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BSI Standards Publication

Railway applications — Track — Test methods for fastening systems

Part 3: Determination of attenuation of impact loads

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National foreword

This British Standard is the UK implementation of EN 13146-3:2012. It supersedes BS EN 13146-3:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RAE/2, Railway Applications - Track.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (EN 13146-3:2012) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2012, and conflicting national standards shall be withdrawn at the latest by October 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13146-3:2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

Detailed changes only have been made in this revision of EN 13146-3:2002.

This European Standard is one of the series EN 13146 "*Railway applications — Track — Test methods for fastening systems*" which consists of the following parts:

— *Part 1: Determination of longitudinal rail restraint;*

— *Part 2: Determination of torsional resistance;*

— *Part 3: Determination of attenuation of impact loads;*

— *Part 4: Effect of repeated loading;*

— *Part 5: Determination of electrical resistance;*

— *Part 6: Effect of severe environmental conditions;*

— *Part 7: Determination of clamping force;*

— *Part 8: In service testing;*

— *Part 9: Determination of stiffness.*

These support the requirements in the series EN 13481 "Railway applications — Track — Performance requirements for fastening systems".

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies laboratory test procedures for applying an impact to a rail fastened to a concrete sleeper or bearer which simulates the impact loading caused by traffic on railway tracks and measuring the strain induced in the sleeper. They are used for comparing the attenuation of impact loads on concrete sleepers or bearers by different rail pads. A reference procedure and alternative procedure are included.

This test is only applicable to ballasted track.

These test procedures apply to a complete fastening assembly.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13146-9:2009, *Railway applications — Track — Test methods for fastening systems — Part 9: Determination of stiffness*

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

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

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

EN 13481-1:2012, *Railway applications — Track — Performance requirements for fastening systems — Part 1: Definitions*

3 Terms and definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13481-1:2012 apply.

3.2 Symbols and abbreviations

For the purposes of this document, the following symbols apply.

a attenuation expressed as per cent reduction in sleeper strain with test pad compared with reference pad;

a_t attenuation at the top of the sleeper, in %;

a_b attenuation at the bottom of the sleeper, in %;

d_a thickness of aluminium plate used with rail pad, in mm;

d_t thickness of rail pad for which assembly is designed, in mm;

M_{dr} positive bending moment at the rail seat of the sleeper, in kNm;

δ vertical deflection, in mm;

ε_{pct} first peak strain in the top of the sleeper with test pad when subject to impact loading;

ε_{pcb} first peak strain in the bottom of the sleeper with test pad;

ε_{pcrt} mean first peak strain in the top of the sleeper with reference pad when subject to impact loading;

ε_{pcrb} mean first peak strain in the bottom of the sleeper with reference pad;

ε_{st} strain in the top of the sleeper due to static preload in alternative test procedure;

ε_{sb} strain in the bottom of the sleeper due to static preload.

4 Principle

An impact load is applied by dropping a mass onto the head of a rail fastened to a concrete sleeper. The effect of the impact is measured as strain in the concrete sleeper. The impact attenuation of a fastening system is assessed by comparing the strains induced with a low attenuation reference rail pad in the fastening system and with the test pad in the fastening system.

With a reference pad in the system the strain induced by the impact load shall not exceed 80 % of the rail seat resistance moment of the sleeper (M_{dr} in accordance with EN 13230-1) at the gauge positions. The drop mass, drop height and resilience of the striking head are adjusted to ensure the limit on strain is not exceeded. Without subsequent change to the drop mass, drop height and striking head, the procedure is repeated with the test pad.

NOTE The test result is not very sensitive to the test load.

5 Apparatus

5.1 Concrete sleeper or bearer

An uncracked concrete sleeper or bearer, made without modification for this test, of the correct rail seat dimensions for the fastening assembly to be tested. The sleeper shall have two resistance strain gauges of (100 to 120) mm nominal gauge length bonded to the side of the sleeper symmetrically about a line through the centre of the rail seat normal to the base of the sleeper. The gauges shall be parallel to the base of the sleeper with one gauge as close as possible to the top of the sleeper rail seat, but avoiding any edge chamfer or radius, and the other gauge at least 10 mm but not more than 25 mm above the base of the sleeper as shown in Figure 1.

