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STUDIES AND EXPERIMENTAL RESEARCHES ON THE AGGRESSIVE BODIES THAT COME INTO CONTACT WITH THE POLYETHYLENE PIPES

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ABSTRACT Following previous studies, the present paper aims to perform several experimental tests on the Instron traction, compression testing machine for the validation of the results obtained through analytical studies and by means of the finite elements of the specialized software.

KEYWORDS : insulation, mechanical action, polyethylene.

1. Introduction

Compared to the fracture of metals, the study of the fracture resistance of polymers is in an early stage [2]. Many of the required theoretical supports are not fully finalized and there are many situations where the concepts of fracture mechanics that apply to metals are no longer applicable to other materials. The fracture resistance of polymer materials has become a major concern recently, when they begun to be used for critical structures. The problem we intend to find a solution for comes from the bibliographic study, in which due to the inappropriate use of the polyethylene pipe protection factor (sand with specific granulation) pinches of various forms appear on the surface of the pipeline unprotected by the latter and other elements (stones, metal parts, etc.) destroy the superficial protective layer and create cracks on the surface of the pipe. [2]

In the case of metals, fracture and yield follow a yielding mechanism. Fragile fracture occurs in materials where deformability is low. Ductile metals, by definition, suffer extensive plastic deformations prior to fracturing. From a general point of view, these principles can also be applied to polymers, but the microscopic details of the yield and fracture of plastics are much more different than for metals.
According to this classification, this chapter will cover the static analyses conducted for the high density polyethylene pipe PE 100 SDR 11 with a Dn 32 diameter used in the natural gas distribution systems.

In order for this study conducted by means of the finite elements to be comparatively precise, we considered that the displaced volume of the bodies is identical and the crush depth of the material is 1 mm.

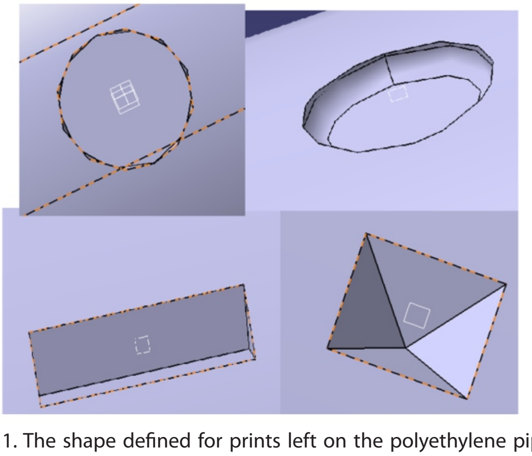

Fig. 1. The shape defined for prints left on the polyethylene pipe (sphere, ellipsoid, triangular prism, right pyramid)

Fig. 2. Shapes of rock that can interact with the polyethylene pipes

In day-to-day practice, there are various shapes of the soil rocks that can accidentally come in contact with the polyethylene pipe. They are shown in Figure 7.
The study resulted in the establishment of four representative models (sphere, ellipsoid, triangular prism, right pyramid) which are presented in Figure 8.

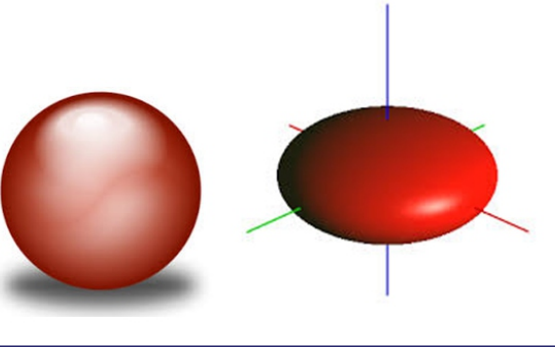

Fig. 3. Representative shapes of the mechanical elements that can affect the integrity of the polyethylene pipe

2. Mechanical Tests

These tests were conducted on the Instron 4303 testing machine. The universal traction, compression and buckling testing machine Instron 4303 is a universal testing tool shown in Figure 4.

