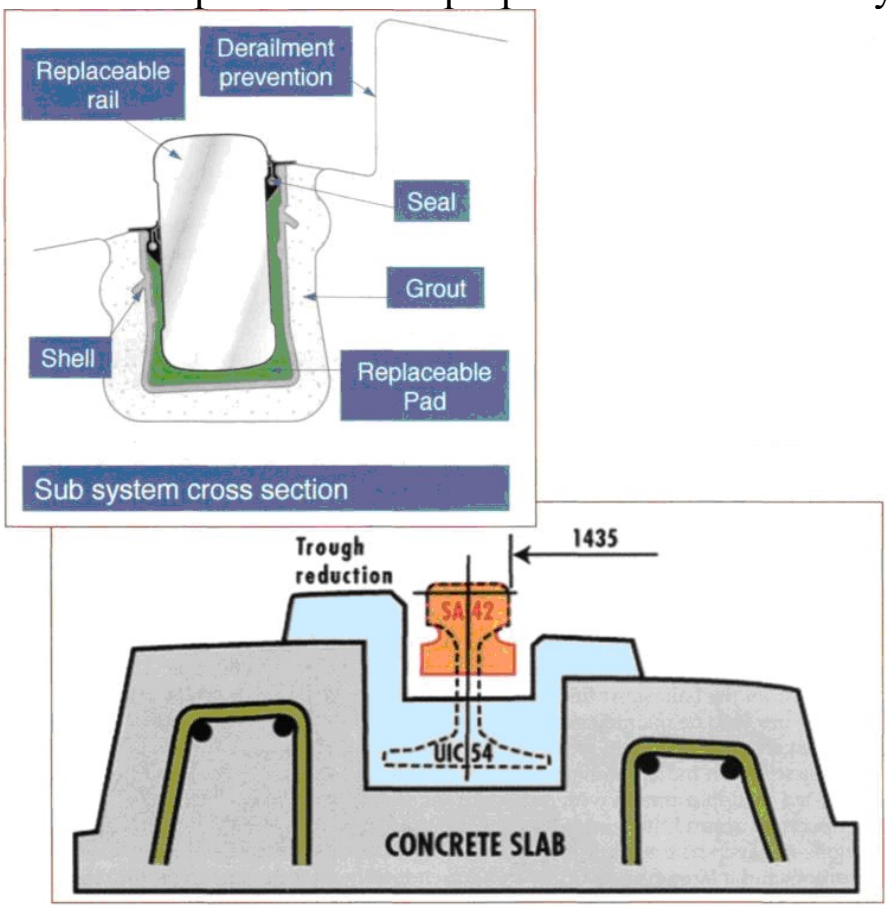
A particular requirement in Britain to prevent earth leakage currents has led to the development of the factory pre-coated rail, which is now the leading system in the country.

More recently, the availability of high-performance microcellular

polyurethanes has enabled rail support components to be designed with dramatically better performance in dynamic support and noise and vibration control. This technology is exploited in *Balfour Beatty's BBEST* **system in which the track slab is constructed using slip forming followed by installing the embedded rail.

The methodology of slip forming the track slab with channels, fitting the continuous resilient pad around the rail and then grouting the assembly into the channels lends itself well to the efficient and rapid construction of embedded slab tracks.

Most existing embedded rail installations use conventional *Vignoles**** or grooved rail profiles. BBEST makes use of an unconventional rail shape, which has the advantage of being removable from its embedment to aid rail renewal. A number of other rail shapes have been proposed for embedded systems.



Top: The BBEST embedded rail system makes use of an unconventional rail shape which is easily removable from its embedment. Diagram: Balfour Beatty Rail Technologies.
Above: The squat and unconventional SA42 rail allows a thinner slab track. Diagram: Edilon

XiTrack – поліуретанова система, для наднадійного фіксування та захисту від руйнування насипів під залізничною колією.

****BALFOUR Beatty Rail Projects*** has developed a new design of fully-supported embedded rail slab track that does not rely on being supported by either sleepers or base plates. It is called ***Balfour Beatty Embedded Slab Track* (*BBEST*)**

******Vignole rail*** – широкопідошовна рейка

Exercise 1

Answer the following questions.

1 What does simple ballasted track need in order to maintain track quality to modern standards? 2 What better ways to do this do you know? 3 What is the main cause of the need for track maintenance? 4 How can the track geometry be restored in such a case? 5 What are the disadvantages of tamping? 6 What are the two strategies to reduce the burden of maintaining ballast? 7 Why does the option to improve ballast have some attraction? 8 What interesting approach to ballast improvement has been demonstrated in Britain? Give detailed information about XiTrack. 9 Slab track is both expensive and cheap. Why? 10 Which of the most recent solutions concerning slab track can be considered a real alternative to conventional track? Speak about them. 11 What rails do most existing embedded rail installations use?

Exercise 2

Divide the text into parts and title each of them. Make a plan of this text and offer your topics for discussion.

Exercise 3

Match the words and word combinations in left column with their definitions in right column.

1) rheology	**a)** a rail with a broad rail flange
2) reluctant	**b)** a person, business firm that enters into contracts
3) deteriorate	**c)** smth difficult to carry; load
4) XiTrack	**d)** slow to act because unwilling or disinclined, offering resistance
5) burden	**e)** make or become of less value or worse in quality
6) Vignole rail	**f)** a science about the flowability of a substance
7) contractor	**g)** polyurethane system for super safe fixation and protection of ballast under the

track from deterioration

Exercise 4

Translate the following words and word combinations into Ukrainian.

Sophisticated equipment, to maintain track quality to modern standards, armoury of a modern railway, track relaying equipment, polymer reinforcement, complement of track machinery, deterioration of track geometry, the settlement of the substructure, to lead to loss of strength and stiffness in the ballast, the burden of maintaining ballast, GeoComposite treatment, a tailored visco-elastic polymer, the ballasted option, embedded rail technology, resilient blocks fixed around the rail, the factory pre-coated rail, high-performance microcellular polyurethanes, slip forming, grouting the assembly into the channels, to aid rail renewal.

