COMPARISON BETWEEN THE MECHANICAL PROPERTIES OF CLASSIC POLYETHYLENE TUBES AND COMPOSITE POLYETHYLENE TUBES

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Abstract: *Polyethylene piping industry has a known in the past couple of years, an important growth. The usage of this kind of pipes is widely spreader through various areas, such as water supplying, heating and so on. One of the major issues with this kind of tubes is the burst of material, caused by in tube pressure. To improve its behaviour, to the polyethylene tube was added a fibreglass coating. This procedure insures higher proprieties that allow the tube to be used at higher pressure points. In the following paper we will compare the normal polyethylene tube with the composite one, using as reference the circumferential proprieties of the tubes.*
Keywords: *polyethylene, fibreglass, circumferential direction, pressure*

1. INTRODUCTION

Nowadays plastic made products are found everywhere. The demand increases as the number of housing projects expands. The piping industry is one of the most sensitive to all of this. Without indoor and outdoor plumbing our lives will be harder to live. Therefore there are a large number of available products on the market, as the research to finding new and efficient materials continues.
In the following study we try to determine the circumferential proprieties of polyethylene composite tubes and compare them to classic polyethylene tubes, which are used especially for water supplying.
On the current market there we are able to find composite polyethylene tubes made with aluminum core that are resistant to higher pressure points and are also very easy to handle because of the metal embedded. But this concept is mainly used in heating tubes rather than water supplying.
We propose a tube made of one sheet polyethylene of 3 mm thick; a double sheet of fiber glass that was embedded with resin is added, lastly a sheet of polyethylene coating is added. In the figure below is shown a section of the three layered material tube.

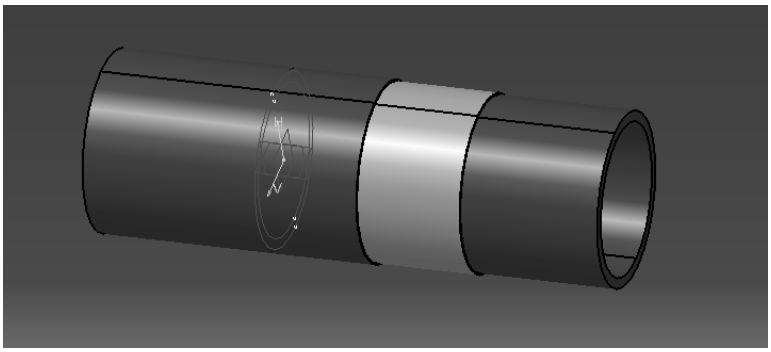

Figure 1: Layout of the composite tube

The small amount of reinforcing material will increase the mechanical proprieties of the tube, making it more resistant to higher pressure points.

The samples that will be tested are shown in figure 2. The dimensions of the reinforced tube are 2 mm larger in diameter than the simple tube.

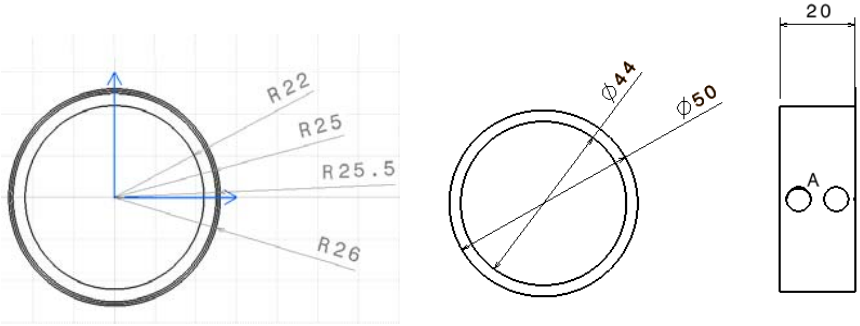

Figure 2: Dimensions of composite tube (left) and polyethylene tube (right)

2. FINITE ELEMENT ANALYSIS

For the finite element analysis the load was applied at an angle of 100 degrees, on the opposite sides of the concentration points. The concentration point area was the one were the boundary conditions were set. The only degree of freedom that was blocked was on the y axis, so the model won't glide with the direction of the center axis. Based on a previous study made upon samples of polyethylene pipes, the model chosen was with two concentration points [6].

