

Prefabricated Slab Track (PST) Solutions
by



yapiray



PREFABRICATED *Slab Track Systems*

In 2012, YapiRay developed the Panelray® prefabricated slab track (PST) system, which has its roots in the Italian IPA system. This was the first time the PST system was introduced. The following year, in 2013, the PST system was used for the first time in a track rehabilitation project for a 100 year old, 425 m tunnel in Çatalca, Istanbul. In this application, Panelray® PST was applied to a reinforced concrete pavement and connection was made with a 5 cm grout. The first version of Panelray® PST was reinforced by means of post-tensioned steel wires in both longitudinal and transverse directions.

As of 2023, Panelray PST provides many other solutions for various projects. Today, various types of Panelray® prefabricated slab tracks are available in different geometric dimensions and different reinforcement solutions.

- **Post-tensioned solution**
- **Steel reinforcement solution**
- **FRP reinforcement solution**

Besides the above, macro and micro synthetic reinforcement solutions are under development.

Panelray® PST can be implemented on two alternative concepts of base layers, the selection of which should be made in accordance with local conditions and project requirements. One of them consists of a non-shrinking grout application with a minimum thickness of 3 cm or a self-compacted concrete application with a minimum thickness of 8 cm.



The latter can also be considered as a pavement layer with a minimum thickness of 10 cm of self-compacted concrete in accordance with EN 16432, provided the reinforcement requirements of the code are satisfied.

Following its first application in Çatalca Tunnel, Panelray® prefabricated slab track system is applied on a 100 km line in the tunnels of the Ankara-Sivas HSL project, which started in 2018. In this project, a self-compacting concrete layer is formed under the prefabricated slabs which conventional steel reinforcement is used. Another Panelray® application was implemented in the rehabilitation of Bulgaria Koprivshtitsa-Stryma track in 2020 in tunnels with a length of 5.8 km. Panelray PST, which is also manufactured in accordance with the requirements of high-speed lines, will be applied in the Bandırma-Bursa-Yenişehir-Osmaneli High Standard Railway Project, currently under construction.

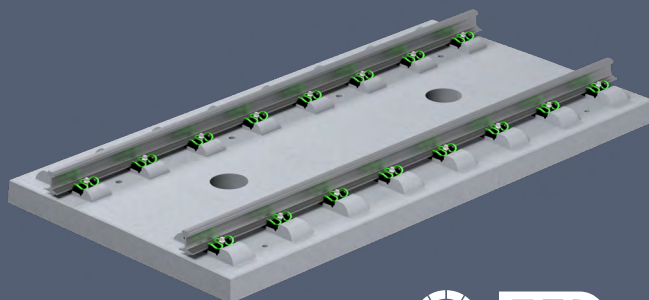
Prefabricated slab track solution for Metro projects, Panelray® PST-M, is specially manufactured for the requirements of Istanbul metro projects and used in Gayrettepe Istanbul Airport Metro Project and Halkalı Istanbul Airport Metro Project.

Panelray® PST utilizes the advantages of highly mechanized production, fast installation and reduced required workmanship. Compared to other track systems, Panelray® PST results in lower costs, requires only a small amount of wet concrete, and offers a higher level of safety. If necessary, solutions for noise and vibration can also be provided. Due to these advantages, Panelray® PST has proven its reliability and performance in various railroad projects with a length of more than 250 km around the world.



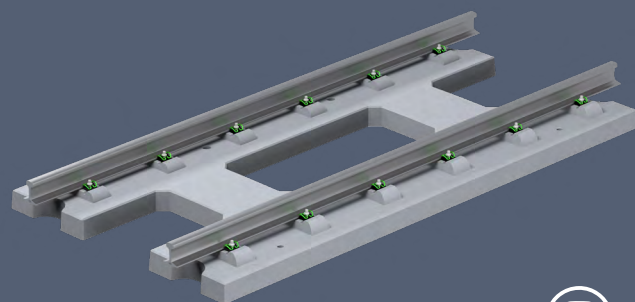
Panelray® PST- E 60

Thickness : 180 mm or 200 mm
Dimensions : 4,75 m x 2,50 m
Weight : 5,5 - 6,25 tonnes
Fastenings : Several options are available
 C50/60 Concrete according to EN 206
 Design according to EN 16432 series



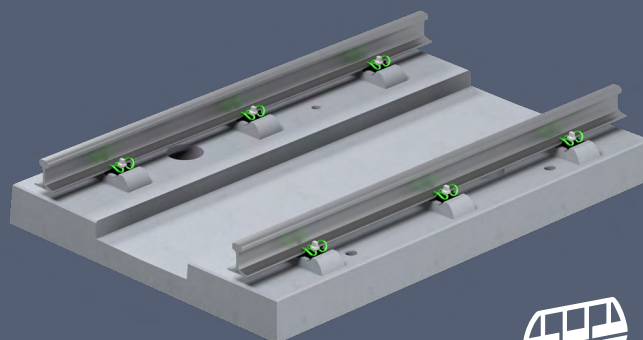
Panelray® PST- M

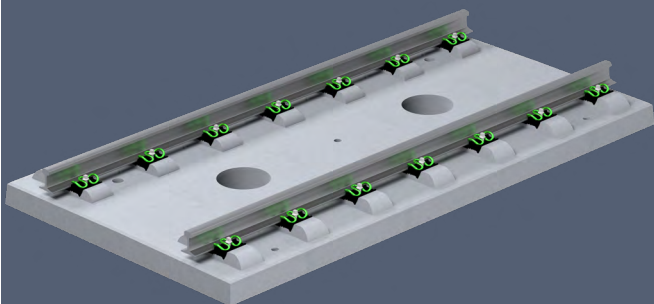
Thickness : 160 mm
Dimensions : 4,45 m x 2,30 m
Weight : 3,30 tonnes
Fastenings : Several options are available
 C50/60 Concrete according to EN 206
 Design according to EN 16432 series



Panelray® PST- F

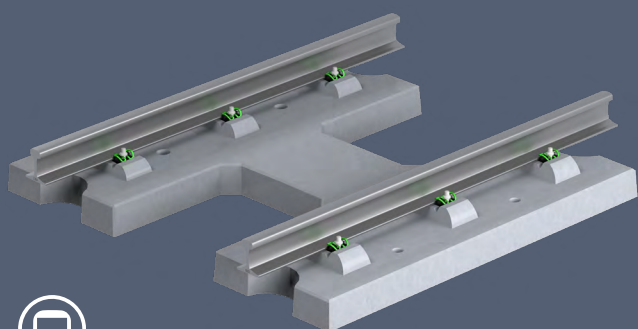
Thickness : 240 mm
Dimensions : 2,10 m x 2,95 m
Weight : 3 tonnes
Fastenings : Several options are available
 C50/60 Concrete according to EN 206
 Design according to EN 16432 series





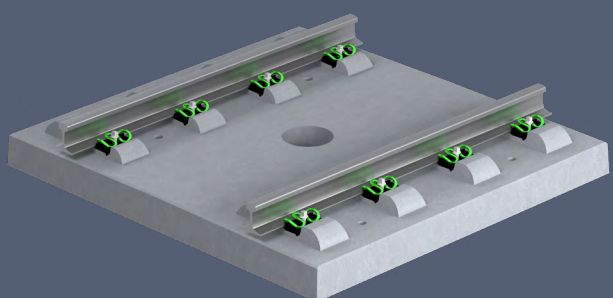
Thickness : 180 mm or 200 mm
Dimensions : 4,50 m x 2,40 m
Weight : 4,50 - 5,50 tonnes
Fastenings : Several options are available
 C50/60 Concrete according to EN 206
 Design according to EN 16432 series

Panelray® PST-E 65



Thickness : 160 mm
Dimensions : 1,90 m x 2,30 m
Weight : 2 - 3 tonnes
Fastenings : Several options are available
 C50/60 Concrete according to EN 206
 Design according to EN 16432 series

Panelray® PST-M Jr.