Exercise 5

Group the following words into pairs of synonyms.

Maintain, realize, enhance, load, deterioration, unwillingness, increase, fasten, cause, burden, wear and tear, complement, alter, usual, fix, set, theoretical, customized, change, tailored, perceive, reluctance, reason, speculative, keep up, conventional.

Exercise 6

Translate into English.

1 Звичайна баластна колія потребує багато складного обладнання, робочої сили та навичок для підтримування її на рівні, який відповідає сучасним стандартам. 2 Звичайна колія мало змінилася за останні 150 років. 3 Більш не можливо обслуговувати колію вручну. 4 Безбаластна колія – це шлях змінити природу обслуговування колії. 5 Головна причина зносу конфігурації колії – це осідання ґрунту основи колії. 6 У цьому випадку конфігурація колії повинна бути відновлена підбиттям баласту. 7 Часте підбиття баласту, в остаточному підсумку, веде до втрати міцності та твердості. 8 Вибір щодо удосконалення баласту має деяку привабливість. 9 Деякі рішення, які стосуються колії з бетонним покриттям та вмурованими рейками, є реальною альтернативою звичайній

колії.

UNIT 5

AN ALTERNATIVE TO CONVENTIONAL BRIDGE SLEEPERS

Active vocabulary

indigenous – туземний, місцевий;
composite – складений, комбінований;
girder bridges – балочний міст;
fibre reinforced plastic – пластмаса, армована волокнами; волокніт;
ban – заборона;
fell – вирубувати, рубати, валити;
performance – функціонування, робота, ефективність; робоча характеристика, експлуатаційні дані;
life span – життєвий відрізок;
subject – зазнавати, піддаватися;
launch – запускати, розпочинати;
remote – віддалений;
adverse – несприятливий, шкідливий.

Pre-text discussion. What types of bridges do you know? What types of sleepers do you know? What kind of sleepers is the most appropriate for the use on girder bridges, conventional tracks, etc.? Do you know anything about innovations in the production of sleepers?

NEW FRP BRIDGE SLEEPERS LAST UP TO 50 YEARS

Indian Railways (IR) will soon be fitting new, indigenously-developed composite sleepers to hundreds of steel girder bridges throughout the country. The manufacturers, Permali Wallace, of Bhopal, see strong export potential for the fibre reinforced plastic (FRP) sleepers and plan to target Europe in a worldwide campaign.

Like many railways, IR traditionally used wooden sleepers on its steel girder bridges. They performed well over the years but then came a ban on tree felling in India because of environmental concerns. Steel sleepers were used as a replacement but these displayed a number of disadvantages.

Performance was not good in an environment subject to high levels of vibration, and insulation was also a problem. Although steel sleepers have a longer life span than wooden sleepers, they were difficult to handle and replace, generated very high levels of noise, and were subject to corrosion that had to be treated at regular intervals, thus pushing up maintenance costs considerably.

The Indian government and IR's Research, Design and Standards Organisation (RDSO) launched a project to develop an alternative to wooden and steel sleepers in 1997 and appointed Permali Wallace as its industrial partner. The company initially manufactured 12 FRP composite sleepers, which were dynamically tested in a laboratory for almost two million cycles representing a sleeper life of about 40 years under Indian traffic and operating conditions. They were found to be in perfect condition at the end of the tests.

Steel girder bridges in India are often located in remote areas with difficult access. The FRP sleeper weighs 54kg, compared with a weight of between 100 and 171kg for a wooden sleeper and 110kg for a steel sleeper. This makes the FRP sleeper easier to transport and handle.

Other major advantages are a life of up to 50 years, compared with

up to 10 years for wooden sleepers and up to 20 years for steel sleepers; zero maintenance because FRP is corrosion free and unaffected by adverse environmental conditions and ultraviolet rays. These are among the factors that also give the FRP sleeper the lowest life-cycle cost.

SLEEPER COMPARISON			
Property	**Wooden**	**Steel**	**FRP**
Durability (years)	8-10	15-20	40-50
Weight (kg)	100-171	110	54
Replaceability	Easy	Difficult	Easy
Maintenance	High	High	Nil
Suitability for track-circuited areas	Suitable	Not suitable	Suitable
Handling	Not so easy	Difficult	Easy
Vibration damping	High	Low	High
Noise generation	Low	Very high	Low
Water absorption	High	Low	Low
Wetting & drying	High	Causes	No effect
Rail fixtures	Few	Many	Few
Dimensional	Poor	Good	Very good
Cost/sleeper	Low	High	High
Life-cycle cost	Low	High	Lowest

Exercise 1

Answer the following questions.

1 What will Indian Railways (IR) soon be fitting to hundreds of steel girder bridges? 2 What do the manufacturers see strong export potential for? 3 What sleepers were traditionally used on steel girder bridges? 4 What made IR think about a new option? 5 What disadvantages were displayed by steel sleepers? 6 What are the advantages of FRP sleeper?

Exercise 2

Look through the table presented in the text very carefully and speak about the advantages and disadvantages of each kind of

sleepers. Think about the possibility of using FRP sleepers on our Ukrainian railways.

Exercise 3
Group the following words and word combinations into pairs of synonyms.
Girder, tie, commence, reinforced, lifetime, sleeper, armoured, fell, unfavorable, performance, life span, distant, subject (*v*), chop down, considerably, beam, launch, composite, efficiency, significantly, remote, expose, complex, adverse.