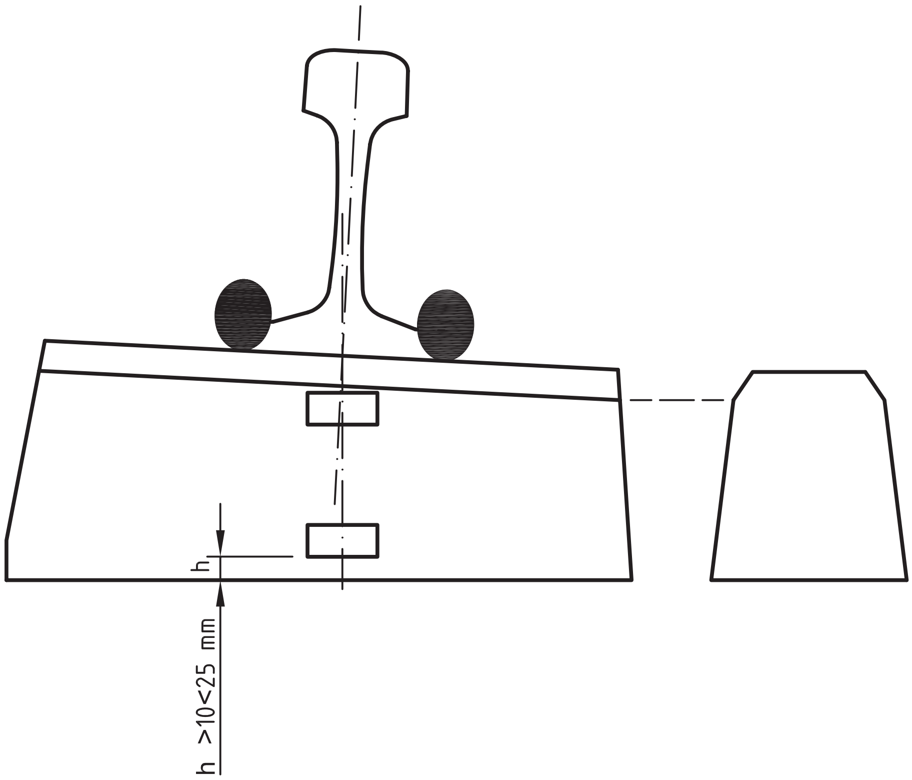
NOTE The sleeper designer or manufacturer should provide the calculated resistance moment at the gauge positions.

5.2 Support

5.2.1 Reference method

The support shall consist of a bed of crushed stone with nominal particle size in the range (5 to 15) mm contained in a tank. The bed shall be continuous for the full length of monoblock sleepers and bearers, and continuous under each block of two block sleepers. The support shall permit a vertical deflection of the sleeper of ($0,1 \leq \delta \leq 0,5$) mm when a sleeper supported on it is subject to an increase in static load from 50 kN to 60 kN at one rail seat

NOTE A suitable depth of crushed stone is 270 mm below the sleeper and a total depth of 370 mm.



Key

h height of base of strain gauge above base of sleeper 10 mm < *h* ≤ 25 mm

Figure 1 — Position of strain gauges

5.2.2 Alternative method

For the alternative method, the support shall consist of a rubber mat on a firm base. The support shall permit a vertical deflection of $(0{,}1 \leq \delta \leq 0{,}5)$ mm when a sleeper supported on it is subject to an increase in static load from 50 kN to 60 kN at one rail seat.

5.3 Rail

A piece of rail (0,3 to 1,0) m long of the section for which the fastening assembly is designed.

5.4 Strain measuring and recording equipment

Instruments which process the output from the strain gauges and provide a record of strain vs. time with a definition of not less than 0,1 ms. The output from the strain gauges shall be measured to ± 0,1 mV.