The machine has a maximum load capacity of 25 kN, controlled through the IEEE-488 interface and the specialized Material Testing System series IX software. This universal testing tool facilitates the control of the speed of the mobile crosshead to an accuracy of 0.5% and the recording of the force with a precision corresponding to class ASME 4-E or DIN 51221 Class 1. The mobile head's control system allows the programming of the moving crosshead's speed and assures the control of the mobile head's position.

The resulting data are specific to the test types for which the machine was built, thus loads, displacements, stresses, specific strains, energies. During a test, the results appear as instantaneous values of the load and of the displacement or of the stress and specific strain, and at the end of the test, they appear as peak values or registered in the points specified by the user.

Fig. 4.a. The traction, compression and buckling testing machine Instron 4303.

The power supply to the Instron machine is controlled by a switch (1). In order to avoid accidental startup, the machine is provided with a mushroom-headed button (2) and it contains two grips for clamping the two rams: (3) for the fixed ram and (4) for the moving ram. The moving crosshead (6) moves vertically by means of the ball screws (8) mounted on the fixed frame (16) and protected against blows, dust and possible splinters by the protective covers (9).

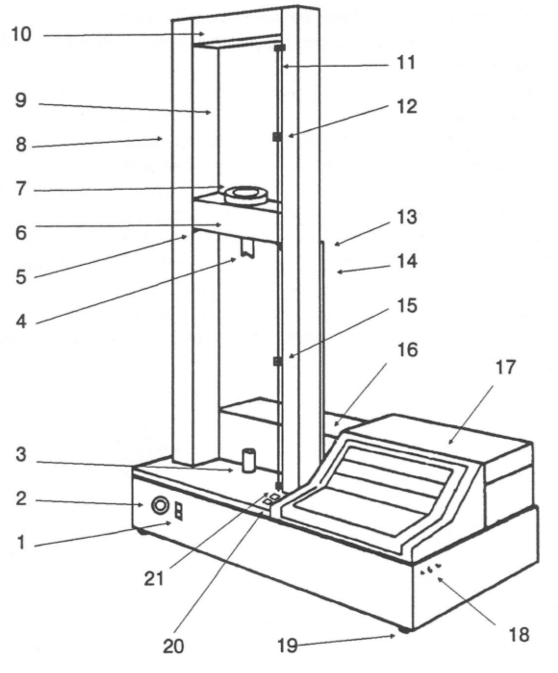

Fig. 4.b. The traction, compression and buckling testing machine INSTRON 4303.

The fixed frame is stiffened by means of the fixed crosshead (10) located at the top of the machine. The transducer for measuring the force (7) and the limit ring that avoids loading the machine with a force exceeding 25 kN (5) are mounted on the moving crosshead. Parallel to the two columns of the fixed frame there are two rods at the end of which there are two limit rings which are designed to avoid hitting the moving crosshead on the fixed crosshead (11) and on the lower part of the fixed frame (4). On these two rods there are also two other mobile limit rings that delimit the working area of the machine according to the size of the work stroke (12, 15). The transducers for measuring displacements (13) and the connectors used to transmit the information from the transducers to the measuring system (14) are mounted on the right-hand column of the fixed frame. On the right of the columns there is the Instron 4303 console (17) used for setting the movement, loading and moving speed of the moving crosshead. The console is also used for connecting the IEEE interface to the computer. The console is provided with a locking system (18) to prevent accidental startup during transport. The machine is provided with four supporting legs (19) for adjusting its position. This must be parallel to the ground in order to avoid the occurrence of measurement errors. There are two buttons next to the work console which allow the fast ascent and descent of the moving crosshead to facilitate the positioning of the clamping jaws at the first test.

The obtained data can be plotted directly in the force-displacement coordinates. However, they are generally converted into stress-strain coordinates.

The experiment program is based on the following:

- the specimens were made;
- the most widely encountered test items have been established;
- a testing method has been developed in the INSTRON test machine's own language, namely the MATERIAL TESTING SYSTEM.