Exercise 4
True or false. If some sentences are false, change then according to the text.
1 IR will soon be fitting new kind of steel sleepers to arch bridges. 2 The manufacturers see strong export potential for the fibre reinforced concrete sleepers. 3 IR traditionally used wooden sleepers on its girder bridges. 4 Steel sleepers have the same life span as wooden sleepers. 5 FRP composite sleepers were found to be in perfect condition at the end of the tests. 6 Heavy weight of FRP sleeper makes it easier to transport and handle. 7 FRP composite sleepers have no advantages in the comparison with the other kinds of sleepers.

Exercise 5
Translate the following sentences into English.
1 Індійські залізниці скоро будуть встановлювати комбіновані шпали на балочні мости. 2 Виробники бачать сильний експортний потенціал для шпал, вироблених з пластмаси, армованої волокнами. 3 Індійські залізниці традиційно використовували дерев'яні шпали, але після заборони валити дерева вони замінили їх на сталеві. 4 Незважаючи на довший життєвий відрізок, сталеві шпали мають цілий ряд недоліків: вони піддаються корозії, їх важко транспортувати та вони генерують дуже високий рівень шуму. 5 Наприкінці випробувань комбіновані шпали, вироблені з пластмаси, армованої волокнами, були у ідеальному стані. 6 Такі шпали

мають ряд переваг: легка вага, довгий життєвий відрізок та ніякого технічного обслуговування.

UNIT 6

CONTINUOUS WELDED RAILS IN TURNOUTS

Active vocabulary

clickety-clack – перестукування;
impose – накладати;
impact load – ударне навантаження;
yard – станційний парк;
translate – трансформувати;
tensile force – сила розтягання;
track buckling – жолоблення колії;
cross-section – поперечний переріз, профіль;
tight tolerance – жорсткий допуск;
track alignment – виправлення колії;
switch blade – гостряк виличного переводу;
frog – хрестовина (виличного переводу);
distortion – викривлення, перекошування;
through track – головна, магістральна колія;
diverting track – відвідна колія;
contract – стискатися;
distort – деформуватися, викривлятися;
switch layout – виличний перевід;
diamond crossing – глуха хрестовина;
crossover – виличний з'їзд;
ambient temperature – температура навколишнього середовища;
feasible – реальний, вірогідний.

Pre-text discussion. What is CWR? What do you know about CWR? Where do you think it must be applied?

CWR GAINS FAVOUR IN TURNOUTS

Continuous welded rail (CWR) has been used in some European countries since the early 1960s. One of its most noticeable effects—for passengers at least—is the elimination of the characteristic clickety-clack sound as the train crosses rail joints.

It's not just about the elimination of noise, though jointed track imposes significant impact loads on the permanent way, as well as rolling stock. The elimination of these impact loads cuts noise, increases passenger comfort, and significantly reduces the damage to track and trains, with subsequent reduction of maintenance costs. Most main lines in Europe are constructed with CWR, but in yards, use of CWR is a relative novelty and needs special attention.

With CWR, rail movement cannot occur as the rail is, in theory, endless. Any temperature change of the rail due to the combination of air temperature and sunshine is translated into forces in the rail: tensile forces with low temperatures and compressive forces with high temperatures. To prevent track buckling at high temperatures, and rail breakages at low temperatures, the rail is made continuous at a defined neutral temperature. At this temperature, no tensile or compressive stress is present in the rail: the neutral temperature is sometimes referred to as the stress-free temperature. The correct definition of the neutral temperature is a function of the minimum and maximum rail temperatures that can be expected and varies in different countries.

In addition to the neutral temperature, measures are taken to prevent track buckling by adopting a larger cross-section for the ballast profile and tighter tolerances for the track alignment. In practice of course, the rail is not endless, and transitions to long-span bridges and viaducts, as well as transitions to jointed track, need extra attention.

CWR is not normally continued into complex areas with many switches and crossings, as correct construction and renewal of CWR at complex switch layouts can be a difficult task. Especially with the

renewal of switch components such as the switch blade or the frog, construction time increases by up to 50% as not only must the welds be made, but also, the rails have to be brought to the correct neutral temperature. Increasing noise legislation in Europe means that use of CWR in switches is becoming more attractive, despite the extra construction time involved. This means that a switch has to be considered as a single element. In order to prevent distortion of the track alignment due to axial forces imposed by using CWR, the combined forces generated by CWR have to be as close as possible to the longitudinal direction of the through track. In cases where only the straight track through the switch is CWR, the resulting force is nil, so there is no risk the switch will displace due to lateral CWR forces. But if both straight track and the diverting track are CWR, there is a resulting force in the switch angle.

When a switch has to be connected with CWR, the switch itself has to be jointless as well. Normally, joints in switches use thermit welds, but construction of these causes difficulties when welding a switch.

For construction of a thermit weld, a joint of 20-25mm is needed and the adjacent rails need to be preheated. The preheating temperature is about 900°C. Approximately 1m of rail next to the joint is affected by this, which results in an expansion of both rail ends of 1.5-2.5mm. The joint for the weld is narrowed to 15-20mm. When the thermit weld mixture flows in the gap, the rail ends initially do not cool down, because the temperature is 2200°C.

When the rail ends eventually do cool down, the weld has already reached a tensile strength enough to withstand the pulling force of the rail end, which wants to contract. The rail is 3-5mm shorter after making the thermit weld. This phenomenon causes severe problems in welding a switch together.

A triangle can be found in every type of switch. In a common switch, this triangle is formed by the two rails between the crossing and the switch blades. The sleepers are at the base of the triangle.

When the thermit welds in these rails are not made simultaneously, triangle is distorted and this can result in severe problems, especially in complex switch layouts at yards. A good welding plan is therefore a necessity to guarantee good alignment of switches, diamond crossings, and intersecting crossovers. Constructing CWR is not

limited to making welds, as the correct neutral temperature has to be obtained. Heating switches to get the proper neutral temperature is not applicable, neither is hydraulic lengthening. Therefore use has to be made of the ambient temperature.