5.5 Drop mass

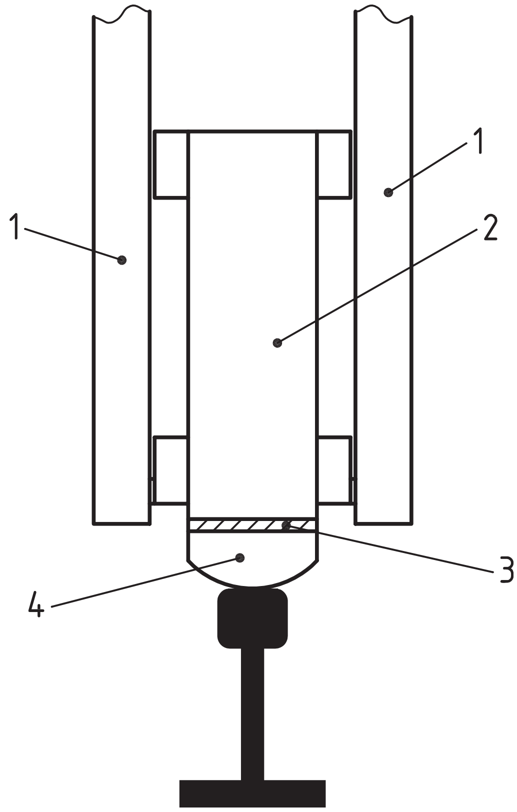
The combination of mass and drop height shall be such that the strain measured at each gauge position shall be less than 80 % of the calculated cracking strain of the sleeper and the time interval for the initial impulse of load shall be 1 ms to 5 ms.

A typical drop mass is shown in Figure 2.

NOTE The strain should be sufficient to be accurately measured.

5.6 Preloading equipment

A set of springs with a total effective stiffness of less than 2 MN/m capable of applying a vertical preload of 50 kN to the rail.



Key

1 guides
2 tup
3 rubber pad
4 tup head

Figure 2 — Typical drop mass

6 Test specimens

6.1 Concrete sleeper or bearer

As described in 5.1.

6.2 Fastening

The complete fastening assembly including all components and baseplate, where appropriate.

7 Procedure – Reference method

7.1 Preparation

The test shall be carried out in a room or enclosure maintained at (23 ± 5) °C. All components used in the test shall be kept at this temperature for not less than 4 h prior to commencement of the test.

The fastening system and rail are assembled with a 5 mm thick plain reference pad of HDPE or EVA with a static stiffness not less than 500 MN/m measured in accordance with EN 13146-9:2009. If the fastening assembly is designed for a thicker pad (thickness = d_t) an aluminium plate (thickness = d_a) shall be inserted between the rail and pad where ($d_a = d_t - 5$) mm. The sleeper with strain gauges fixed as in 5.1 is placed on the support in 5.2.1.

An impact load is applied to the rail by free fall of the drop mass and the strain recorded with the record commencing not less than 3 ms before impact and continuing for not less than 5 ms after impact. For an established test rig the magnitude and time interval of the first strain peak shall be compared with the mean of 10 preceding impacts. If it differs by more than 10 % the test conditions shall be adjusted to achieve the mean condition.

For a previously unused test rig or when the ballast or sleeper or bearer has been changed, a series of impacts shall be carried out and the strain recorded every 10 impacts. When five consecutive strain measurements have first strain peak magnitude and time intervals within ± 10 % of their mean, preparation is complete.

7.2 Testing

With the test pad in place, carry out five impacts. Then record the strain during three subsequent impacts as described in 7.1.

7.3 Check on sleeper condition

The integrity of the test sleeper shall be checked after each impact test by comparing the ratio of strains measured at the top gauge position and bottom gauge position with the corresponding ratio for a similar sleeper subject to static loading only. The static loading shall be in accordance with the rail seat test load in EN 13230-2 and EN 13230-3. If the ratio from the impact test differs from the ratio from the static test by more than 10 % of the static ratio, the measurements for impact loading shall be rejected and the test repeated using a new sleeper.

7.4 Calculation

Calculate the attenuation at the top and bottom of the sleeper for the test pad relative to the reference pad for each of the three measured impacts using Equations (1) and (2).

$$a_t = 100\left(1 - \frac{\varepsilon_{pct}}{\varepsilon_{pcrt}}\right)\% \qquad (1)$$

$$a_b = 100\left(1 - \frac{\varepsilon_{pcb}}{\varepsilon_{pcrb}}\right)\% \qquad (2)$$

For each measured impact calculate a using Equation (3).

$$a = \frac{(a_t + a_b)}{2}\% \qquad (3)$$

The result shall be reported as the mean value of *a* for the three measured impacts, rounded to 5 %, using the test pad.

A sample calculation is shown in Annex A.

