THE SPECIAL CONSTRUCTION FACILITY AT INCD-INSEMEX FOR TESTING EXPLOSIVES AND CHEMICAL FERTILIZERS WITH DETONATION IN SAFE CONDITIONS

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Abstract: *Tests on explosives for civil use and chemical fertilizers which are likely to have an explosive behavior, involves special risks when the load is confined in steel tubes. The bunker was designed as a half buried construction, with baffle, with the base plate of reinforced concrete and a steel plate in the blasting area*

Keywords: confined explosive charges, safety, blasting facility.

1. General issues

Technical requirements for testing on site involve detonation of explosive charges in accordance with harmonized European standards with the laws and regulations in force require special equipment and facilities.

Tests on explosives for civil use and chemical fertilizers which are likely to have an explosive behavior, involves special risks when the load is confined in steel tubes.

To avoid risk of injury due to shrapnel resulting from the detonation of explosive charge confined in steel tubes, is necessary to take appropriate measures to protect staff.

To this purpose, in INCD-INSEMEX the explosives test area was made a proper construction for that kind of tests in safe conditions.

This construction should meet a series of very severe requirements regarding the work for which it was provided and the dynamic stresses on structural elements caused by the explosion. Detonation of explosive charges in the confined environment (steel pipe) the explosion generates a pressure that manifests dynamically on constructive elements of the bunker and projects metal shrapnel at thousands of m / s, which due to kinetic energy and very sharp cutting edges can damage the construction.

Given these two aspects had designed a technical solution which, on the one hand to give adequate strength to dynamic manifestation of explosion pressure with its release to the outside and on the other hand an inner plating designed to retain splinters resulting the performed tests

Structure calculation had as primary elements the maximum amount of explosive detonated instantly, predictable, for safe on inside retention of all the splinters, expansion of explosion pressure, a reasonable time to remove fumes explosion in a dilution without a mechanical ventilation.

2. Design, construction and maintenance

The maximum quantity of explosives planned to detonate was established to be 10 kg TNT equivalent of considerations arising from the test procedures applied in the laboratory,

both for civil use explosives detonated confined in steel pipe and for the test the detonability of chemical fertilizers in accordance with European Regulation 2003/2003.

This maximum amount was the result of calculations that are necessary for testing of chemical fertilizers on detonability with high ammonium nitrate content where the effective approximate load in the steel tube is 8.5 kg fertilizer and it is applied a booster of 500 g for initiation weight. The 10 kg TNT equivalent considered results from applying a safety factor to compensate for the sudden increase of pressure on the walls and ceiling of the construction and cumulative effects that lead to "fatigue of material " (steel concrete), after such repeated dynamic loads.

Figure 1. *General view of the blasting facility (bunker)*

The bunker was designed as a half buried construction, with baffle, with the base plate of reinforced concrete and a steel plate in the blasting area in accordance with the standard SR EN 13631-11, and the walls should be provided with replaceable liners of hardwood.

The resistance structure of the bunker consists of reinforced concrete, with high density of corrugated iron-Φ16 mm in brush and cast at once as a concrete structure piece.

Parameters for calculating the internal volume of 28 mc (3,15 x 3,15 x 2,8 m) to explode the maximum amount provided for 10 kg TNT equivalent explosive generates a maximum dynamic pressure varied according to certain structural elements of the location load (which detonates on the floor).

Explosion pressure decreases exponentially with increasing the distance from the structural elements, so the calculations revealed a maximum: at the ceiling 8 N/cm^2, at the walls 15 N/cm^2 and at the floor 20 N / cm $^{2.}$

Figure 2. *Fumes resulted after a blasting operation in the bunker*

If charges of explosives for civil use are detonated (e.g. Determination of velocity of detonation) in the confined environment, the explosive charge is placed freely suspended near to the geometric center of the room with the remark that of the charge will be smaller than the 10 kg TNT equivalent considered in the design.

Figure 3*. Confined explosive charge placed in bunker – ready to blasting*

Where the blasting scheme of chemical fertilizers for detonability test established in European Regulation 2003/2003, the charge confined in the steel pipe inside Φ100 mm, is placed on six lead cylinders with 100 mm height on a steel plate with thickness of 120 mm, on the floor in the center of the room.

Figure 4. *Blasting scheme for the detonability test for chemical fertilizer in bunker*

In this situation the pressure on the floor is considerably higher than that exerted on the walls and ceilings. Protecting the reinforced concrete construction elements resulting splinters after blasting charges was confined with half balls of wood on walls and ceiling and a thick layer of sand 120/150mm.at the floor. Wooden balls were mounted to protect the ceiling and walls are destroyed relatively quickly (3-5 shooting) with charges close to the nominal, and the often replacement is necessary.

In order to reduce human labor consumption in refurbishing and maintenance activities in 2011 was decided to replace the wooden ceiling plating with steel armor, 20mm thick sheets, fixed on a metal frame made of rectangular sections of mining type track.

3. Conclusion

The structure is operational from 2006 fulfilling to the needs of the testing laboratory, while behaving well, being made a considerable number of bastings in maximum safety conditions, without damage to the structure of resistance.

4. References:

[1] *Regulation (EC) nr.2003/2003 of the European Parliament and of the Council* of 13 October 2003 relating to fertilizers.

[2] *Recommendations on the TRANSPORT OF DANGEROUS GOODS. Manual of Tests and Criteria. United Nations* New York and Geneva, 2003.

[3] **Rus, D.C.,** *„Studiu privind situaţia pe plan mondial şi European a capacităţii tehnice de efectuarea ciclurilor termice pentru realizarea testului de detonabilitate a îngrăşămintelor chimice cu conţinut mare de azotat”*, INSEMEX Petroşani, 2010.

[4] *Test Procedure ETI-PI-2.2 "Determination of the detonability of fertilizers based on ammonium nitrate with high nitrogen content.* INSEMEX Petroşani, 2010