Republic of Turkey

GENERAL DIRECTORATE OF INFRASTRUCTURE INVESTMENTS, RAILWAY CONSTRUCTION DEPARTMENT, ANKARA

MASS-SPRING SYSTEM TECHNICAL SPECIFICATIONS

PREPARED BY	APPROVAL

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MASS SPRING SYSTEM TECHNICAL

1. SCOPE

This specification covers the general characteristics of the Mass Spring System (MSS) to be used on concrete roads.

2. TECHNICAL SPECIFICATIONS AND APPLICATION CONDITIONS OF THE MSS

2.1 MSS will be constructed as a ballastless track and will be used in locations deemed necessary based on the results of noise and vibration analysis (in tunnels, stations, and viaducts) to reduce ground- or structure-borne vibrations and to minimize impact forces acting on structures.

2.2 Prior to construction, the contractor shall submit the MSS type, design calculations, detailed application procedures, and methodology—in accordance with the requirements for the sections where MSS will be used—to the Construction Inspector for approval.

2.3 The Cstat and Cdyn values of the MSS will be determined based on the ground conditions in the tunnels and/or the proximity to residential areas. This assessment will be conducted separately for each area to be used, and a report specifying which MSS with which static and dynamic stiffness will be used in each area will be submitted to the Construction Inspector.

2.4 The combined rail deflection from the concrete road connection system and the MSS shall be designed so that their sum does not exceed 3 mm.

2.5 The MSS to be used must be suitable for the project design speed specified in this bid. The contractor shall guarantee that the mass spring system to be used can operate reliably at the specified project speed.

2.6 To ensure that the elastic mats used in the MSS remain continuously effective and elastic, they must be manufactured from homogeneous, new materials. Profiling (e.g., voids, grooves, strips, etc.) of the mats and the use of plasticizers to achieve the desired flexibility are prohibited.

2.7 During the concrete pouring process, solutions recommended by the MSS manufacturer and approved by the Authority will be implemented to prevent cement from seeping into the joints of the mats.

2.8 Data required by the operator prior to the selection of elastic mats: The DIN 45673-7 standard clearly stipulates that test weights and evaluation areas must be determined in accordance with the requirements of mass-spring systems and superstructure engineering.

Therefore, the fllowing data is absolutely required: [all values in N/mm²]

cr0 = Minimum load (Self-weight of the load-bearing slab)

crl = Operating load (Self-weight and existing traffic load (including deflection coefficient))

cr2 = Load point for evaluation (self-weight and measuring device for superstructure engineering verification (including deflection coefficient))

cr3 = Maximum load (including 1.35 times cr0, 1.5 times the measurement device)

2.9 The MSS will be manufactured from polyurethane, EVA, or pure rubber. No fraying of any kind and/or rubber made from recycled materials shall not be used.

2.10 The MSS to be used in the project must not degrade in terms of mechanical behavior in the presence of water and under normal temperature conditions (between -30°C and 50°C), must be resistant to continuous train loads, and this must be proven through testing.

2.11 The drainage details of the mass spring system shall be submitted to the Authority.

2.12 Transition zones will be designed within the mass spring system at the beginning and end of the MSS. All materials to be used in this application are included in the unit price, and the contractor shall not claim any additional charges.

2.13 Tolerances for the characteristic values of the mass spring systems are ±15%.

2.14 The contractor shall submit the specific gravity and chemical analysis values of the mass spring system to be used to the Authority.

2.15

The MSS to be used will be placed beneath the leveling concrete. The MSS mats will be designed so that they extend 5 cm outward from each side, as shown in the Appendix (Typical Cross-Sections).

3. ACCEPTANCE CONDITIONS

3.1 General

3.1.1. The Construction Inspector shall be authorized to conduct observations at every stage of production. This representative shall be authorized to monitor production methods during the day or at night, to be present during all tests related to the manufactured MSS and the materials to be used in production, and to verify the results obtained from these tests.

3.1.2. For each batch, the MSS manufacturer shall submit to the Authority a Type 3.1 or 3.2 inspection certificate for the MSS material in accordance with the EN 10204 standard.

3.1.3. Test samples will be selected and marked under the supervision of the Construction

Inspector.

3.1.4. The tests and inspections to be carried out for each MSS during acceptance, together with the expected results, are specified in the relevant section.

3.1.5. With the approval of the Administration, if the materials are delivered with a factory warranty, all tests specified in this Specification shall be carried out by the manufacturer at the quantities specified herein, and the test reports shall be submitted to the Engineer for approval. The Engineer reserves the right to request the repetition of some or all of the tests in order to verify the values stated in the relevant test reports.