8 Procedure – Alternative method

8.1 Preparation

This shall be as in 7.1 except that the sleeper shall be supported on a rubber mat in accordance with 5.2.2 and a vertical downward preload of 50 kN shall be applied to the rail in accordance with 5.6. The static strains in the sleeper caused by the preload shall be measured and the numerical mean taken as ε_{sb}.

8.2 Testing and checking

This shall be carried out in accordance with 7.2 and 7.3.

8.3 Calculation

Calculate the attenuation *a* % for the test pad relative to the reference pad for each of the three measured impacts using Equations (4), (5) and (6).

$$a_t = 100\left(1 - \frac{(\varepsilon_{pct} - \varepsilon_{st})}{(\varepsilon_{pcrt} - \varepsilon_{st})}\right)\% \quad (4)$$

$$a_b = 100\left(1 - \frac{\varepsilon_{pcb} - \varepsilon_{sb}}{\varepsilon_{pcrb} - \varepsilon_{sb}}\right)\% \quad (5)$$

$$a = \frac{(a_t + a_b)}{2}\% \quad (6)$$

The result shall be reported as the mean value of *a* for the three measured impacts, rounded to 5 %, using the test pad.

A sample calculation is shown in Annex A.

9 Test report

The test report shall include at least the following information:

a) number, title and date of issue of this European Standard;

b) name and address of laboratory performing the test;

c) date test performed;

d) name, designation and description of fastening assembly used in the test;

e) details of reference pad and test pad;

f) details of the concrete sleeper including whether monoblock or two block and its mass;

g) origin of test specimens;

h) test procedure used;

i) mean attenuation of test pad compared with reference pad.

Annex A
(informative)

Sample calculation

Figure A.1 shows an actual strain/time plot from the strain gauge adjacent to the top of the sleeper using a reference pad and a preload.

Figure A.2 shows the corresponding plot for the strain gauge adjacent to the base of the sleeper using a reference pad.

Figures A.3 and A.4 are the corresponding plots using the same sleeper with a test pad.

From Figure A.1 ε_{pcrt}= −156,5 mV and ε_{st}= −45,0 mV

From Figure A.2 ε_{pcrb}= 115,7 mV and ε_{sb}= 17,0 mV

From Figure A.3 ε_{pct}= −138,6 mV and ε_{st}= −45,0 mV

From Figure A.4 ε_{pcb}= 100,0 mV and ε_{sb}= 17,0 mV

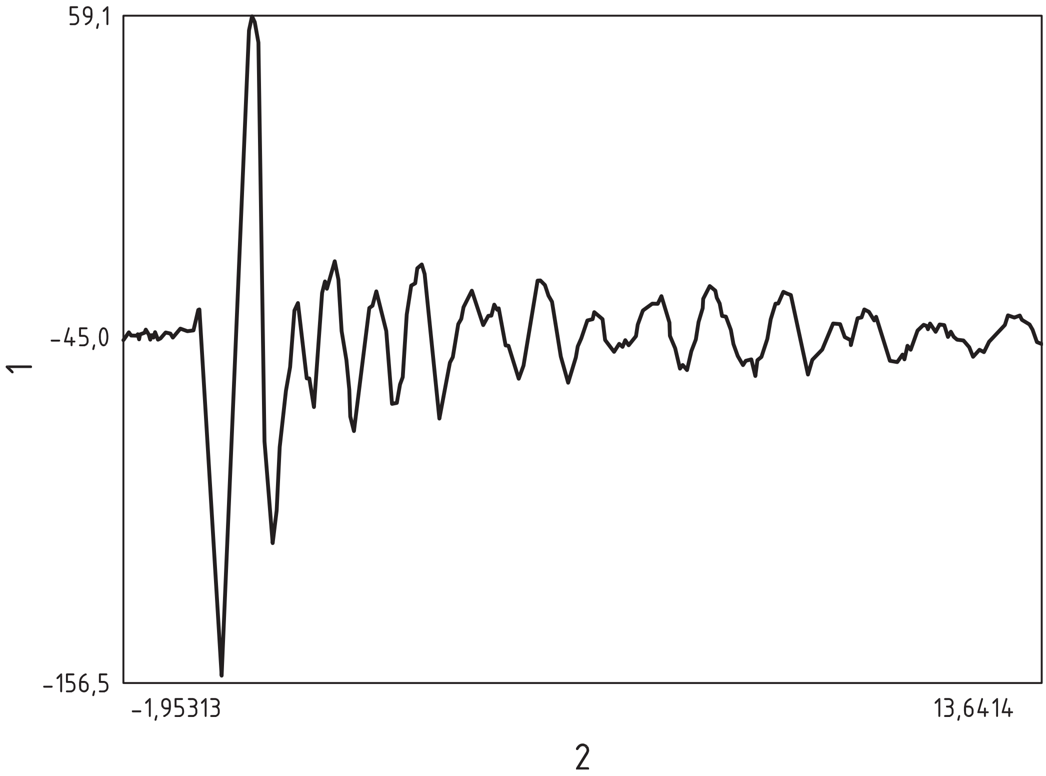
Using Equations (4), (5) and (6):