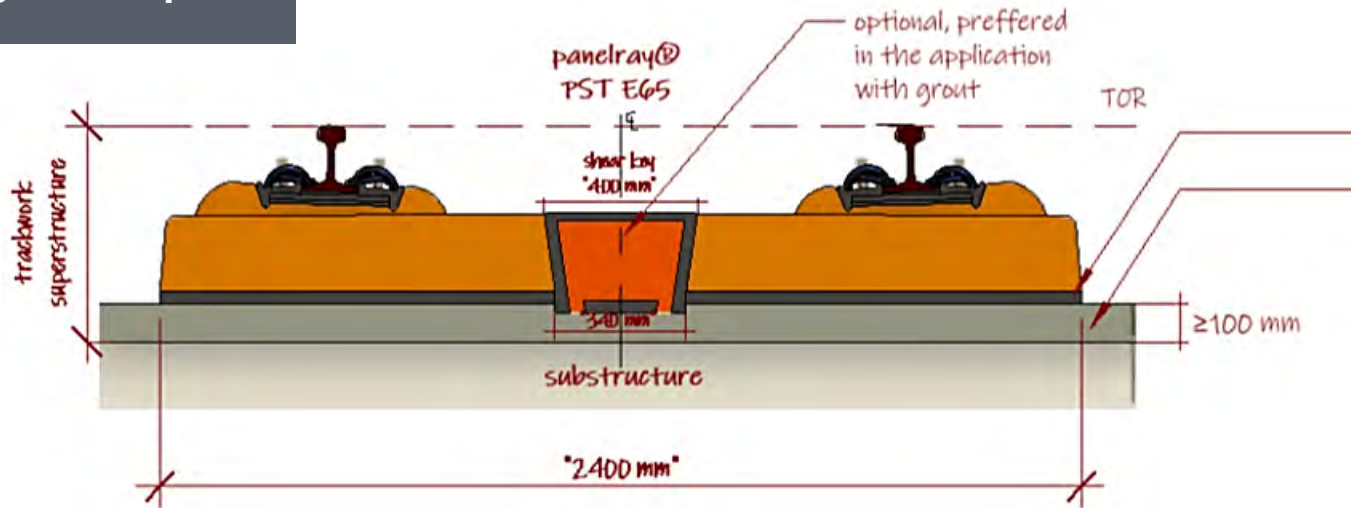
Thickness : 195 mm
Dimensions : 2,50 m x 2,35 m
Weight : 2 - 3 tonnes
Fastenings : Several options are available
 C50/60 Concrete according to EN 206
 Design according to EN 16432 series

Panelray® PST-Jr.

MAIN CONCEPT

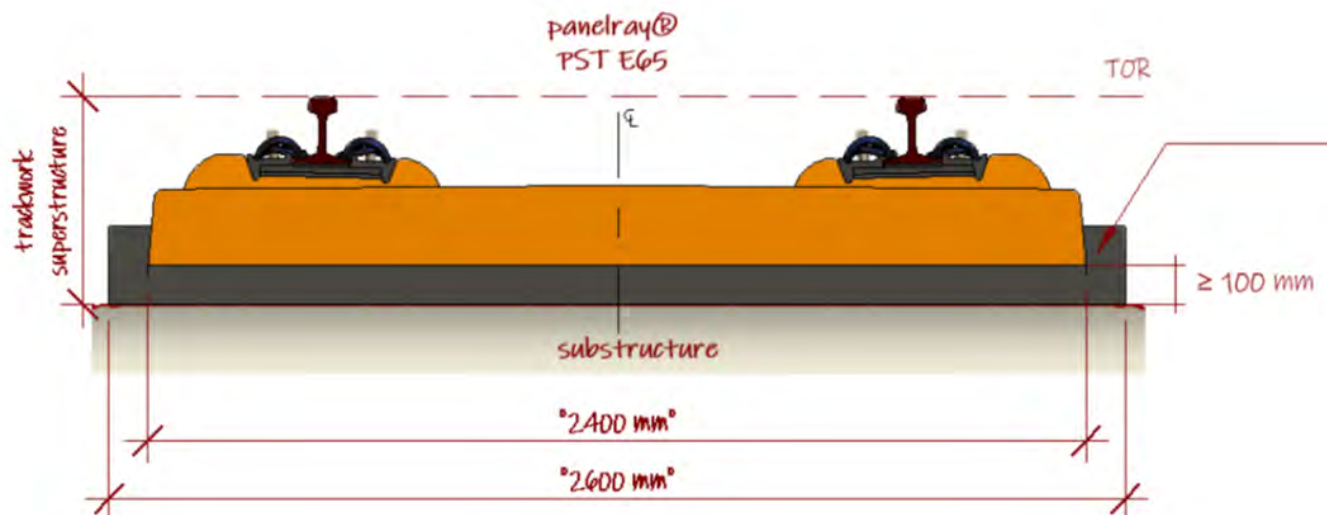
Designs

Design Concept 1



self compacted concrete ≥ 80 mm
or grout ≥ 30 mm –
pavement
(according to EN 16432-2) -

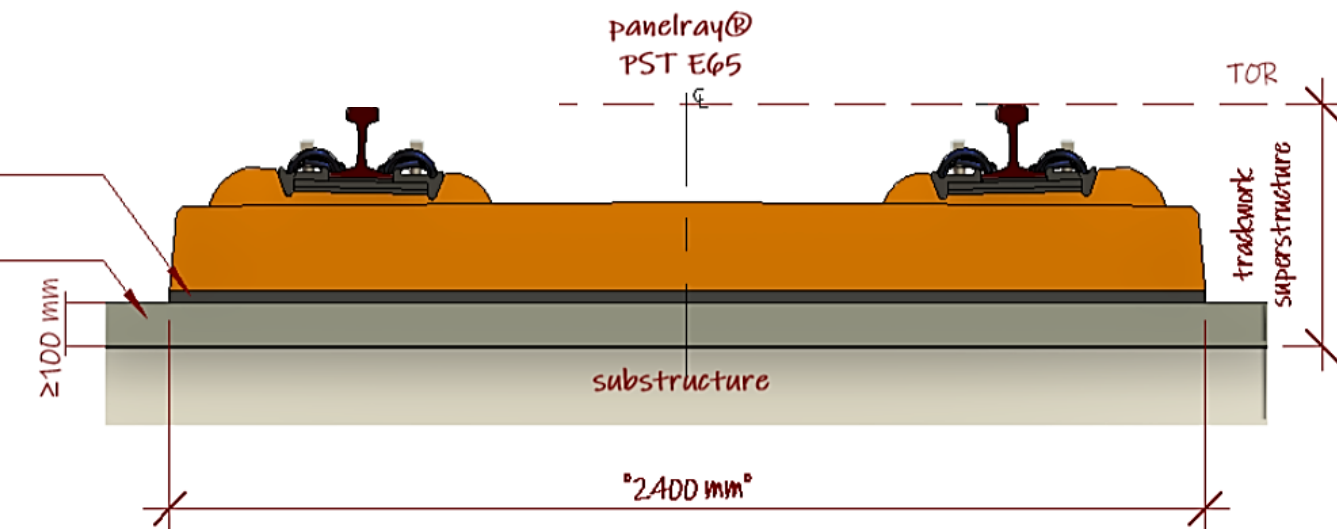
Design Concept 2



grout ≥ 30 mm

pavement
(according to EN 16432-2)

In the first concept, a minimum 3 cm thick grout or a minimum 8 cm thick self-compacted concrete can be used for interlocking the pavement and the Panelray® Slab Track System.



self compacted concrete

In the second concept, a self-compacted concrete pavement is applied as a bending element with a thickness of at least 10 cm on the substructure as the pavement layer of the system.

PANELRAY® *System*



The Panelray® PST system, which enables high quality solutions for ballastless tracks, provides numerous advantages with its feasible approaches. A variety of application methods incorporate additional solutions according to project requirements. The Panelray® trademark includes a wide range of products that have been developed through extensive research and development. The Panelray® trademark is proud of an extensive product portfolio, which reflects our long-standing expertise.

The geometric structure of Panelray® PST ensures that it adapts to any project. The system has a variety of tailor-made solutions depending on track conditions and project needs. Panelray® PST is one of the best alternatives for high-speed line railway projects with infrequent maintenance intervals and “fit and forget” application method. Prefabricated slab tracks can be expertly applied not only in high-speed lines, but also in metro and funicular projects.