Should the Building Inspector identify any non-compliance with the specifications or contract provisions regarding the materials, he or she shall be authorized to require that such non-compliance be corrected and rectified or to reject the materials entirely. The Contractor is obligated to comply with the provisions of any written notice issued in this regard and to correct the defects in accordance with the specifications and contract provisions within 10 days at the latest from the date of notification.

3.1.6. The fact that production is carried out under the control and supervision of the Construction Inspection Officers does not relieve the contractor of liability, nor does it require acceptance of the produced MSS.

3.1.7. Test methods, the conditions under which tests are to be conducted, acceptance criteria, and

conditions of application not specified in these specifications, UIC, EN, TS, DIN, and DB standards shall be used. In such cases, the Construction Supervision Officer's approval must be obtained regarding which standard to use, with priority given to the specifications and standards listed below.

a) DIN (German Standards) 45673-7 (Mechanical vibration—Resilient elements used in railway tracks—Part 7: Laboratory test procedures for resilient elements of floating slab track systems)

b) Technical Specifications for the Construction of Ballastless Railway Tracks

c) EN 16432 (Ballastless Track Systems)

3.2 Details of the Tests

Two types of tests will be conducted:

Design and Production Approval Test: These tests are conducted
demonstrate that the materials comply with the design requirements

Routine Acceptance Inspection Tests: These are product inspection tests to be conducted under the supervision and inspection of Construction Inspection Officers during QMS acceptance, outside of the factory's production control processes. In cases where the Construction Inspection Officer cannot participate in the tests, the required material tests will be documented with a 3.1 or 3.2 certificate in accordance with the EN 10204 standard.

3.2.1 Design and Production Approval Tests

- These tests will be conducted for the construction inspector to grant approval to QMS-certified manufacturers' factories.
- Companies shall submit to the Authority the tests and/or approvals demonstrating that the raw material complies with the relevant standard, the technical specifications of the raw material used in MSS production, and the test reports or documents prepared in accordance with the standard to which this raw material is subject. Furthermore, a specific gravity test and chemical analysis shall be performed on the MSS material to be used. The values approved by the Authority must be met.
- Dimension inspection will be performed on 10 samples.
- The tests required for factory approval are listed below.

3.2.1.1 MSS Parameters

- Vertical Static Bedding Modulus (C_{stat-Z}),

  In continuously installed MSS systems, the Vertical Static Bearing Module (C_{stat-Z}) represents the static stiffness of the concrete pavement per unit area. The static support modulus of the MSS, which will be used to reduce vibrations, superstructure-induced noise, and airborne noise, will be determined by calculating the C_{stat} value as specified in Section 2.3. This test will be conducted in accordance with the DIN 45673-7 standard.
- Horizontal Static Bearing Modulus (C_{stat-h}),

  The Horizontal Static Bearing Module (shear stiffness) of the MSS to be used will have a sufficiently high value to ensure the safe distribution of loads in both the transverse and longitudinal directions of the roadway and to ensure the positional stability of the concrete pavement. The tests to be performed will be conducted in accordance with the DIN 45673-7 standard.
- Vertical Dynamic Bearing Modulus $C_{dyn\,(f)}$,

  The frequency-dependent Vertical Dynamic Bearing Module $C_{dyn(f)}$ of the MSS to be used affects the vibration dynamics of the concrete pavement system. The tests to be conducted to determine the $C_{dyn(f)}$ parameter will be performed in accordance with the DIN 45673-7 standard.
- The loss factor Γ,

affects the movement of the precast concrete pavement panel under dynamic train loads and the system's vibration damping capacity. This test will be conducted in accordance with the DIN 45673-7 standard.

3.2.1.2 Mechanical Fatigue Strength

The fatigue test will be conducted in accordance with DIN 45673-7. Following the fatigue test, the change in the static bearing modulus value relative to the initial value shall be less than 20%. Additionally, after the test is completed, the MSS specimen will be visually inspected, and no perforations, tears, damage, and/or any other defects shall be observed. The vibration amplitudes recorded during both loading stages and the results of the visual inspection will be documented.

3.2.1.3 Shear Strength (Shear Creep) Test

This test will be conducted in accordance with DIN 45673-7. Following this test, the change in creep elongation values for the static bearing module and thickness relative to the initial value shall be less than 20%.

3.2.1.4 Material Identification Tests

- Specific gravity of the final product, including the product and all MSS components.
- Chemical analysis results in accordance with values selected by the manufacturer: Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), identification of organic components using an FTIR (Fourier Transform Infrared Analysis) spectrometer, etc.
- The values determined during qualification tests are established as baseline values for quality assurance and quality testing. The material properties established by the qualification tests must be met during production with a maximum tolerance of ±10%.