The points to pay attention to are:

• avoid problems with daily temperature changes between day and night when welding several switches together; in spring or autumn the daily temperature change is limited to approximately 20°C, so temporarily a joint every 100m is enough, and

• the closing thermit welds have to be made at a rail temperature of 25°C.

Elimination of rail joints in yards has great advantages for noise and maintenance reduction and improves passenger comfort.

Although the maintenance needs overall decreases, the time for renewal activities increases as rail welding and stressing activities are necessary increases. Though technically demanding, the growing trend for lengthy occupations and 'big bang' remodeling schemes makes implementation of CWR in switches and crossings more feasible, both in financial and engineering terms.

Exercise 1

Answer the following questions.

1 Since what time has CWR been used in some countries of Europe? 2 What are the most noticeable effects of tracks using CWR? 3 Why is it necessary to make the rail continuous at a defined neutral temperature? 4 What is the neutral temperature sometimes referred to? 5 What other measures are taken to prevent track buckling? 6 Why isn't CWR normally used in complex areas with many switches? 7 What tells for the fact that use of CWR in switches is becoming more attractive? 8 What condition has to be fulfilled to prevent distortion of the track alignment due to axial forces imposed by using CWR? 9 Is a good welding plan a necessity to guarantee good alignment of switches, diamond crossings and intersecting crossovers? 10 What are the points to pay attention to?

Exercise 2

Group the following words and word combinations into pairs of synonyms.

Continuous, removal, elimination, kind, impact, assure, extra, regulation, distortion, additional, alignment, shock, practicable, through track, nonstop, decrease, type, guarantee, main line, reduction, deformation, feasible.

Exercise 3

Translate the following word combinations from Ukrainian into English.

Безстикова колія, характерне перестукування, помітний ефект, усунення ударного навантаження, зміна температури рейки, сила розтягання, обумовлена нейтральна температура, вільна від напруження температура, відрізнятись у різних країнах, жорсткий допуск для виправлення колії, відновлення частин виличного переводу, завдяки осьовій силі, поздовжній напрямок магістральної колії, зварювання виличного переводу, охолодження кінців рейок, витримувати тягнуче зусилля кінця рейки, робити термітне зварювання одночасно, усунення рейкових стиків у станційних парках.

Exercise 4

True or false. If some sentences are false, change then according to the text.

1 One most noticeable effects of CWR is the elimination of the characteristic clickety-clack sound as the train crosses rail joints. 2 Jointed track does not impose significant impact loads on the permanent way, as well as rolling stock. 3 Most main lines in Europe are constructed with CWR. 4 With CWR, rail movement occurs as the rail, in theory, is not endless. 5 To prevent track buckling at high temperatures, and rail breakages at low temperatures, the rail is made continuous at a defined temperature. 6 The correct definition of the neutral temperature varies in different countries. 7 CWR is normally

continued into complex areas with many switches and crossings. 8 Increasing noise legislation in Europe means that use of CWR in switches is becoming more attractive. 9 Normally, joints in switches use arc welds, but construction of these causes difficulties when welding a switch. 10 Heating switches to get the proper neutral temperature is applicable, as well as hydraulic lengthening.

Exercise 5
Write an annotation to the text.

UNIT 7

A NEW TYPE OF A BALLASTLESS TRACK SYSTEM

Active vocabulary

anchorage – анкераж, кріплення;
height tolerance – допущення висоти;
crucial – рішучий, ключовий;
intrinsic – власний;
displacement – деформація, зсув;
overturning moment – перекидальний момент;
mortar – будівельний / вапняний чамур;
interstice – проміжок, щілина;
recess – заглиблення, виїм;
cant – нахил, скіс.

MODIFICATIONS TO GETRAC BALLASTLESS TRACK APPROVED

Getrac is a ballastless track system consisting of rails and concrete sleepers whereby the track panel is directly supported by asphalt. The track panels are connected to the asphalt layer by positive-fit anchorage, but can be removed from the asphalt as required. Accuracy

of the individual components, from the bottom up, is critical. The height tolerances of the sleepers and the asphalt layer are especially crucial for the exactness of the track position.

There are two types of Getrac: Al and A3. Getrac A1 consists of normal-width sleepers, whereas Getrac A3 has wide sleepers. A so-called anchor block secures the sleepers to the asphalt in order to assure sufficiently strong fastening of the track panel in longitudinal and lateral directions.

The use of Getrac on operational lines belonging to German Rail (DB) has confirmed its engineering suitability. Up to now, there has been no negative experience or observations made on its operational behaviour. The application of Getrac as a permanent ballastless track system is unrestricted. These positive experiences have enabled the layer thicknesses and widths to be optimised, and Getrac to be adapted to various subgrade conditions.

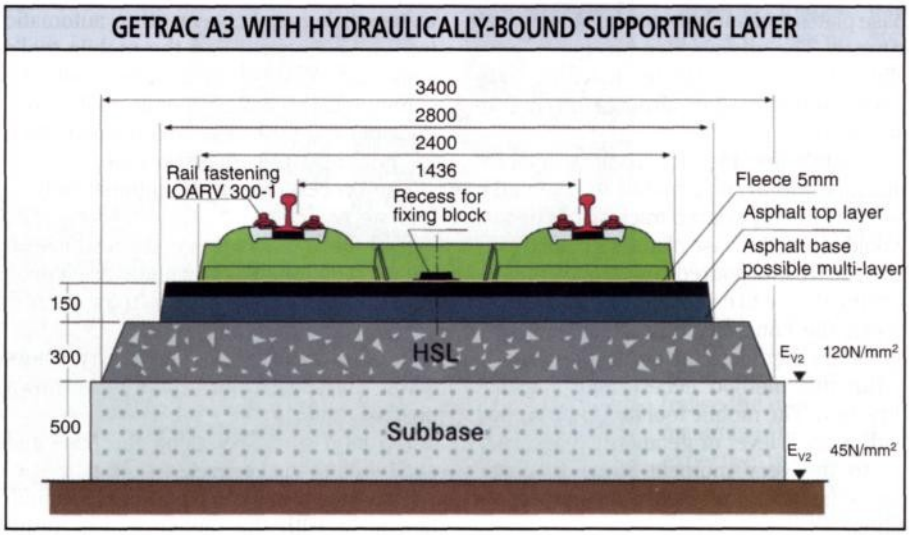
The essential difference between the Getrac A1 and Getrac A3 is the type of prestressed concrete sleepers used.