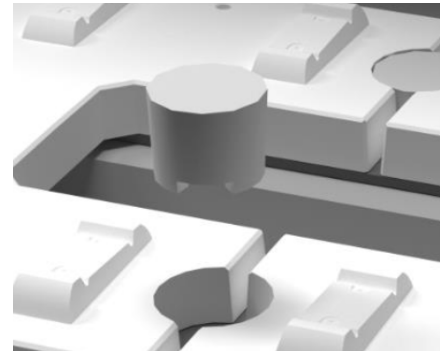
Panelray® PST allows high-precision adjustment to track geometry, which can reduce operating costs compared to other standard in-situ concrete applications. This system has flexible, powerful, and simple installation procedures for both manual and automated processes. In addition to this, high quality precast concrete with sufficient thickness and lightness, provides easy transportation and installation.

YAPIRAY which has more than 20 years of experience in the railway industry, has become an industry leader in ballastless tracks. The company maintains all trackworks from production to application with environmental sensitivity. YAPIRAY is committed to environmental responsibility and has undertaken significant initiatives to reduce carbon footprint. These efforts encompass energy-efficient manufacturing processes and underline the company's commitment to both innovation and sustainability.

SPECIFIC SUBJECTS *for design*

Solution Against Lateral Forces

Prefabricated shear keys and in-situ shear keys resist horizontal forces in combination with the prefabricated slab's own weight and frictional forces. Prefabricated shear key reduces construction costs and optimises labour requirements its perfect complement to Panelray® PST prefabricated slab track. Thanks to the prefabricated slab track system, shear keys are applied on the track with a fast and trouble-free application. With the help of prefabricated shear keys, the amount of wet concrete volume is reduced and a more efficient, engineering safe and economical construction process is provided.



Design Approval Tests

Since 2018, structural design verification tests have been performed on Panelray® prefabricated slab track system at a 1:1 scale in the Structural and Earthquake Engineering Laboratory at Istanbul Technical University.

The tests include static, dynamic, and fatigue loading and utilize all layers of the Panelray® system. The tests not only examine the behavior of the system components both also show that the system keeps its structural integrity even after 3 million cycle fatigue loading.



Special Solutions

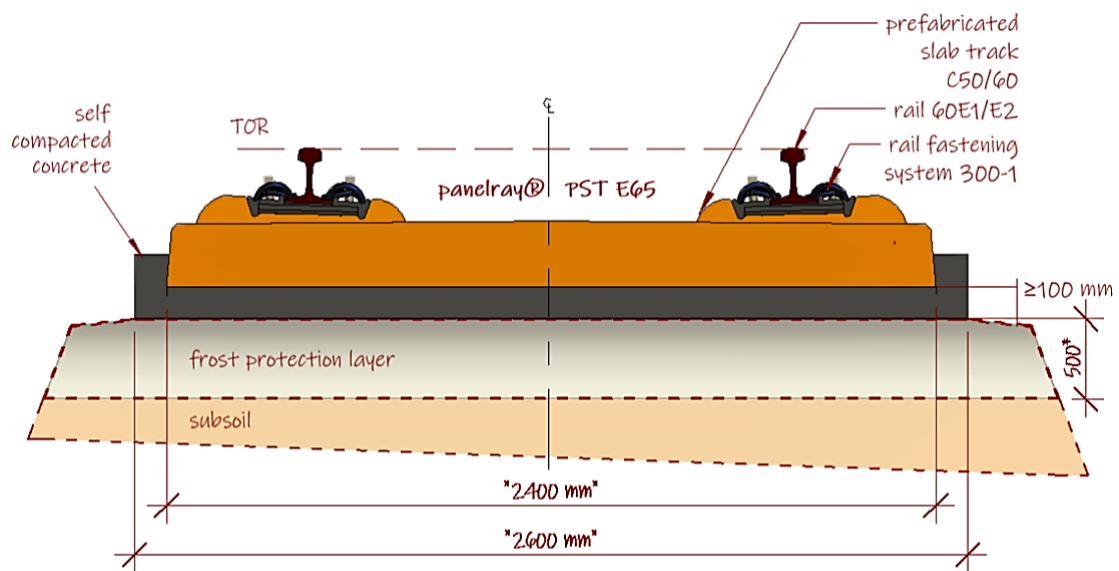
Tailor made solutions can be created with Panelray® prefabricated slab track system for each project by Yapıray.



Installation at Grade

The self-compacting concrete layer is applied on the frost protection layer, with a minimum of 10 cm in-situ concrete with bottom-up construction method at grade.

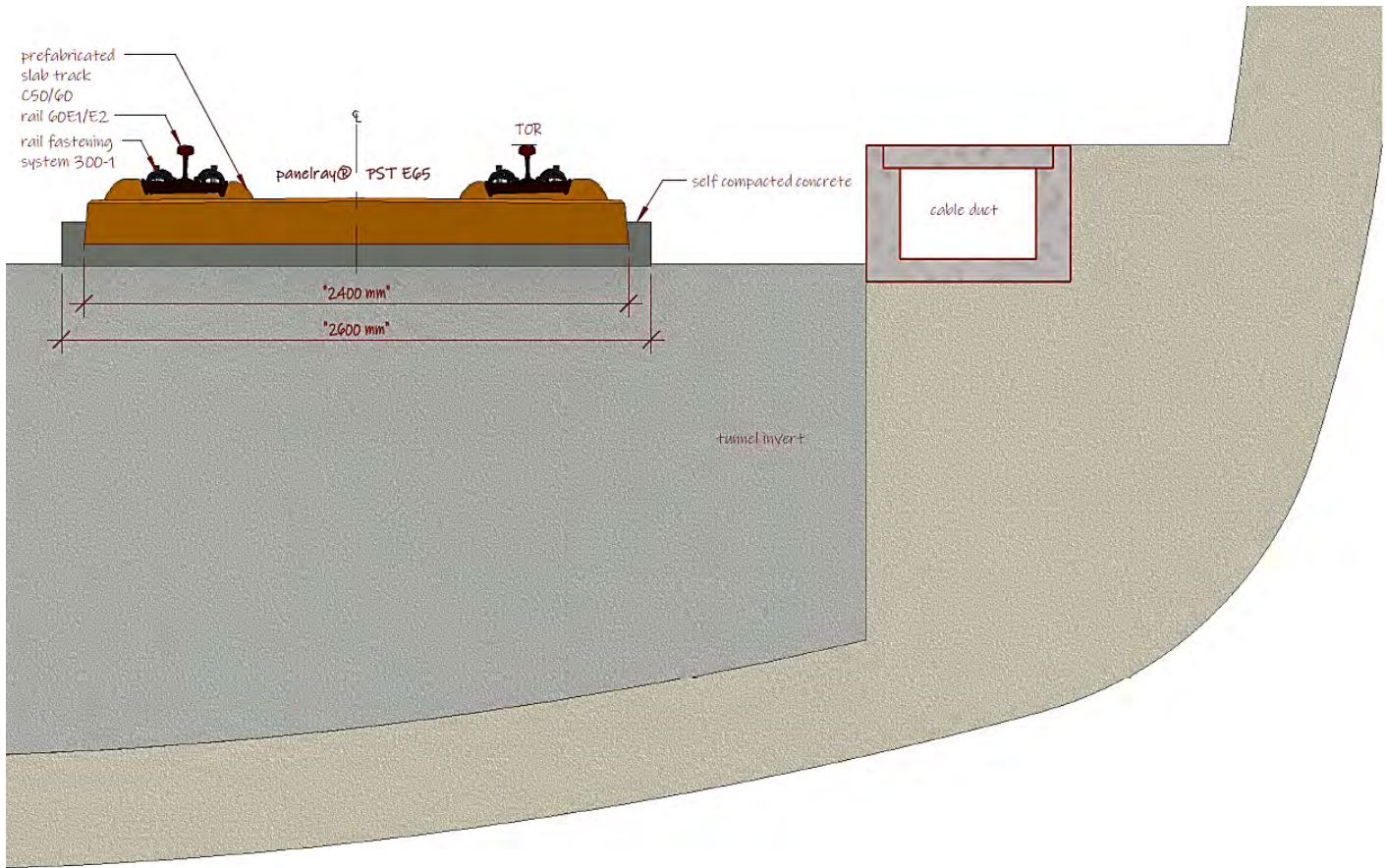
The thickness of the frost protection layer is depending on the subgrade and properties of the supporting layer.