3.2.1.5 Material and Component Testing

The MSS material to be used on concrete roads must be resistant to all typical environmental effects (water, ozone, oil, etc.). There will be no change in the material's properties during outdoor storage. If the MSS consists of multiple layers, each layer and the interlayer bonding layers will be tested independently.

- **Fire Resistance:** The MSS's fire resistance shall be at most "normal" flammability (Class B2 according to DIN 4102 EN ISO 11925-2).
- **Freeze-Thaw Resistance**: This test will be conducted in accordance with the DIN 45673-7 standard. After completion of 50 cycles, the change in the dynamic bearing modulus $_{Cdyn}$ (f)

  in the dynamic bearing modulus will be documented. The change in the dynamic bearing modulus ($_{Cdyn}$ (f)) will be ≤ 10%. Additionally, the test specimen will be visually inspected, and any cracks or swelling will be noted in the report. Cracks and swelling will not be permitted.
- **Water Absorption Capacity**: This test will be conducted in accordance with the DIN 45673-7 standard.

  and the percentage changes in both volume and mass will be calculated. As a result of the test, the change in mass and volume of the MSS will be :S 35%.
- **Water Resistance**: This test will be conducted in accordance with the DIN 45673-7 standard. As a result of the test, the change in the MSS's tensile strength and elongation at break will be :S 10%.
- **Tensile Strength**: This test will be conducted in accordance with the DIN 45673-7 standard. As a result of the test, the tensile strength of MSS will be > 0.35 N/mm².
- **Resistance to Aging**: This test will be conducted in accordance with DIN 53508. The static bearing modulus will be determined before and after aging. The percentage change in mass will be calculated from the average mass changes measured before and after the accelerated aging process.

  Mass Change: < 3%

  Increase in Static Bearing Modulus: <

  10% Compression Set: < 10%

3.2.1.6 Results to Be Obtained from the Tests

If, in any test conducted as part of the design and production approval tests, the samples fail to meet the required specifications, samples will be collected a second time under the same conditions for the tests that yielded negative results, and those tests will be repeated. If the expected results are not achieved in any of these repeated tests, the manufacturer will be rejected. If the samples collected the second time yield positive results, all tests related to the design and production approval tests

will be repeated; if any of these tests yields a negative result, the manufacturer will b e rejected; if all results are positive, the manufacturer will be granted production approval.

3.2.2 Routine Acceptance Control Tests

3.2.2.1 All test procedures and application methods shall comply with the DIN 45673-7 standard.

3.2.2.2 In routine acceptance tests, 6 samples will be taken for each lot (every 5,000 m^2). However, if the number of test samples calculated based on this ratio is less than 6, all tests will be conducted on a minimum of 10 samples.

3.2.2.3 The routine acceptance control tests required for each delivery are listed below. The values required in the routine acceptance tests will be the same as those required in the Design and Production Approval tests.

- Product dimensions and mass,
- Product density,
- Vertical static bearing modulus (C_{stat-Z}),
- Vertical dynamic support module C_{dyn} (f),
- Horizontal static bearing module (C_{stat-h}),
- Specific gravity and chemical analysis of the MSS material

3.2.2.4 Results to Be Obtained from Tests,

If the samples do not meet the required specifications as a result of the tests and inspections, a second sample will be taken under the same conditions. If the expected results are not obtained from these samples either, that batch will be rejected. If positive results are obtained from the second set of samples, a third sample will be taken for confirmation purposes. The results obtained from the third set of samples will serve as the basis for acceptance.

4. MARKING

Each batch of MSS material submitted for acceptance must include the identifying information specified below

MSS on the top surface, (visible surface) 1 meter intervals

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- The manufacturer's identification mark,
- Year of manufacture,
- Type of MSS produced

5. PACKAGING

It is the contractor's responsibility to establish packaging, shipping, and storage procedures to prevent permanent damage that could adversely affect the use of the MSS units during transportation and storage.

6. WARRANTY

The contractor shall provide a warranty for a period of 24 (twenty-four) months following final acceptance of the work against any manufacturing or workmanship defects that could not be identified during the QMS acceptance and inspection process. Positive reports issued by the Construction Inspector during acceptance and positive results from tests conducted during acceptance do not relieve the manufacturer of liability.

7. PATENT RIGHTS

Patent rights (if any) shall be the responsibility of the manufacturer; any damages incurred by the TCDD Administration as a result of a claim in this regard shall be compensated by the manufacturer-contractor.

8. FINAL INSPECTION

The Administration will conduct final MSS inspections at the delivery locations in Turkey. If, for any reason, the Construction Inspection Personnel are unable to participate in the tests to be conducted at the factory, or when deemed necessary, the Administration reserves the right to have the tests listed in this specification performed by an organization of its choosing. The costs of these inspections and tests shall be borne by the contractor at no charge. Materials found to be defective as a result of these inspections and tests will be rejected.