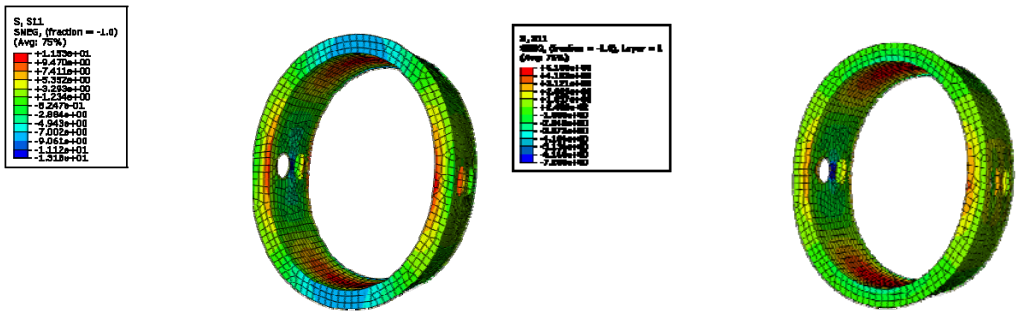

Figure 3: Normal stress for polyethylene tube (left) and composite tube (right)

In the figure above (Figure 3) we present the variation of the normal stress on the whole body of the sample. As it can be shown, the area in which the values are at a higher point are the ones on which the pressure was applied. The purpose was to observe the distribution of stress in the area were the concentration points are.

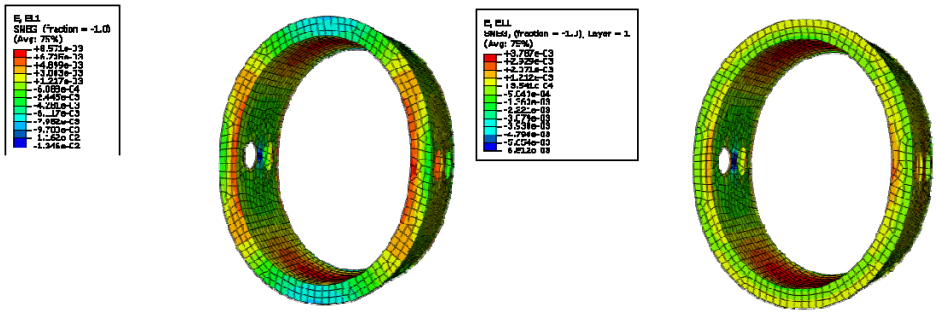

Figure 4: Strain for polyethylene tube (left) and composite tube (right)

Figure 4. brings a comparison between strain in x direction for both samples. The higher values are recorded on the polyethylene tube.

3. RESULTS

For the results we extracted the values of the normal stress on the x direction, and the strain, also on normal direction. The area in which the values were probed was the one with the concentration points.

Table 1: Values for normal stress and strain on x direction

node	S11-pe tube	S11-composite tube	E11- pe tube	E11- composite tube
553	4.28992	0.674159	0.001367	0.0001389
2808	3.16051	0.085942	0.000975	-0.000365
588	2.03111	-0.52278	0.000519	-0.000837
580	-11.1789	-6.41629	-0.0117	-0.0057
2815	-13.1789	-7.19994	-0.01346	-0.00651
574	-11.6739	-6.41512	-0.01176	-0.00573
567	2.81573	-0.50843	0.000563	-0.000812
2814	3.88786	0.045386	0.001041	-0.000394
535	4.60987	0.059988	0.00139	-0.000000573

The values obtained in the simulation process were compared for normal stress and strain, as shown in the following charts (Figure 5). The values were negative in the area between the concentration points, getting more constant on the strait surfaces that follow those points.

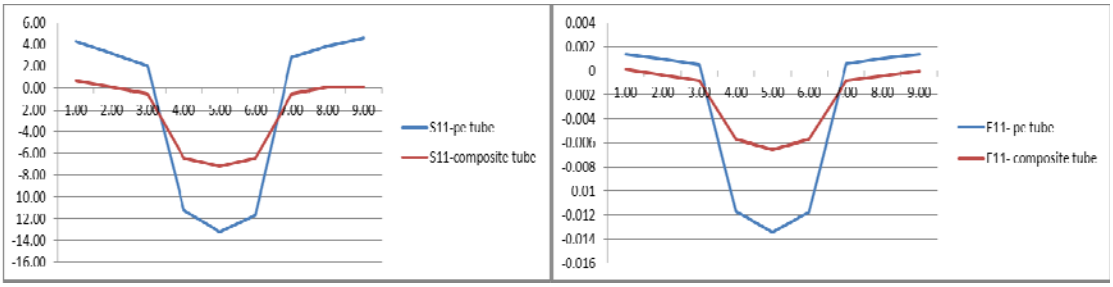

Figure 5: Charts for stress and strain for both polyethylene and composite tubes

4. CONCLUSION

Regarding the two cases that were simulated, the polyethylene sample had a distribution of stress that was less uniform and registered higher values of both strain and stress than the ones registered for the polyethylene fiberglass tube. Therefore, the composite pipe will be appropriate for usage at higher pressures. The fiberglass coating provides enough strength to be three to four times stronger than the normal polyethylene pipe. The extra cost for material is justified by the safety of usage and thus longer life of the pipe.

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