$$a_t = 100\left[1-\frac{(-138{,}6+45)}{(-156{,}5+45)}\right] = 16{,}1\ \%$$

$$a_b = 100\left[1-\frac{(100{,}0-17)}{(115{,}7-17)}\right] = 15{,}9\ \%$$

$$a = \frac{(16{,}1+15{,}9)}{2} = 16{,}0\ \%$$

NOTE This example is for one impact; the test procedure requires three impacts.

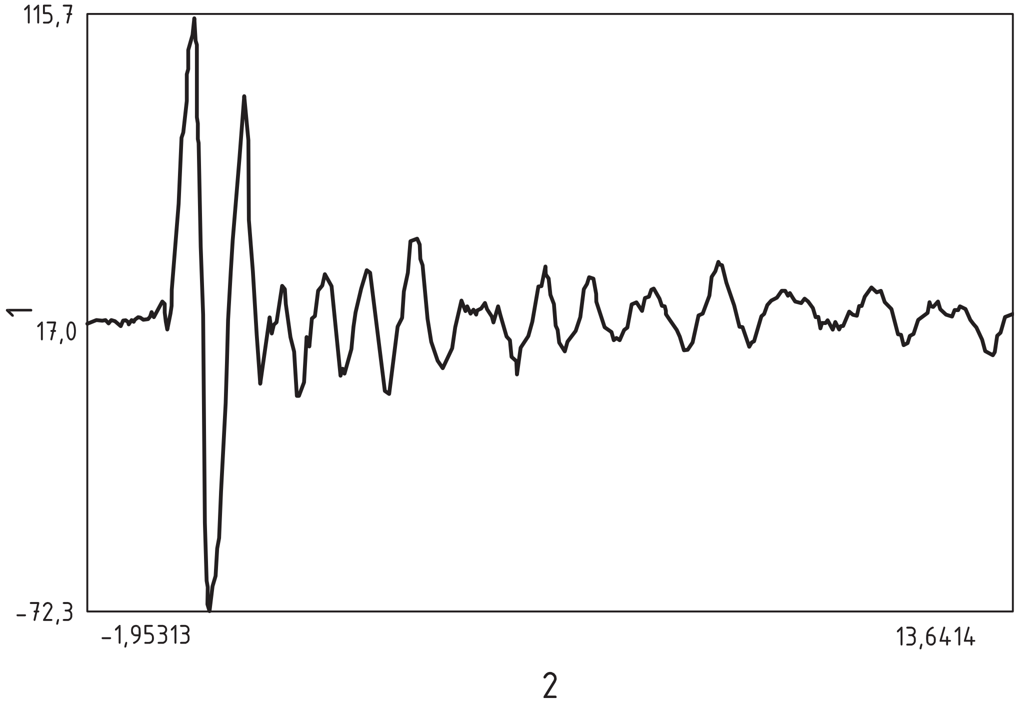


Key

1 strain gauge output (mV)

2 time (ms)