One advantage of the sleeper, used by Getrac A3, is its larger bearing surface, with consequently a more uniform load distribution on the ballastless track system, and with reduced unit contact pressure between the sleeper and the asphalt. Another advantage is that these wide sleepers almost completely cover the asphalt surface. As a result, single-track tunnels can be converted to ballastless track in configurations that allow only relatively low and narrow ballastless track structures.

The high intrinsic weight of the wide sleeper, almost double that of a normal sleeper, is associated with greater longitudinal and lateral displacement forces. This greater weight has the advantage that the broad bearing surface provides greater overturning moment with respect to the longitudinal forces that are introduced out of the rail into the sleeper.

To ensure track-position stability, anchor blocks enable elastic fastening of the track panel to the asphalt layer. The Neoprene support layer installed between the anchor blocks and the sleepers allows vertical movements between the track panel and the supporting layer. Elastomer layers elastically support horizontal forces longitudinally and laterally to the track axis. The technology implemented in this anchorage of the sleepers to the asphalt layers results in great system

stability, even under dynamic loads applied to the tracks. Measurements conducted on tracks in service have disclosed that the fastening of every third sleeper with an anchor block is sufficient, provided the blocks are designed to transmit lateral and longitudinal track forces into the asphalt layer satisfactorily. The recent approvals of these systems have already taken these conditions into account.
The circular anchor blocks are fitted in the sleeper factory with their Neoprene support layers, and are attached to their respective sleepers with a safety strip so that they cannot be lost. After the sleepers have been laid and the rails installed, the track panel is aligned and placed into its final position. A moisture-insensitive quick-hardening mortar is poured to seal the interstice between the anchor block and the recesses provided in the asphalt layer. This permanently fixes the sleeper to the asphalt.



Getrac has the following advantages:
• use of asphalt as easily worked, permanent supporting-layer material, with the possibility of providing track cant of up to 180mm
• almost immediate availability of the track after installation
• support of rails on prestressed concrete sleepers
• long-term maintenance of track geometry as a result of elastic fastening of the track panel to the asphalt layer by means of an intermediate elastomer layer
• rapid installation because of fewer work steps, a high degree of mechanisation, use of conventional road and track construction equipment (with conventional laying and alignment techniques), and installation independent of the weather

• great resistance to lateral and longitudinal shifting
• long life cycles, with low maintenance costs, and
• rapid restoration of tracks to service after train accidents.

The design of the original Getrac A1 and Getrac A3 systems has been further enhanced, primarily to improve their permanence and cost effectiveness. On the other hand, no restrictions would be introduced for a particular speed range or in the form of axleload limitations.

Exercise 1

Answer the following questions.

1 What is Getrac? 2 How many types of Getrac do you know? 3 What is the difference between them? 4 What are the advantages of the sleepers, used by Getrac A3? 5 What do anchor blocks enable to ensure track –position stability? 6 What layers are used in the system? 7 What is to be done in the sleeper factory with the circular anchor blocks so that they cannot be lost? 8 What is done to fix the sleeper to the asphalt? 9 What are the advantages of Getrac?

Exercise 2

Translate the following words and word combinations from English into Ukrainian.

Ballastless track system, asphalt layer, positive-fit anchorage, the height tolerances of the sleepers, the exactness of the track position, longitudinal and lateral directions, engineering suitability, operational behaviour, pre-stressed concrete sleepers, single-track tunnels, intrinsic weight, overturning moment, elastic fastening, dynamic loads, quick-hardening mortar, interstice, long-term maintenance, lateral and longitudinal shifting, restoration of tracks.

Exercise 3

Fill in the gaps with the words given in the box.

intrinsic; vertical movements; normal-width; prestressed; wide; bearing; ballastless; longitudinal and lateral; asphalt; horizontal forces; critical; components

1 GETRAC is a …. track system consisting of rails and concrete sleepers whereby the track panel is directly supported by … . 2 Accuracy of the individual … , from the bottom up, is … . 3 Getrac A1 consists of … sleepers, whereas Getrac A3 has … sleepers. 4 The essential difference between the Getrac A1 and Getrac A3 is the type of … concrete sleepers used. 5 One advantage of the sleeper, used by Getrac A3, is its larger … surface. 6 The high … weight of the wide sleeper is associated with greater … displacement forces. 7 The Neoprene support layer allows … between the track panel and the supporting layer. 8 Elastomer layers elastically support … longitudinally and laterally to the track axis.

Exercise 4

Match the words with their definitions.

1	Getrac	**a)** the act of displacing or the condition of being displaced
2	anchorage	**b)** something that fastens, such as a clasp or lock
3	crutial	**c)** one of the blocks supporting the rails on a railway track
4	intrinsic	**d)** something that supplies a secure hold for something else
5	displacement	**e)** a mixture of cement or lime or both with sand and water, used as a bond between bricks or stones or as a covering on a wall
6	vertical	**f)** very important
7	horizontal	**g)** a minute opening or crevice between things
8	fastening	**h)** parallel to the plane of the horizon; level; flat
9	sleeper	**i)** of or relating to the essential nature of a thing; inherent
10	mortar	**j)** at right angles to the horizon; perpendicular; upright
11	interstice	**k)** the ballastless track system on asphalt

Exercise 5

Project.