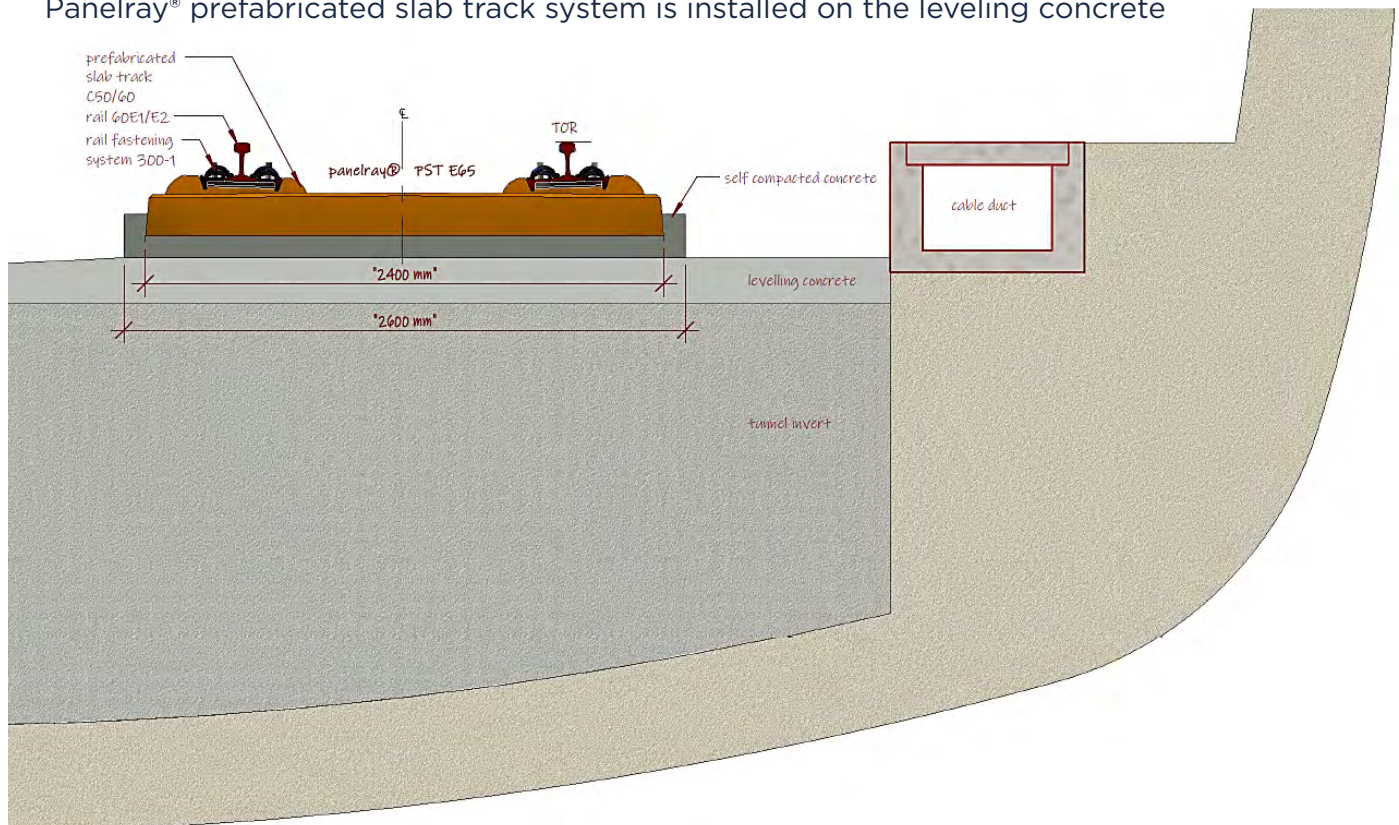
**) depending on the sub-grade and the properties of the supporting layer*

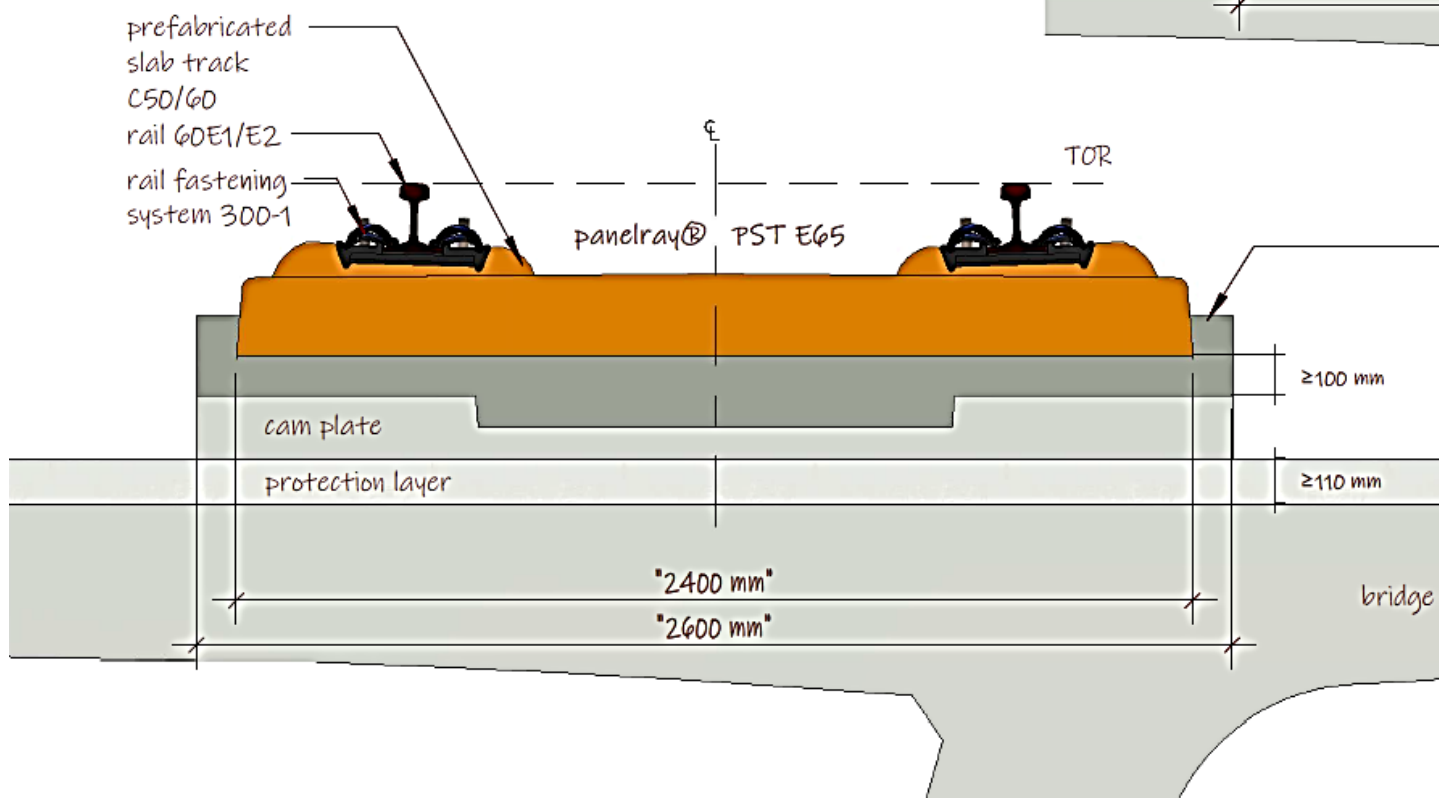
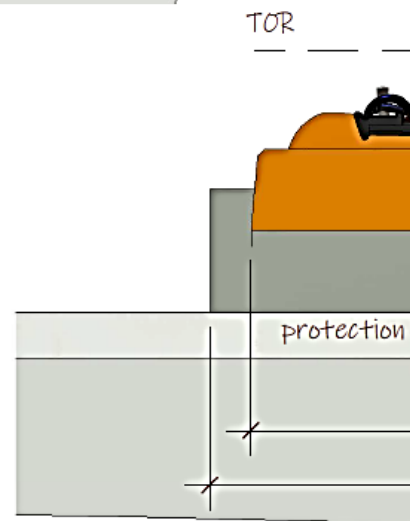
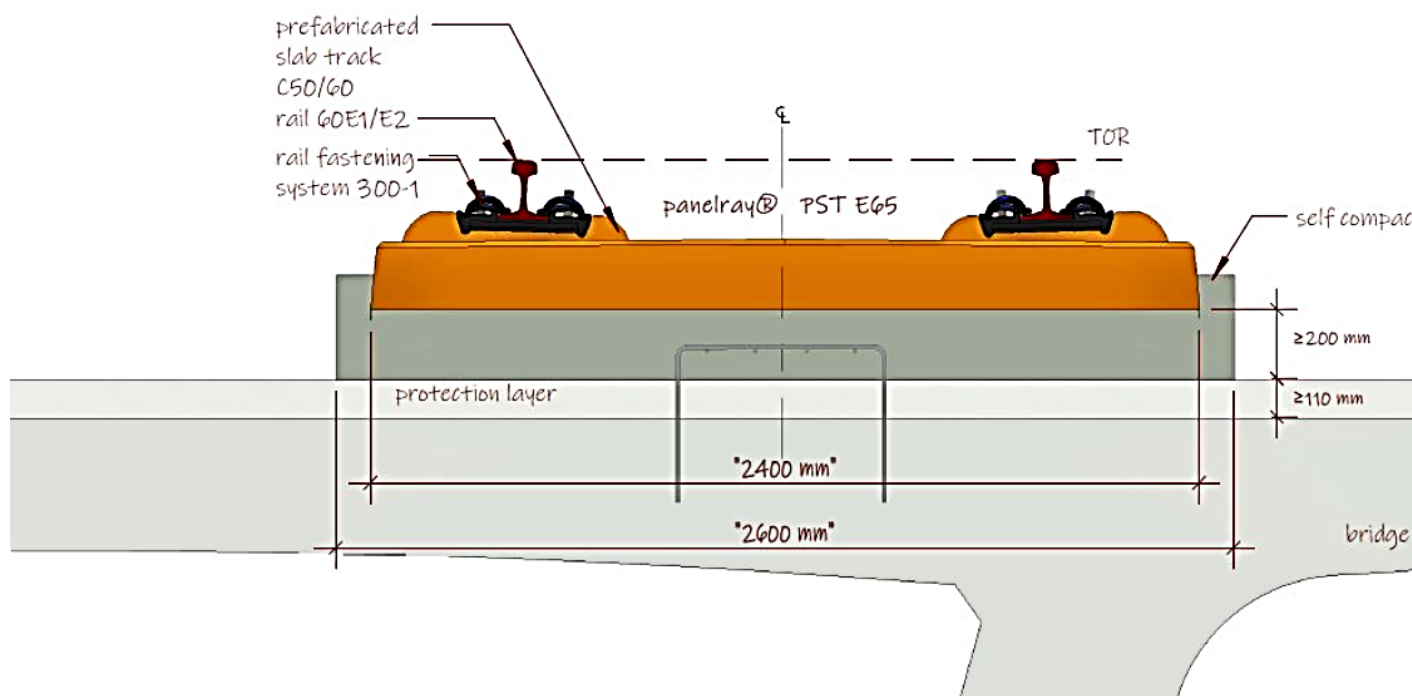
Installation in Tunnel