Figure A.1 — Strain record from top gauge on the sleeper using reference pad

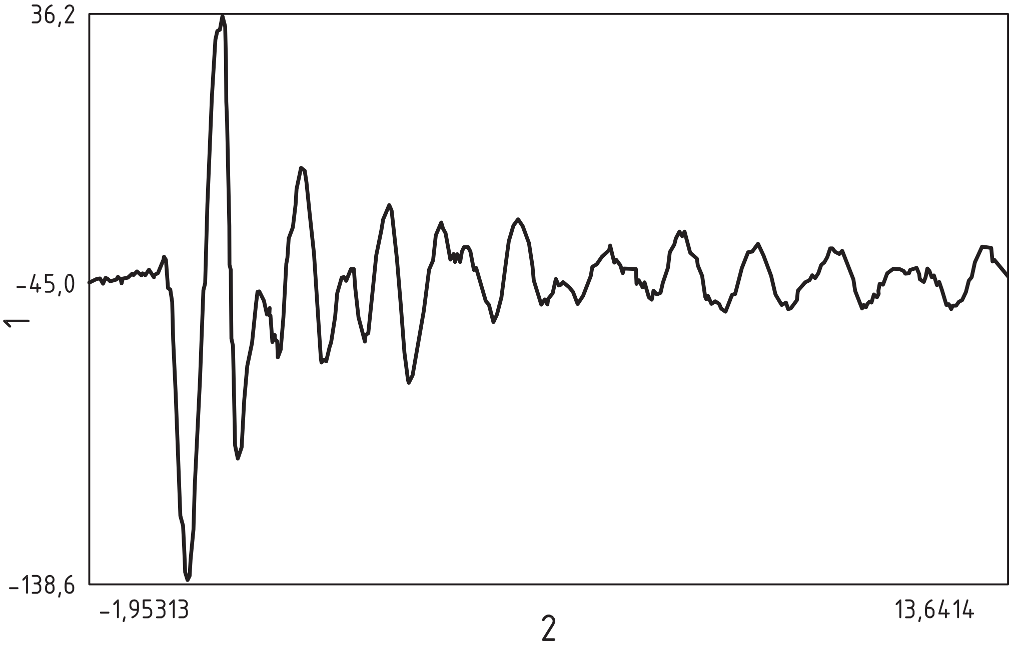


Key

1 strain gauge output (mV)

2 time (ms)

Figure A.2 — Strain record from bottom gauge on the sleeper using reference pad

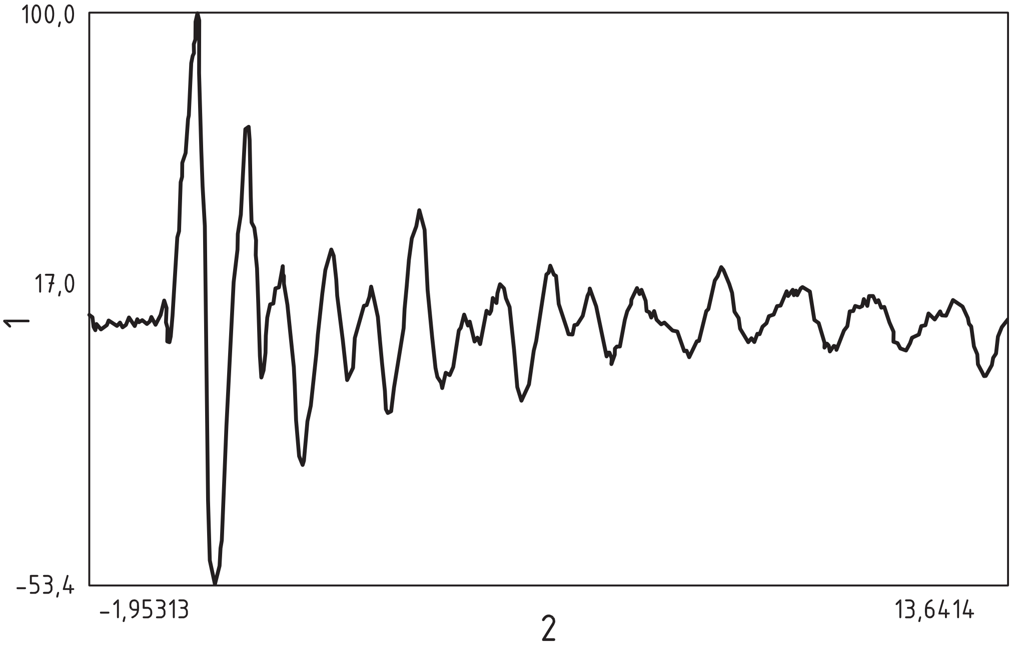


Key

1 strain gauge output (mV)

2 time (ms)

Figure A.3 — Strain record from top gauge on the sleeper using test pad



Key

1 strain gauge output (mV)

2 time (ms)

Figure A.4 — Strain record from bottom gauge on the sleeper using test pad

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BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK