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"Under Sleeper Pads (USP) - Recommendations for Use"

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The International Railway Solution

The International Railway Solution (IRS) are structured in a General Part and in some eventual Application Parts.

The General Part is valid worldwide, while the Application Parts are valid for a specific railway application, based on a geographical or on a service implementation.

The eventual Application Parts may thus be added according to the current needs of the Railway Community.

Structure of the International Railway Solution:

IRS 70713-1: Railway Application - Track & Structure - "Under Sleeper Pads (USP) - Recommendations for Use"

General part

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Foreword

An International Railway Solution (IRS) is a document drawn up by consensus and applied on a voluntary basis which aims to facilitate and harmonize railway operation. IRSs are gradually replacing UIC leaflets.

Members of the International Union of Railways (UIC) participate in the creation of IRSs, of which they benefit in full. Furthermore, marketing to railway stakeholders contributes to the sharing and harmonization of good practices, in accordance with UIC's primary goal.

While IRSs do not have the force of law, they are created and published in a professional manner and with technical approval on the basis of UIC procedures, and have full technical legitimacy in the railway sector.

The "General application" section constitutes the heart of the IRS and contains the working group's expertise applicable in the broadest manner. The addition of a "Specific application" aims to cover factors specific to a region, a type of service, etc.

While the application of this IRS is optional, some provisions shall be implemented in all cases to ensure correct application and maintain the system's cohesiveness. Certain operational circumstances require that specific provisions be systematically applied by all users of the document.

For the purposes of understanding, the user acknowledges that the expression of:

- obligation indicates requirements to be respected in order to comply with the expertise expressed in the document (usually "shall" in the present);
- recommendation indicates options that are favourable but not essential (usually "should" in the present);
- permission indicates options that are recognized but without consequence (usually "may", "need not" in the present);
- capacity indicates possibilities from a technical standpoint and not permissions or probabilities (usually "can" in the present).

Obligation, recommendation and capacity can be expressed in the negative to indicate prohibiting, non-recommendation and incapacity.

If applicable, notably for the purposes of compliance with a UIC approval, passages that are recommended or mandatory for the cohesiveness of the system will be accompanied by the letters "R" and "MCS" respectively.

This IRS reflects the following UIC working group expertise:

UIC Track and Structure (T&S) sector has been responsible for this work through the Under Sleeper Pads working group, that was created in the frame of the Track Experts (TEG) Group.

It integrates in full or in part the following UIC leaflets:

Not applicable. This is a completely new item of work.

It complements the following standards:

Future EN 13230-6 (see Normative references - page 4).

The following IRSs constitute a complementary series:

This IRS complements the current UIC leaflet 713 about monoblock concrete sleepers, which will be updated in a coherent way with this document into the new IRS 70713.

Summary

This IRS contains recommendations regarding the use of Under Sleeper Pads (USP), dealing with the field of application of under sleeper pads (USP) in ballasted tracks with concrete sleepers.

It summarizes:

- recommendations for the use of USP
- requirements for qualification and quality control procedures
- technical and economic findings based on up to-date experience with USP.

All these recommendations and requirements are based on the results of research project works carried out between 2005 and 2012 in two UIC projects on USP (No. I/05/U/440 and P000295).

They shall be considered a guide to good practices when using USP as well as pointing out the limitations for their use.

The IRS also includes a discussion of the interaction with other elastic components in the track superstructure, such as soft rail pads and under ballast mats (UBM).

This IRS is intended to complement the European and other international standards in this area.

Normative references

1. UIC Leaflets

International Union of Railways (UIC)

UIC Leaflet 713: Design of monoblock concrete sleepers, 1st edition, November 2004

UIC Leaflet 719-1: Recommendations for the use of Under Ballast Mats. UBM, 1st edition, June 2011 (this leaflet was published in english only)

UIC Leaflet 720: Laying and Maintenance of CWR Track, 2nd edition, March 2005

2. European Standards

European Committee for Standardization (CEN)

EN 13230-1:2016: Railway applications - Track - Concrete sleepers and bearers - Part 1: General requirements, May 2016

EN 13230-2:2016: Railway applications - Track - Concrete sleepers and bearers - Part 2: Prestressed monoblock sleepers, May 2016

EN 13230-3:2016: Railway applications - Track - Concrete sleepers and bearers - Part 3: Twin-block reinforced sleepers, May 2016