Find some additional information about Getrac and present it to your group-mates.

UNIT 8

A NEW DEVICE SPEEDS UP SLABTRACK INASTALLATION

Active vocabulary

pin – штифт, прогонич;
inserter – пристрій для вставлення;
casting – виливання;
shuttering – палуб;
provisional – тимчасовий;
support – опора;
base plate – опорна плита, підкладка;
slip-form – ковзний;
definitive – визначений, остаточний;
runway – злітна смуга;
controller – регулятор;
traffic load – навантаження від транспортних засобів;
surfacing materials – наплавочні матеріали;
feasible – придатний;
mast – стовп, щогла.

APPITRACK SPEEDS UP SLABTRACK INASTALLATION

APPITRACK, which stands for Automatic Plate and Pin Inserter for Trackwork, has been patented by Alstom. In developing Appitrack, Alstom took advantage of new developments in the automation of concrete erection. Appitrack integrates the processes of casting slab-track and laying track, with the result that Appitrack can lay track four times faster than traditional manual techniques.

About 40m of concrete slab track can be laid per day using traditional top-down track construction. This is due to the numerous preparations that must be carried out. These include positioning, adjusting and checking of shuttering, and installation of provisional supports. After concreting, which fixes the position of the rail base

plates and anchors, the provisional supports must be removed and the remaining holes filled.

Using a slip-form concreting machine would eliminate all these operations as well as prepare a definitive track slab into which base plates and anchors can be inserted accurately. The original idea was to employ a slip-form concrete-laying machine normally used in road or airport runway construction.

Alstom's first idea for using a slip-form machine was to run a mobile tool behind it over the freshly poured track slab. The tool would insert the base plates and fixing pins into the freshly poured concrete using a vibrating device to establish good contact between the concrete, base plate and pins, and to fix them into the correct position.

But this method necessitated constant direction. The mobile tool had to be guided with a good level of geometrical accuracy up to the very moment when the base plates and anchors reached the correct position.

The problem prompted the second idea: to divide the process into two operations, one for rapid but not accurate placement, and the second for adjustment and definitive placement. The challenge was to establish the reference for correct placement and then to transmit it to the mobile tool and its position-adjustment device.

The answer was an automatic topographic station that could be combined with the controller for the mobile tool. The automatic topographic station would be able to define the position of the base plate and fixing pins held in the mobile tool's inserting head. The difference between the target position and the correct position could therefore be calculated in an automatic dialogue between the automatic topographic station and the mobile tool's controller. Finally, the results would be communicated to the mobile tool's position-adjustment device, which would then fix the proper placement position.

The process continues automatically in four steps:

- the mobile tool moves to the next inserting position for an approximate placement
- the inserting head moves to the correct position up to the concrete
- the tool inserts the base and anchors with a vibrating stroke, up to the final down position, and
- vibration stops, releasing the base and anchors into the concrete.

Two base plates can be processed simultaneously, with the mobile tool assuring their relative position.

When first demonstrated in France, Appitrack showed that it was

able to match any kind of rail, base plate and fastening in a direct-fixation system. It also met the requirements for traffic load, geometrical accuracy of track, and the use of any kind of track surfacing materials such as grass, stone, or bituminous concrete. Alstom says Appitrack conformed to environmental rules on noise and vibration damping, and suspended slab has been erected easily using slip-form. Appitrack also reduced the duration of trackwork with a resulting reduction in construction costs.

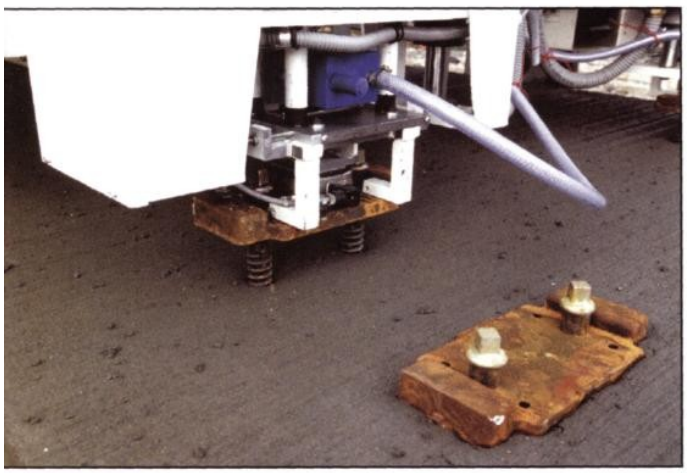
Other benefits include the flexibility of the process. Alstom says Appitrack makes it easy to construct track in a discontinuous line when earthwork progress or road-traffic requirements do not allow a continuous process. It is also easy to go back and forth and to construct track section by section, due to the fact that the slip-form and the mobile inserting machines can easily be referenced on the line layout by the automatic topographic stations. The automation of the construction process reduces non-quality occurrences, due to the continuous checking of the position of the base plates by the topographic stations. Alstom estimates that by using Appitrack, track

construction companies would be able to reduce total track-construction duration by at least 30%.

Rear view of Appitrack showing the automatic baseplate inserting machine. The slip-form paving machine is at the front.

Now Alstom is developing a new machine, which will be faster, more reliable, and lighter than the original machine and which is feasible for use in light rail projects. The original machine was a multi-plate machine, but this made it very heavy. There are a lot of interfaces with things such as drains and electrification masts when laying light rail track in a city. It is also very difficult to provide long lengths of track at a time on a light rail project. For these reasons, a lighter machine that can be easily moved from site to site and which is more manoeuvrable is necessary.

The new machine will be suitable for use on light rail and metro projects, but Alstom will probably need a different machine for mainline railway applications.



Close-up of Appitrack inserting baseplates into the concrete slab.

Exercise 1

Answer the following questions.