« SCC layer is between Panelray® PST and tunnel invert »



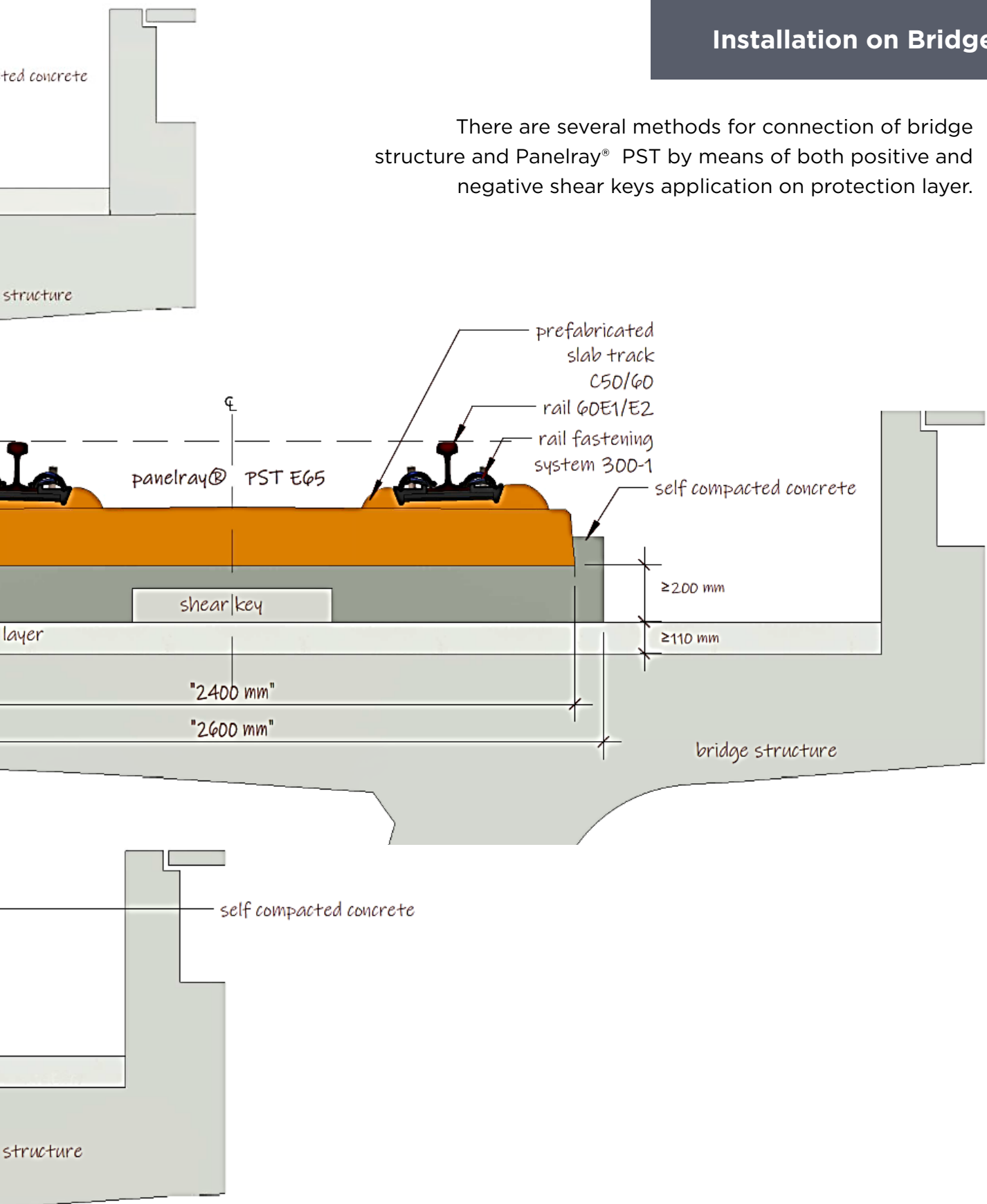
Panelray® prefabricated slab track system is installed on the leveling concrete





Installation on Bridge

There are several methods for connection of bridge structure and Panelray® PST by means of both positive and negative shear keys application on protection layer.



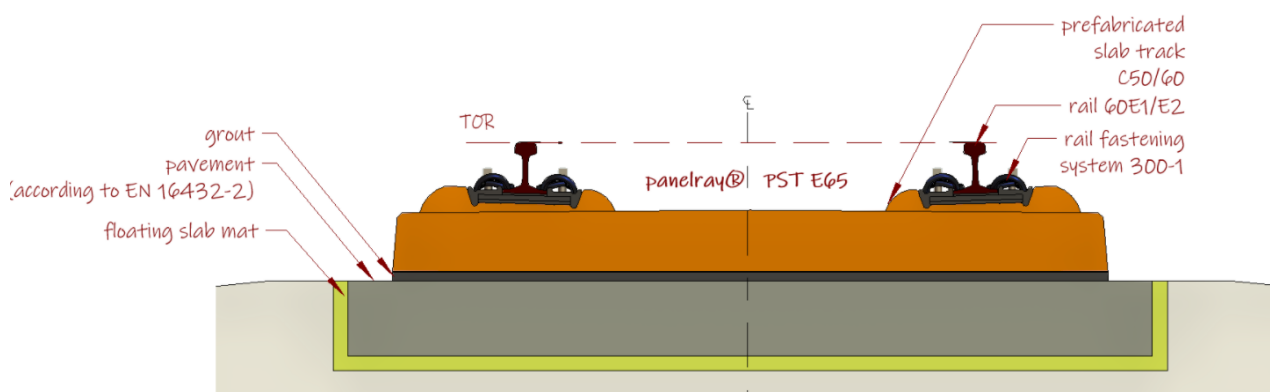
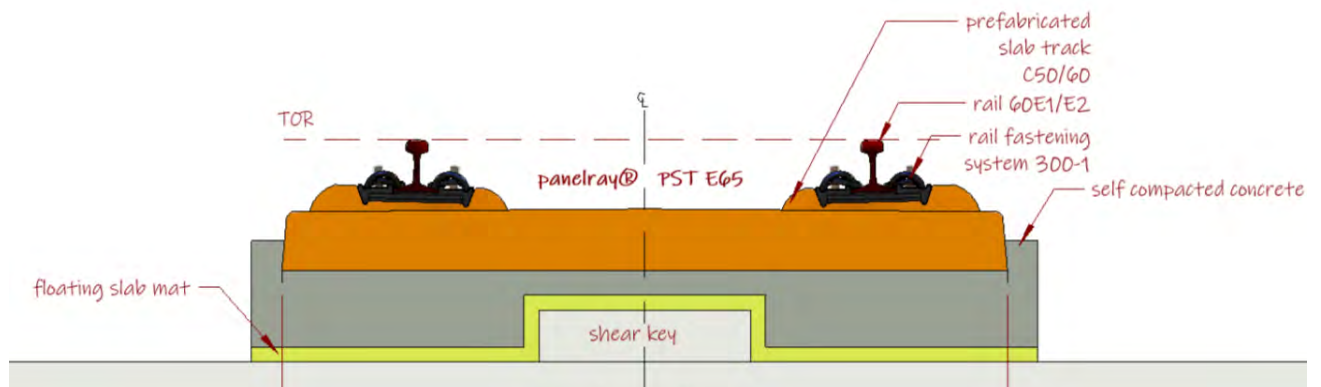
SPECIAL Applications

Noise and Vibration Mitigation

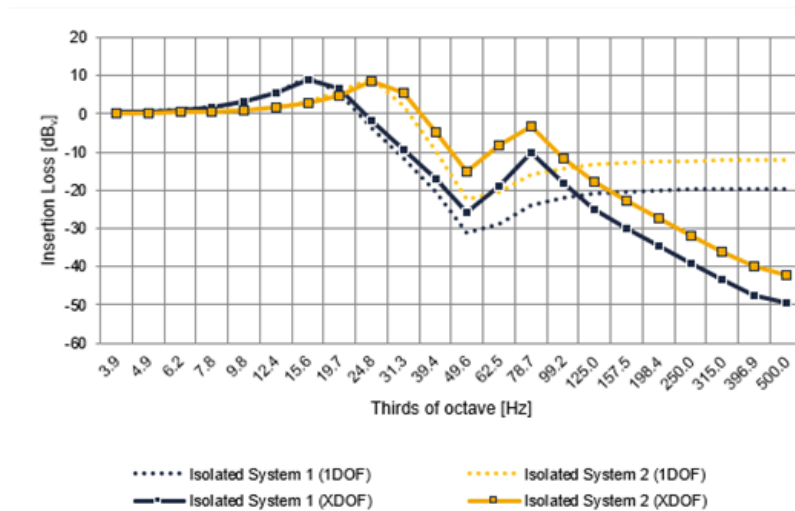
One of the most important issues for the track in which passing through the residential area is noise and vibration. In recent years, one of the biggest problems of people living around and near the tracks is air-borne and ground-borne noise and vibration. On the other hand, air-borne noises originating from vibrating walls and re-radiating from buildings. Therefore, vibration emission and noise may cause lots of uncomfortable situations.

Vibration

Vibrations propagate from the track through the ground can affect the people living around. In order to reduce the vibration effects, mass spring systems are used in railway tracks considering the relevant international standards and codes.

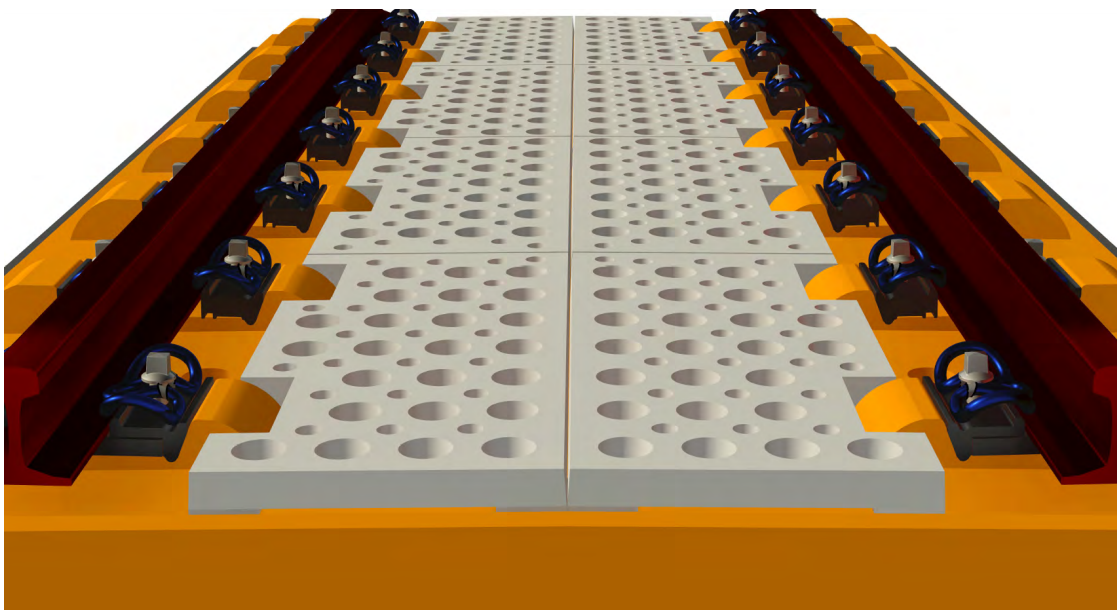


Considering the floating slab mat application concepts, the following graph is given for the vibration mitigation solution of Panelray® prefabricated slab track system.



Noise

Because of wheel-rail interaction, structures and dynamic effects of train movement may cause noise problem. Panelray® prefabricated slab tracks have the specially designed anti-acoustic cover solution against contact noise.



SPECIAL *Applications*

Insulated Slab Track

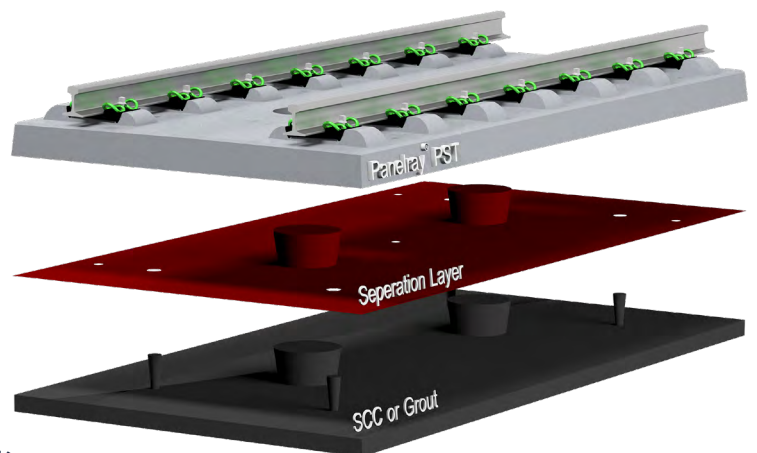
One of the special issues of the ballastless track is the interface with signaling equipment due to electromagnetic fields that may occur meshes of steel reinforcement. In order to deal with this phenomenon, Panelray® Prefabricated Slab Tracks have a solution: Insulated Slab Tracks. Insulated Panelray® Prefabricated Slab Track solution is applicable for all types of Prefabricated Slabs.

