

TECHNICAL REPORT

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TEST SPECIMEN	Applicant's identification: <i>Protective covers for steel reinforcements</i> Delivery Note No.: 58023
TEST	Impact test. Test of penetration resistance. California Occupational Safety and Health Regulations (CAL/OSHA) Title 8, section 344.90
APPLICANT	AIJU- INSTITUTO TECNOLÓGICO DEL JUGUETE Avenida de la industria 23 03440 Ibi, Alicante
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SIGNATORY/IES

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1.-PURPOSE AND SCOPE

This report summarises the impact test for determining penetration resistance of protective covers for the ends of steel reinforcements used in construction work. These protective covers are components for preventing or reducing damage to workers caused by accidental falls of different reinforced concrete items furnished with these devices and where the steel reinforcements protrude.

AIJU (Instituto Tecnológico del Juguete), the Technological Institute for Toys, representing the company Santa María Inyección de Plásticos, in accordance with the requirements of the California Occupational Safety and Health Regulations (CAL/OSHA), requested that these tests be carried out in order to experimentally evaluate penetration resistance of these protective covers for the ends of steel reinforcements.

In this context, samples, selected and supplied for the "**Penetration Resistance Test**" of section 344.90 of the CAL/OSHA standard, were submitted for testing.

The test was performed in the facilities of the *AIDICO Safety Components Laboratory*, as this laboratory specialises in experimental verification of the requirements that Collective Protection Systems and various Aids and Equipment must meet to be used for performing temporary work at height.

This document references the conditions and results of the test indicated, with the expressly described considerations and limitations stated herein.

2.-APPLICABLE REGULATIONS

The applicant company requests these test to be performed as a first assessment of the protection against the penetration resistance requirements, demanded by the California Occupational Safety and Health Regulations.

The California Division of Occupational Safety and Health (DOSH), through the California Department of Industrial Relations, Division 1, sets out a series of safety standards, organised by type of industry (Chapter 4, Division of Industrial Safety).

In this context, there are safety standards for the construction sector (CSO, Construction Safety Orders, Subchapter 4) arranged by operations or phases of the construction process. In the raising and construction phase of the structure (article 29), special mention is made of the dangers originating from reinforced steel bars (structure reinforcements) (**Section 1712, Hazards associated with the use of reinforcing steel and other similar projections**), indicating the general specifications (dimensions, material) that these protective covers must meet, and establishing the obligation to meet test requirements listed in **Section 344.90, Impalement Protection. Specifications and testing criteria**, (Note 1).

The penetration resistance test, described in this section for protective covers under study (devices to be used to cover impalement risks for staff who are performing work at the same level of protection) consists of subjecting the protective cover to impact caused by free fall of a test mass of 250 pounds (113.4 kg) from a height of 2.3 m.

Note 1: Chapter 3.2 California Occupational Safety and Health Regulations (CAL/OSHA); Subchapter 2. Regulations of the Division of Occupational Safety and Health; Article 14. Limitations on Division Eligibility for Certifications, Licenses and Registrations for Aliens. Section 344.90, Impalement Protection. Specifications and Testing Criteria.

3.- DESCRIPTION AND FEATURES OF PROTECTIVE COVERS

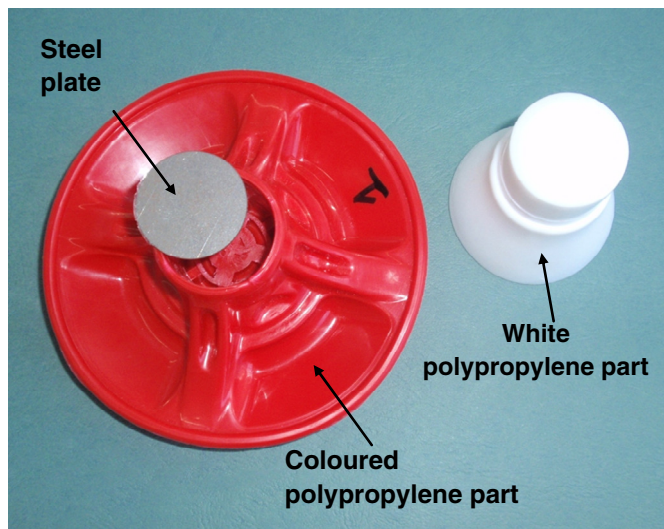
The samples were supplied to the Safety Components Laboratory, prior to the date of assay, and were received and duly stored in the laboratory facilities.

Regarding general specifications (materials, dimensions, etc.) required of these types of protective covers referenced in section 1712 (section d):

- These are made of plastic material, composed of three different parts, manufactured from materials of different types, where the final composition is a composite which must provide the properties sought. The external casing of the protective cover is made of two parts manufactured in polypropylene. They are jointed together with a 2 mm thick steel plate between the white part and the coloured part, providing the resistance capacity against penetration.



Photograph 1: Protection for reinforcement ends, object of the study.



Photograph 2: Components making up the protective cover.

The device has a diameter of approximately 114 mm. The following diagram shows the geometrical features of the supplied protective covers under study.