EN 13230-4:2016: Railway applications - Track - Concrete sleepers and bearers - Part 4: Prestressed bearers for switches and crossings, May 2016

EN 13230-5:2016: Railway applications - Track - Concrete sleepers and bearers - Part 5: Special elements, May 2016

EN 13146-9:2009+A1:2011: Railway applications - Track - Test methods for fastening systems - Part 9: Determination of stiffness, October 2011

EN 13481-2:2012+A1:2017: Railway applications - Track - Performance requirements for fastening systems - Part 2: Fastening systems for concrete sleepers, January 2017

EN 13674-1:2011+A1:2017: Railway applications - Track - Rail - Part 1: Vignole railway rails 46 kg/m and above, May 2017

EN 16730:2016: Railway applications - Track - Concrete sleepers and bearers with under sleeper pads, June 2016

EN 60300-3-3:2005: Dependability management - Part 3-3: Application guide - Life cycle costing analysis, December 2005

3. International Standards

International Organization for Standardization (ISO)

ISO 37:2017: Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties, November 2017

ISO 48-4:2018: Rubber, vulcanized or thermoplastic — Determination of hardness — Part 4: Indentation hardness by durometer method (Shore hardness), August 2018

ISO 15686-5:2017: Buildings and constructed assets - Service life planning - Part 5: Life-cycle costing, July 2017

4. Divers

International Union of Railways (UIC)

UIC USP project - Noise & Vibration - Final report, 2012

Summary Report of UIC-USP-project (Project N° P00025), 2013

RIVAS EU Project, deliverable D1.10 - Description of test procedures based on laboratory tests and field tests including validation, 2014

List of abbreviations

C_{dyn-XHz}	Dynamic bedding modulus
CR	Chloroprene Rubber
C_{stat}	Static bedding modulus
CWR	Continuously Welded Rail
e	horizontal distance pad to sleeper edge
GBP	Geometric Ballast Plate
h	Hardness
IRR	Internal Rate of Return
IRS	International Railway Solution
k_{LFP}	Dynamic low-frequency rail pad stiffness
k_{SP}	Static rail pad stiffness
LCC	Life Cycle Cost
LLT	Levelling, Lining and Tamping
m	Mass
NR	Natural Rubber
PUR	Polyurethane
R	Radius of curvature
RR	Reclaimed/Recycled Rubber
s	additional sleeper height due to pad
S&C	Switches and Crossings
SL	Service Life
TPE	Thermoplastic Elastomer
UBM	Under Ballast Mat

UIC	International Union of Railways
USP	Under Sleeper Pad
V	Speed
σ	Tensile strength

Railway Application - Track and Structure
"Under Sleeper Pads (USP) - Recommendations for Use"

General Part

1 - Recommendations for use

1.1 - USP classification

The different bedding moduli have different functions:

- For the indicative classification of USPs, the static bedding modulus should be used to determine the fields of application (see [Table 1](#) and [Table 2 - page 10](#));
- For more detailed calculation including rail deflection, it is necessary to use the dynamic bedding modulus at 5 Hz (see [Table 4 - page 26](#));
- For vibration mitigation, it is necessary to use the higher dynamic bedding modulus (10 Hz and above).

The following table gives indicative values for the classification of the USP static bedding modulus:

Table 1 : Classification of USP static bedding modulus

USP type	Static bedding modulus C_{stat}
Stiff	$0,25 \text{ N/mm}^3 \leq C_{stat} < 0,45 \text{ N/mm}^3$
Medium	$0,15 \text{ N/mm}^3 \leq C_{stat} < 0,25 \text{ N/mm}^3$
Soft	$0,08 \text{ N/mm}^3 \leq C_{stat} < 0,15 \text{ N/mm}^3$
Very soft (not part of this IRS)	$C_{stat} < 0,08 \text{ N/mm}^3$

The static bedding modulus C_{stat} of USP with a concrete block has to be determined according to *EN 16730:2016* (see [Normative references - page 4](#)).

Therefore, this classification does not correspond exactly to the dynamic behaviour of the track. For medium and stiff USPs, the impact of the difference between the static and dynamic bedding modulus (stiffening factor) is low. For soft and very soft USPs, this impact cannot be neglected, and therefore must be assessed with the dynamic bedding modulus (see table of Low-frequency dynamic vertical bedding modulus $C_{dyn-5Hz}$ in [Table 4](#)).

NB: The relation between the static and dynamic bedding modulus differs depending on the product used and its application.