Figure 5 shows the specimens used for the testing and the actual testing methodology on the INSTRON 4303 testing machine.

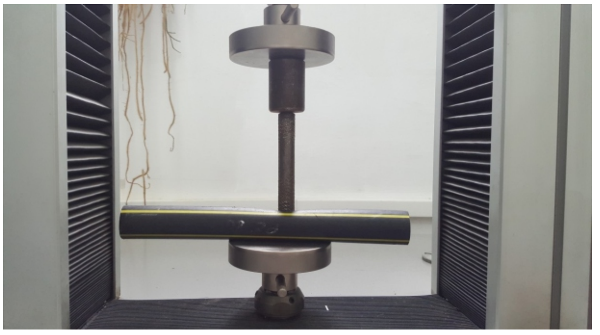

Fig. 5. Imprinting the polyethylene pipes with a 1000 N force in order to measure the deformations produced by the four pins

The measurement of the punch depth immediately after releasing the part led to the following values of the displacements.

Shape of print	Value of displacement [mm]
Circle	0.47
Ellipsis	0.43
Prism	0.49
Pyramid	0.53

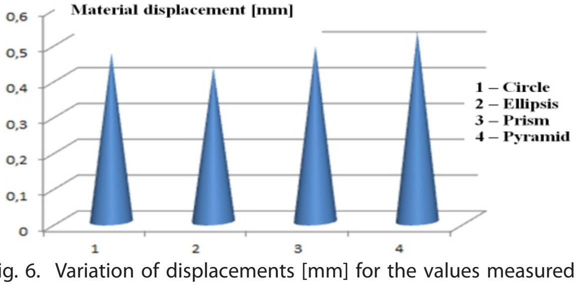

Fig. 6. Variation of displacements [mm] for the values measured after the tests

3.Conclusions

The following conclusions resulted from the present research:

- After conducting a bibliographic study we noticed that the accidentally encountered shapes are those chosen in the present research;
- The means of conducting the analysis for the theoretical, analytical and experimental study were established, so that the results of the chosen methods would be comparable;
- We reproduced the main prints considered the result of the accidental pressing of the bodies on the high density polyethylene pipes used in natural gas distribution systems;
- The pipelines have been modeled with the chosen real-size shapes and they have been subjected to a certain chosen force, observing which of the chosen shapes shows a higher stress;
- It can be noticed that there is a slight difference between the value of the experimentally determined displacements and those determined by means of the finite element method, a fact that can be attributed to the elastic rebound of the material.

It has been noticed that the present subject is topical and approaches aspects related to the correctness and the importance of conducting such works, taking into account the existing danger. Thus, the emphasis will be laid on following-up such works in order to make sure the stages of the works are observed in the natural gas distribution networks.

This topic will be developed in future studies for other diameters and work situations encountered in day-to-day practice.

References

1. AVRIGEAN, E. Studii teoretice si experimentale asupra comportarii mecanice a ansamblurilor sudate de tevi si fitinguri din polietilena de inalta densitate. "Lucian Blaga" University Publishing House, Sibiu. 2015.
2. Balan, M. L. Contributii la utilizarea procedeului de sudare cap la cap a tevilor de polietilena destinate transportului si distributiei gazelor naturale. Doctoral thesis. Sibiu, 2009.
3. DUSE, D. M. , BONDREA, I. Fabricatia integrata de calculator CIM a transmisiilor cardanice. "Lucian Blaga" University Publishing House, Sibiu, 2003 - chapter 3 - Model of a market study on cardan shafts.
4. LUPU, N.I. Conducte din polietilena in sistemele de distributie. "Lucian Blaga" University Publishing House, Sibiu, 2000.
5. MURARIU, C. Influenta imperfectiunilor imbinarilor sudate ale structurilor din polietilena de inalta densitate asupra comportarilor mecanice. – Doctoral thesis. Timisoara. 2008
6. OLEKSIK, V., PASCU, A.M. Proiectarea optimala a maşinilor si utilajelor, "Lucian Blaga" University Publishing House, Sibiu, 2007.