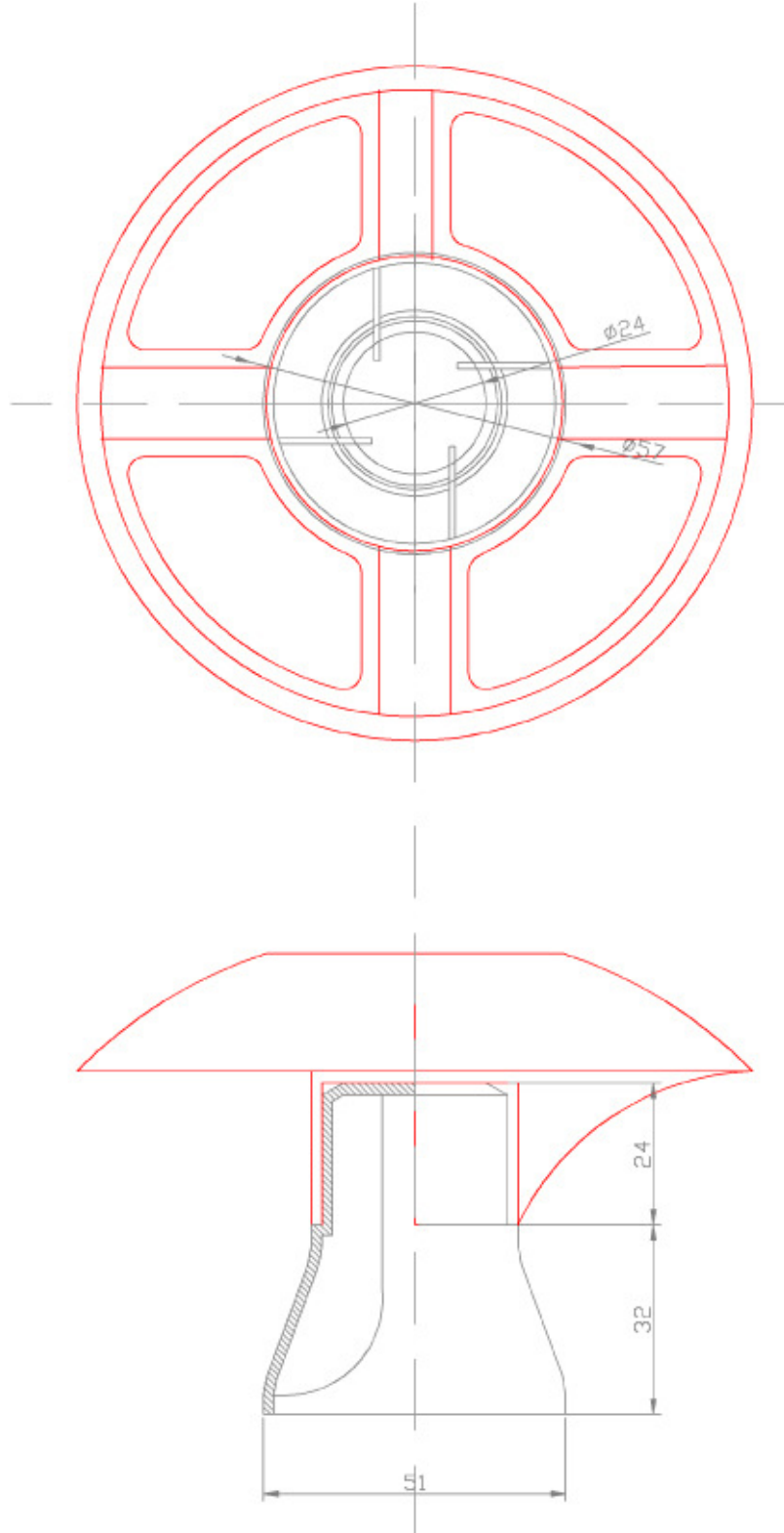


Figure 1: Diagram showing the steel reinforcement end protective cover under study.

4.- DESCRIPTION OF THE TEST PROCESS

Work done

For experimental evaluation of the protective cover under study, a series of tasks had to be performed in advance.

- Prior study of the reference standard.
- Planning of the test schema, reproducing as exactly as possible the conditions of the test indicated in the previously cited standard.
- Reception of the test sample and conditioning in a climatic chamber under controlled conditions for a period of over 72 hours.
- Prior mounting and test execution:
 - **Preparation of the test mass (according to section 344.90, section e.1.A):** it was necessary to make a cylindrical sack weighing 113.5 kg filled with dry sand. The dimensions of the sack are such that it leaves a small extra space at the top allowing movement of the sand. The base of the sack is reinforced with a special material preventing its penetration by the steel bar or the protective cover.
 - **Installation and mounting of the steel bar (according to section 344.90, section e.1.B):** the test must be performed on a bar of size #4 (bars with nominal diameter of 12.7 mm). In this case, the test was performed on bars of **12 mm** diameter. As a supporting structure for mounting the steel bar, a prefabricated concrete beam was used. The bar was installed on it with an exposed length (above the beam) of 150 mm.