GFRP Reinforcement Solution

Unlike the known steel reinforcing mesh, Insulated Panelray® PST is the reinforced form of steel rebars combined with GFRP rebars. The earthing system in the product is solved without using a steel reinforcing mesh. By means of the Insulated Panelray® PST, signaling equipment is not affected by the developed product.

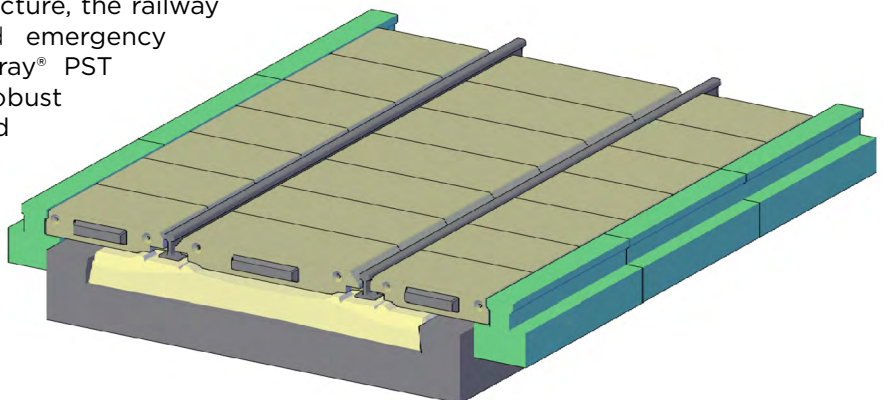
Seperation Layer

For debonding of two different layers, separation membranes can be applicable underneath Panelray® PST members. These intermediate layers give some advantages of disassembling of the precast elements in case of need. By adding this intermediate layer electrical isolation ability of the system can be also increased.



Level Crossing (Prefabricated)

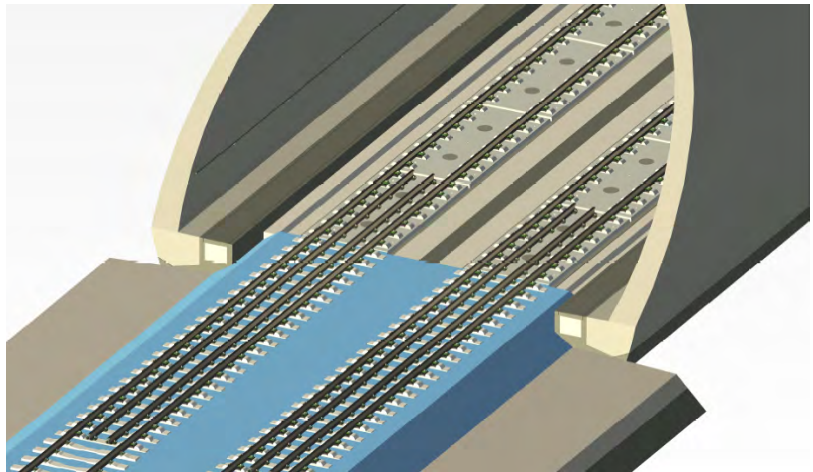
The rising trend in recent years, new and rehabilitated tunnels include vehicular access to allow the rubber-tired vehicles move along the a suitably modified ballastless track. By the help of this type of superstructure, the railway line can be used by rubber-tired emergency or maintenance vehicles. As Panelray® PST solutions is already very stable and robust systems, they can be easily modified to incorporate a flat road surface. Panelray® PST solves existing problems within the best and easiest way. The facilities of the system are planned in accordance with the track requirements and international standards.



Transition Zone

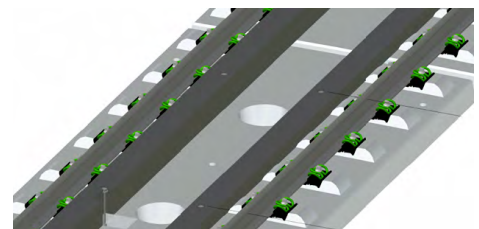
The existence of transition points for substructure or superstructure, especially on transitions between embankments and engineering structures, make it necessary to implement transitions because of long term differential settlements and stiffness changes to prevent high dynamic forces to the track structure or to preserve passenger comfort.

To smooth out this sudden change in stiffness and differential settlement along the line there are various solutions validated by experience which can also be combined with each other. One of the solutions widely used is add to the system two additional rails. Panelray® Transition slabs are designed for this purpose.



Guard Rail / Derailment Containment

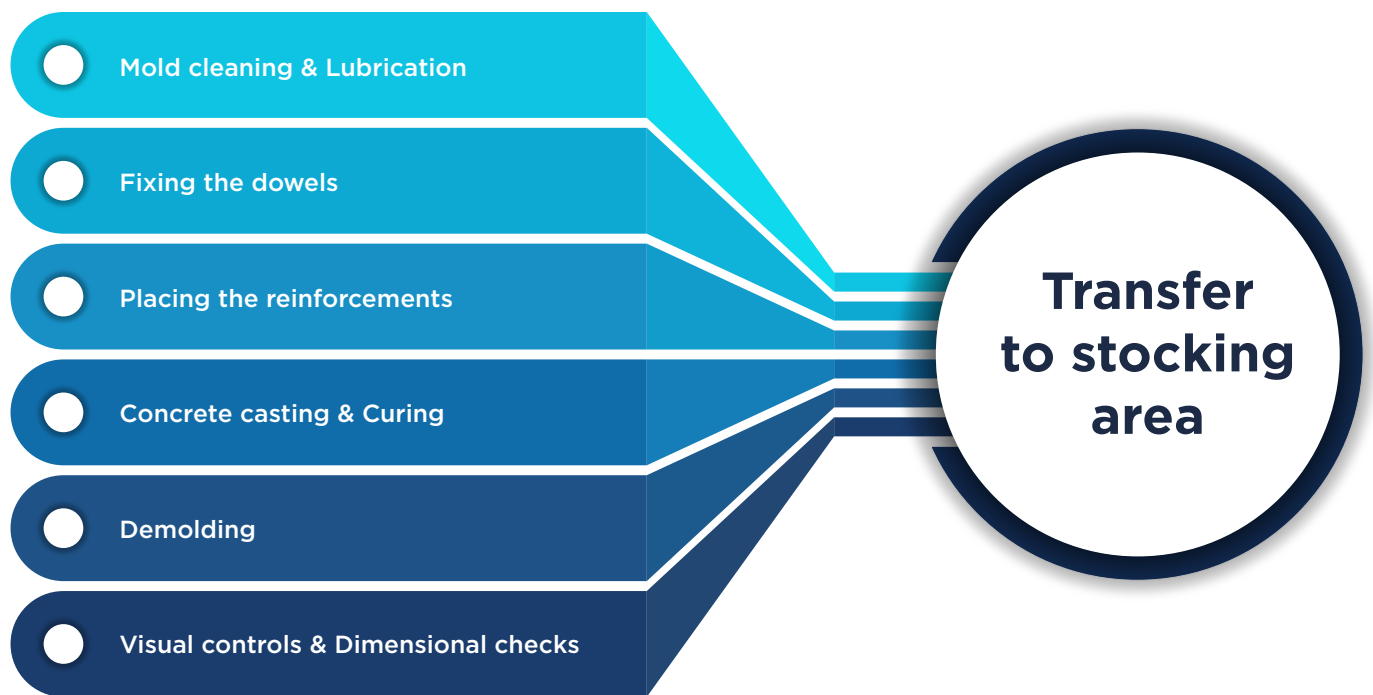
Despite many measures and regulations ensure the safety of railway operations, possibility of derailment is still alive. In addition, statistics show that although considerably harsh safety standards, probability of the derailment is constant. Guardrails are the additional precautions which aims to minimize/abolish the fatal consequences of derailment incidents.



The impact of derailments is much bigger at high speeds because guardrails are deadly obstructive for derailed vehicles. Due to the high kinetic energy of railway vehicles, in case of accident, rolling stocks can produce excessive damages. By using of guard rails and guiding lines it is possible to minimize the impact hazard.