1 What is Appitrack? 2 What processes does Appitrack integrate? 3 What is the difference between the traditional topdown track construction and that one offered by Alstom? 4 What was Alstom's first idea for using a slip-form machine? 5 What would this tool do? 6 Why did this method necessitate constant direction? 7 What was the second idea prompted by the problem? 8 What was the answer to the problem? 9 How many steps does the process contain? 10 What advantages did Appitrack show when first demonstrated? 11 Is this machine feasible for the use in all rail projects?

Exercise 2

Translate the following words and word combinations from Ukrainian into English.

Що означає…; використовувати щось у своїх інтересах; виливання бетонного покриття; традиційні ручні методи; перевірка палубу; тимчасова опора; рейкова підкладка; ковзна машина для бетонування; мобільне знаряддя; вібрувальний пристрій; встановлювати контакт; геометрична точність; підказувати ідею; пристрій, який регулює положення; автоматична топографічна станція; регулятор мобільного знаряддя; вимоги до навантаження від транспортних засобів; екологічні норми; колійні наплавочні матеріали; уривчаста лінія; скоротити тривалість будівництва на…; більш маневрений.

Exercise 3

Group the following words into pairs of synonyms.

Stand for, temporary, traditional, movable, construction, steady, position, landing strip, provisional, exact, runway, mean, mobile, nonstop, device, conventional, correct, regulator, constant, building, controller, placement, continuous, mechanism.

Exercise 4

Complete the sentences with the words and word combinations from the box, given below.

positioning, traditional, prompted, stands for, concrete slab track, slip-form machine, shuttering, adjusting, provisional, noise and vibration damping, base plates, fixing pins, match, fastening, dis-continuous, took advantage of, conformed, suspended slab, mobile tool.

1 Appitrack … Automatic Plate and Pin Inserter for Trackwork. 2 Alstom … new developments in the automation of concrete erection. 3 About 40m of … can be laid per day using … top-down track construction. 4 Numerous preparations include…, … and checking of …, and installation of … supports. 5 Alstom's first idea for using a … was to run a … behind it over the freshly poured track slab. 6 The tool would insert the … and … into the freshly poured concrete. 7 The

problem … the second idea: to divide the process into two operations. 8 Appitrack showed that it was able to … any kind of rail, base plate and … in a direct-fixation system. 9 Appitrack … to environmental rules on …, and … has been erected easily using slip-form. 10 Appitrack makes it easy to construct track in a … line.

Exercise 5 Project.
Find in the Internet (or use any other source) some information about Appitrack today. What are their goals, developments and achievements? Speak about the advantages and disadvantages of Appitrack. Think if we can use this machine in our country. If not, offer your own variant of such machine.

UNIT 8

THE TRIAL OF A BALLASTLESS TRACK

Active vocabulary

to occur – виникати, з'являтися;
objective – ціль, завдання;
pilot project – пробний / дослідний проект;
civil engineering – громадське будівництво;
track specifications – технічні умови;
implementation – реалізація; уведення в експлуатацію;
trial – випробування;
undertaking – гарантія;
requirement – вимога;
subsoil – грунт;
sufficient foundations – достатні підстави;
continuously welded track – безстикова колія;
residual – залишковий;
residual deviations – залишкові відхилення;
rainwater drainage – дренаж (стік) дощової води;
vibration emission – випромінювання вібрації;
noise emission – випромінювання шуму;
track gauge – ширина колії;

inclination – ухил;
corrugation – хвилястість, рифлення;
reprofiling – перепрофілювання;
grinding – притирання, шліфування;
train safety system – система безпеки поїздів;
passing sections – перехідні / обгінні ділянки;
thermit weld – зварювання термітне;
axleload – навантаження на вісь;
discrete support – переривчаста підтримка;
flange decarbonisation – зневуглецювання гребня колеса / підошви рейки;
unevenness – нерівність;
penetration – проникнення;
to be sealed hermetically – бути зачиненим герметично.

NS* TO START BALLASTLESS TRACKS TRIALS NEXT MONTH

Slab track offers demonstrable benefits compared with ballasted track in terms of maintenance. It is known in particular tat problems with the ballast bed can occur where trains operate at speeds above 250 km/h. The objective of the Best project is to gather data concerning constructing methods and costs as well as the performance of the concrete slab track with embedded rails.
The pilot project has been divided into two phases. The civil engineering part covers the production of track specifications, the design of the foundations, the construction of the concrete slab, the implementation method, and the tracklaying schedule. The trial phase comprises the measurement programme to obtain civil engineering information. This will include vibration measurements and the noise measurements under NS' quieter traffic (STV) project.
The contract provider for the Best project is NS's Railinfrabeheer (RIB) System Development. In discussion with RIB project centre, it was decided to incorporate the 3km slab section within the existing project to expand from two to four tracks the Boxtel-Eindhoven section of line in the Best district.
Since the contract provider had most of the knowledge in the field of non-ballasted track systems, a design team was created jointly to

translate the functional specifications into technical specifications. The design team is also involved in determining the method of implementation and in undertaking the civil engineering measurements.
In the design of the Best slab track, sleepers and fastenings have not been used. It was decided instead to use the superstructure system with embedded rails which was developed by NS and has been in use for 25 years on its main lines.
When the ballast bed, the sleepers, and the fastenings are removed, their functions must be taken over by the slab track. Therefore, the design must tack into account the following functional requirements:
~ local settlement in the subsoil must remain limited and geometric corrections must be possible, unless it can be demonstrated that this is not necessary because, for example, there are already sufficient foundations for the concrete slab
~ forces from continuously welded track and forces exerted by train traffic must be transferred to the subsoil without residual geometric deviations occurring
~ construction of rainwater drainage must be included
~ under train loading, the track must have a vertical compression of between 1.5 and 2 mm
~ vibration emission to adjacent housing should not be greater than that of ballasted track
~ noise emission should not be greater than that of ballasted track with concrete sleepers
~ the embedding medium for the rails must be sufficiently strong to take up the forces from continuously welded track and from train braking
~ the rails must be electrically insulated in the concrete slab so that the track has an insulation value of at least 50 km
~ the track gauge, the direction, the level, and the inclination of the rail (1:40) must be achieved with sufficient accuracy and it must be possible to preserve this accuracy
~ it must be possible to build in, maintain, and replace special elements such as insulated joints and expansion joints without problems
~ the shape of embedding must take it possible to undertake rail maintenance, including removal of rail corrugation and reprofiling by grinding