Photograph 3: Arrangement of the bar on the test supporting structure.

- **Preparation of the test equipment:** instrumented tower crane, lifting platform, tool for releasing the test mass, test mass, etc.
- Performance of the test, which includes three impacts using a new sample for each of the impacts.
- Photographic report providing evidence of deformation, possible breakages, etc. after performing the different impacts on the protective covers.
- Technical report summarising the behaviour of this protective cover.

Method and nature of the test

To perform the evaluation of the protective cover against the resistance to penetration requirements indicated in section 344.90 of CAL/OSHA, three impacts were performed with a kinetic energy of approximately 2.5 kJ.

The test method is based on the free fall from a height of 2.3 m of a test mass of 113.4 kg that is released by means of a rapid release mechanism, as indicated in the following diagram.

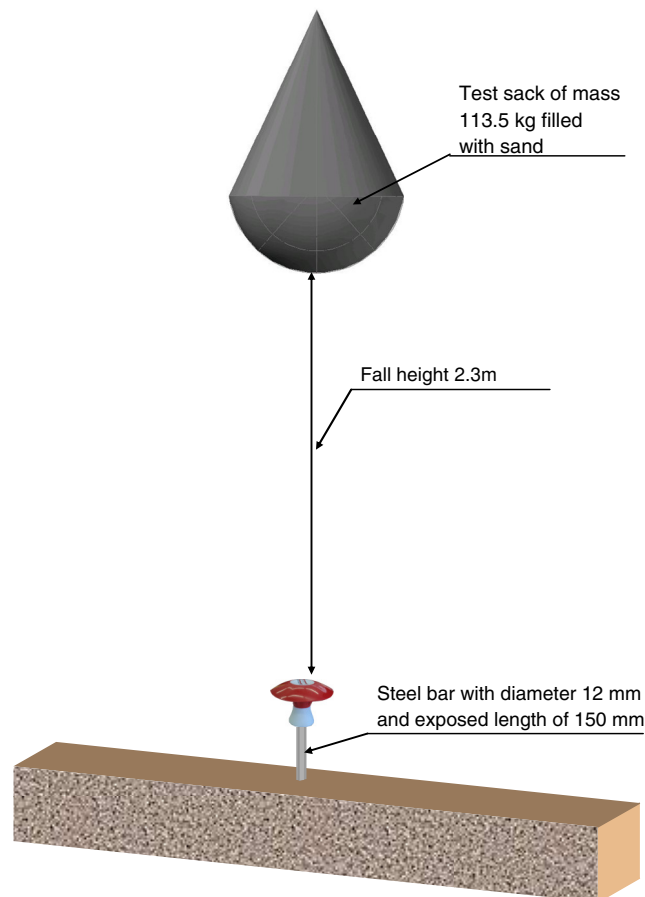


Figure 1: Test schema.

Three impacts were performed, using a new device for each impact:

- The first impact was performed with the protective cover installed perfectly square to the bar.
- The second and third impacts were performed installing the device at the maximum allowed angle with respect to the bar.



Photograph 4: Initial arrangement of the test for the first impact. Placement of the protective cover at right angles on the bar.



Photograph 5: Initial arrangement of the test for the second and third impact. Placement of the protective device with the maximum angle on the bar.

5.- TEST RESULTS DESCRIPTION OF THE BEHAVIOUR OF THE PROTECTIVE DEVICES DURING THE TESTS

The results obtained after the application of each of the impacts, with the conditions and configuration as expressly indicated, is summarised below.

Impact 1: Test with the protective device at right angles

After the application of the dynamic load on the centre of the protective device for the ends of steel reinforcements, the following was observed:

- **The protective device supports the impact made without penetration.**
- Partial breaks were observed in the internal steel reinforcement and in the white part.

Impacts 2 and 3: test with the protective device at the maximum angle

After the application of the dynamic load on the centre of the protective device for the ends of steel reinforcements, the following was observed:

- **The protective device was penetrated by the steel bar.**
- Placement of the protective device at the maximum angle results in the bar penetrating through the zone where the steel reinforcement does not act, penetrating both the white part and the coloured part.

6.- PHOTOGRAPHIC REPORT

First Impact:



Photograph 6: Initial arrangement of the protective cover for the first impact.



Photograph 7: Arrangement of the protective device after the first impact. No penetration of the protective cover by the bar occurred.



Photograph 8: Deformations and partial breaks caused in the mushroom by the impact.



Photograph 9: Deformations and partial breaks caused inside the component.

Second Impact:



Photograph 10: Initial arrangement of the protective cover on the bar for performing the second impact.



Photograph 11: State of the protective cover after performing the second impact. The protective cover was penetrated.

AIDICO is only responsible for the results on the analysis methods used and described in this document and referring exclusively to the materials or samples indicated herein and that remain in its possession, limiting the professional and legal responsibility of the centre to this. Except where expressly mentioned, the samples were freely chosen and sent by the applicant.

This document summarises the results obtained in the previously described tests and requested by the applicant company for its own control process, without it being in any way a certification.

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