Panelray® PST systems can effectively respond to detailed track requirements with using a differentiated guardrail application approach. While experience indicates that various solutions are possible, it will be shown different usage areas of derailment containment such as bridges, tunnels and switches. For derailment containment, these extra measures can be adopted to all types of Panelray® PST systems.

SLAB *Production*





Application

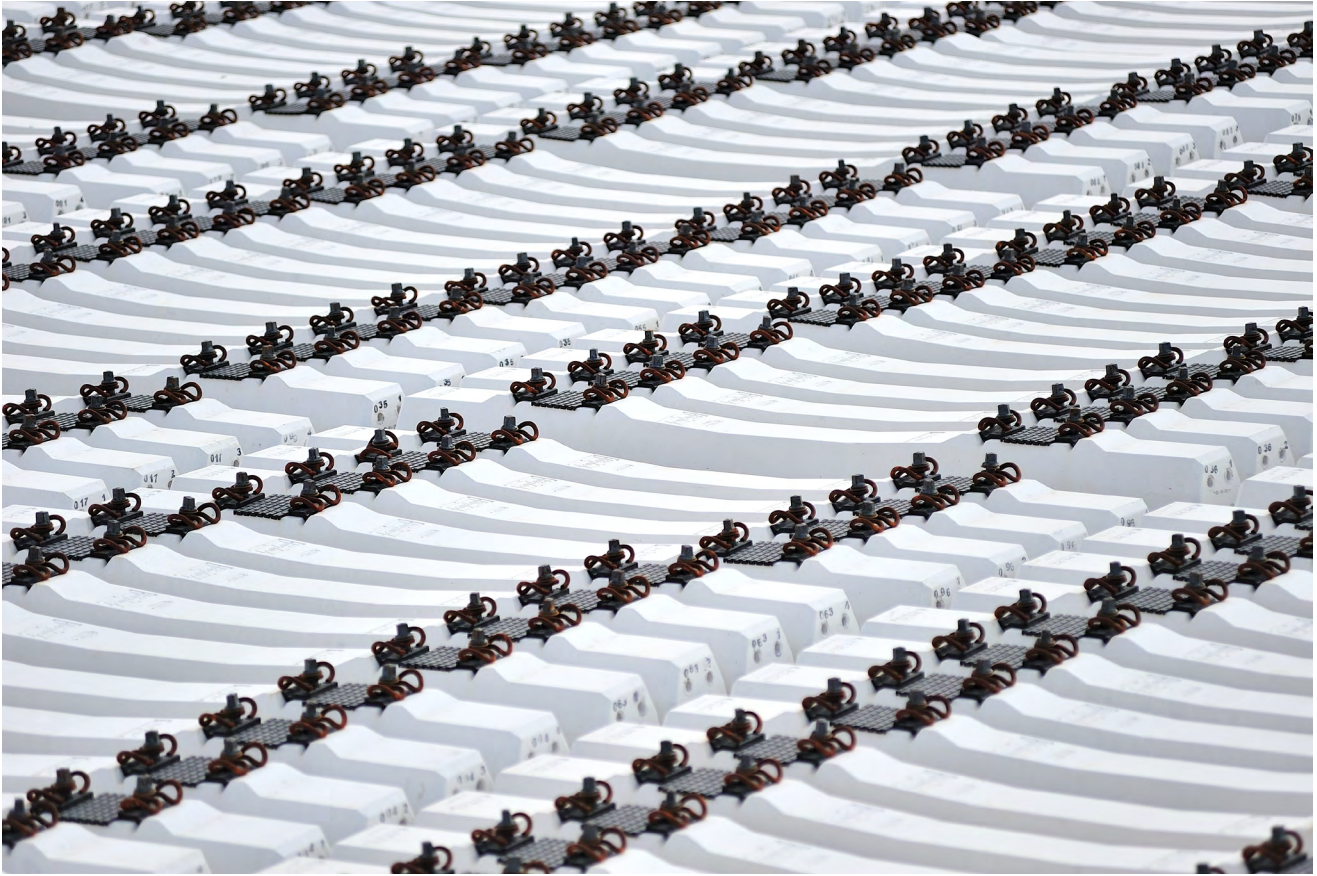
- Before the Panelray® PST is placed on the line, leveling concrete (if required) casting is completed into the application area.
- Application points that will guide the placement of the panels are pre-marked on the line.
- After the prefabricated slab layout is completed, the pre-assembly of the fastening systems is started. (this step is not necessary if the fasteners are assembled at the factory)
- Sleeper screw holes on the prefabricated slab are lubricated in accordance with the procedure and in a way to prevent water penetration. After this process, the fastening systems are mounted and set to the park position.
- On the other hand, rails which were previously distributed to the construction site, are placed on the slab with the help of suitable equipment.
- After the rails are placed, the sleeper screws are tightened to the required torque level with the help of screwing machines.
- After the final checks of the rails which are fastened on the slab, the necessary level-axis adjustments should be completed by using probes.
- Finally, according to the project criterias of ballastless track, self-compacting concrete or grout casting is performed after the preparation of formwork.

PRODUCTION *Capability*



	Production Name	Rail Type	Sleeper Type	Quantity	Project / Employee
1	Panelray Prefabricated Slab Track	54E1	Slab Track	17.500	Gayrettepe-Istanbul New Airport Metro Line / KKC Marmaray Construction
2	Panelray Prefabricated Slab Track	60E1	Slab Track	1.210	Panelray® FCA Production for Tunnel Rehabilitation in Bulgaria Koprivishitsa Stryma / Bulgaria
3	Panelray Prefabricated Slab Track	54E1	Slab Track	15.340	Halkalı-Istanbul New Airport Metro Line / KKC Marmaray Construction
4	Panelray Prefabricated Slab Track	54E1	Slab Track	303	Rumeli Hisarüstü-Aşiyan Funicular Line / Metrostav Ankara Construction
5	Panelray Prefabricated Slab Track	60E2	Slab Track	8.740	Kayaş-Yerköy High Speed Train Line / TCDD
6	Panelray Prefabricated Slab Track	60E2	Slab Track	21.000	Yerköy-Sivas High Speed Line / TCDD
7	Panelray Prefabricated Slab Track	60E2	Slab Track	21.452	Bandırma-Osmaneli High Standard Railway Line / Kalyon Construction (On-going)
8	Rayton Sleepers	Various	Sleeper	5.000.000	Various Project





References



GAYRETTEPE - İSTANBUL AIRPORT METRO PROJECT *Completed - Turkey*

80 km Slab Track 

16309 pieces Panelray PST-M 

120 km/h Design Speed 

9 Stations 



YERKÖY - SİVAS HIGH SPEED RAILWAY PROJECT *T&C Construction-Turkey*

Total Length 510 km 

100 km Slab Track 

21000 pcs Panelray PST 

300 km/h Design Speed 

6 Stations 



İSTANBUL HİSARÜSTÜ - AŞIYAN FUNICULAR PROJECT *T&C Construction-Turkey*

Total Length 860 m 

600 m Slab Track 

235 pcs Panelray PST-F 

36 km/h Design Speed 

2 Stations 



KAYAŞ - YERKÖY HIGH SPEED RAILWAY PROJECT *T&C Construction-Turkey*

9000 pcs Panelray PST 

300 km/h Design Speed 



HALKALI - İSTANBUL AIRPORT METRO PROJECT *Under Construction-Turkey*

62 km Slab Track 

14.270 pieces Panelray PST-M 

120 km/h Design Speed 

7 Stations 



ÇATALCA TUNNEL REHABILITATION PROJECT *Completed - Turkey*

430 m Slab Track 

90 pieces Panelray PST 

120 km/h Design Speed 



BANDIRMA - BURSA - YENİŞEHİR - OSMANELİ HIGH STANDARD RAILWAY PROJECT *Under Construction-Turkey*

90 km Slab Track 


20.000 pieces Panelray PST-E65 

250 km/h Design Speed 

4 Stations 

SAFETY QUALITY *Certificates*



All our mainline sleepers are produced under  trademark of Yapıray.

All our bridge and turnout sleepers are produced under  trademark of Yapıray.

All our slab tracks are produced under  trademark of Yapıray.



DEMİRYOLU İNŞAAT SİSTEMLERİ SAN. VE TİC. A.Ş.
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