~ connection of the cables to the rails must be possible
~ the existing train safety system must also be able to operate on slab track, and
~ in the event of a disaster, it must be possible to establish passing sections quickly and to make thermit welds.
In general, slab track with embedded rails is suitable for track which is operated by high speed trains with heavy axleloads. Although there is no indication that the embedded rail design would function less well at higher traffic speeds, there is also no absolute certainty that this is the case.
There has not yet been any opportunity to test the performance of the embedded rail at high speed in practical trials, though laboratory tests have shown it should be satisfactory for train operation up to 250 km/h.
NS' experience over many years with various types of non-ballasted track meant that a number of additional design criteria could also be set for the Best track. NS had built a test track previously at Deurne, and it was apparent from this that a concrete slab track composed of pre-fabricated elements would be too expensive.
This is due to the manufacturing methods, employing expensive dimensionally-stable moulds, and also to the cost of the extremely accurate tracklaying method.
The requirement for the Best pilot project was therefore to produce the concrete slab by a continuous pouring method. The track must be suitable for rail traffic with axleloads of 22.5 tonnes at a speed of 300 km/h.
It must be assumed that all elasticity in the track is supplied by the elastic embedment of the rails. Calculation has helped to confirm that the occurrence of rail corrugation is dependent on a number of factors. NS has found that three of these factors together have a major influence, and that, with a correct choice, the occurrence of rail corrugation can be delayed significantly.
The three key choices which have been made are to provide continuous support of the rails rather then discrete support, to introduce proper elasticity in the track, and to carry out preventive grinding of the rails to remove flange decarbonisation as well as any uneveness of the rail head.
Results obtained from the slab track tested in Deurne and data from various steel and concrete bridges show that rail corrugation starts to occur after 17 years.

It has been determined by NS that track elasticity which allows a vertical displacement of 1,5 to 2mm in non-ballasted track often produces problems within 10 years. Wear occurs rather quickly between the parts which move in relation to each other. Additionally, in wet conditions the elastic layers often produce problems in the form of a pump action which damages the surface of the concrete.

Therefore, NS' standard track construction must meet certain requirements in the area of elasticity. The wear on various track elements must be reduced by ensuring that the movements in non-ballasted track take place internally within the elastic material. This means that the elastic material must be attached to both surfaces, introduced between them by means of vulcanisation or some similar method.

To prevent penetration by water and dirt, the construction must have such an open nature that the wind is able quickly to dry all components and remove dry dirt rapidly. Alternatively, it can be sealed hermetically to prevent invasion by water or dirt.

Construction with embedded rails meets these requirements. It appears to be a form of construction which is easy to design and implement. However, this appearance is highly deceptive.

In particular, it has taken many years of development to meet the requirements set in the areas of compression, force absorption, and permanent hermetic sealing against rainwater. The construction work itself must also be undertaken in diverse weather and within the available track possession times.

**NS* - Norfolk Southern

Exercise 1
Make up 10 questions to the text and answer them.

Exercise 2
Give English equivalents to the following Ukrainian words and word-combinations.

Безбаластна колія, колія з бетонним покриттям, пробний проект, грамадське будівництво, ціль проекта, технічні умови колії, розподілятися на дві фази, випробна фаза, функціональні вимоги, геометричні корекції, достатні підстави, безстикова колія, стік дощової води, випромінювання вібрації та шуму,

ширина колії, система безпеки поїздів, обгінні ділянки, зварювання термітне, вода та бруд.

Exercise 3

Read and translate the following confirmations. Think whether they are true or not (read the text attentively). If not, give the right variant.

1 Slab track offers demonstrable benefits compared with ballasted track.
2 The objective of the Best project is to gather data concerning construction methods and costs as well as the improvement of ballasted track.
3 In the design of the Best slab track, sleepers and fastenings have not been used.
4 One of the functional requirements of the construction of slab track is that the construction of rainwater drainage must be included.
5 In general, slab track is not suitable for track which is operated by high-speed train or trains with heavy axle loads.
6 The other requirement for the Best pilot project was to produce the concrete slab by a continuous pouring method.
7 To prevent penetration by water and dirt, the construction must have closed structure.

Exercise 4

Work in pairs.

a) Discuss with your partner the advantages of concret slab of a non-ballasted track.

b) A: You are the representative of the firm, offering its own project of the railway track construction. Prove the necessity of the railway track construction with concret slab.

B: Prove the necessity of constructing the railway track with asphalt bed.

Exercise 5

Crossword. Find the hidden word. Words can be arranged in any direction, except bias.

ціль (o....)
грунт (s....)
ухил (i....)
шліфування (g....)

дренаж (d....)
ширина колії (g....)
зварювання (w....)
випромінювання (e....)
навантаження на вісь (a....)
вібрація (v....)
підошва рейки (f....)
безпека (s....)

O	S	S	O	E	M	I	S	S	I
B	U	B	I	I	N	C	L	I	O
J	E	C	L	V	I	B	R	N	N
D	R	T	G	G	I	T	A	A	T
I	A	I	R	N	O	S	A	F	I
N	A	V	I	I	N	Y	T	E	O
G	G	E	N	D	A	N	G	E	N
A	E	A	X	F	L	R	R	A	T
U	W	E	L	E	C	O	U	G	I
G	E	L	D	L	O	A	D	N	O

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