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ABOUT THE STUDY OF STRESSES FOR DESMOPAN MEMBRANE BY FINITE ELEMENTS METHOD (FEM)

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ABSTRACT

This paper presents an original work about the study of stresses for a desmopan membrane by Finite Elements Method (FEM). The desmopan is a thermoplastic polyurethane, so an anisotropic material for which is made in a very wide range of models and types. This requires as input the mechanical characteristics, determined by Digital Image Correlation Method (DICM) and the geometrical characteristics. The stresses, output of FEM, are necessary to calculate the fatigue resistance to limited durability to fracture and after, the reliability studies of membranes. This work forms the basis of reliability studies of the desmopan membranes, that diaphragm pumps are equipped. Determination of fatigue resistance to limited durability for desmopam membrane is very important to estimate the membrane life, respectively, determining the number of failure cycles.

Keywords: Desmopan membrane, Mechanical characteristics, Geometrical characteristics, Stress analysis, Finite elements method (FEM).

1. INTRODUCTION

Membrane stresses analysis by theoretical modeling completed the applied membrane research with determination the necessary elements for calculus of fatigue resistance to limited durability of pump membranes. Determination of fatigue resistance to limited durability for desmopam membrane is very important to estimate the membrane life, respectively, determining the number of failure cycles.

This paper presents an original work about the study of stresses for a desmopan membrane by Finite Elements Method (FEM). This requires as input the mechanical characteristics, determined by Digital Image Correlation Method (DICM) and the geometrical characteristics.

Theoretical calculus of curved plates [1] and the plate analytical calculus, Cretu [2] and Warren [3], are known.

The mechanical characteristics for desmopan membrane are determined by Digital Image Correlation Method (DICM), [4], after Botean [5] and (http://www.dantec-dynamics.com). They are input for Finite Elements Method (FEM), Botean [5], Hardau [6] and Suciu [7], with geometrical characteristics and the loads too. The stresses, output of FEM, are necessary to calculate the fatigue resistance to limited durability to fracture and after, the reliability studies of membranes.

2. THEORETICAL PREMISES FOR FINITE ELEMENTS METHOD (FEM)

Thoeretical premises of Finite Elements Method (FEM) for membrane study is known Botean [5], Hardau [6] and Suciu [7]. For theoretical stress analysis and stress determination for desmopan membrane was used FEM for axially symmetric revolution pieces [7].

The stress values obtained for desmopan membrane studied by FEM will be used to calculate the fatigue resistance to limited durability for the desmopan membrane.

3. MEMBRANE STRESS ANALYSYS BY FINITE ELEMENTS METHOD (FEM)

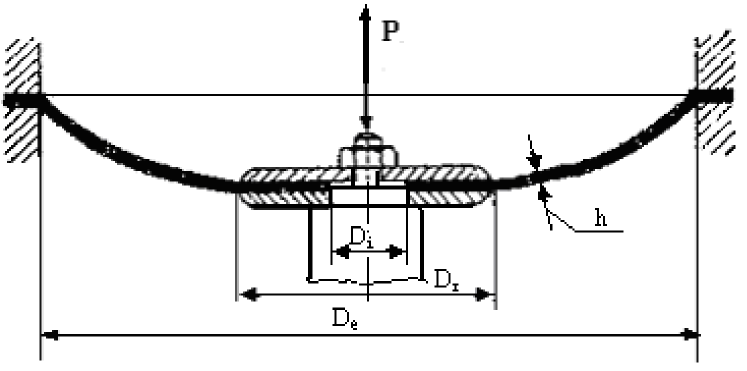
The desmopan is a thermoplastic polyurethane, so an anisotropic material for which is made in a very wide range of models and types.

After determining the material characteristics for desmopan specimen by Digital Image Correlation Method (DICM), [4], we did membrane stress analysis by Finite Elements Method (FEM). It was considered a desmopan membrane (Fig-1.) from a D82 diaphragm pump.

Fig-1. Desmopan membrane.

It has the following geometrical characteristics: D_e = Ø 101 mm, D_r = Ø 56 mm, D_i = Ø 14 mm, h=3,51 mm, the longitudinal elastic modulus - E=38 MPa (Suciu L. et al., 2013), Poisson's ratio – ν = 0,38 [4], resting and loaded as shown in Fig-2.

Fig-2. Request scheme for desmopan membrane.



The membrane is loaded with 3 sets of pressure (0,5 MPa; 1,5 MPa; 2,5 MPa), considered to have acted on the range between D_e and D_r, membrane is supported on exterior contour, with 10 mm imposed displacement, limited by piston race.

Meshing was done in 4167 triangular elements with 2187 nodes (Fig-3.).

Fig-3. Meshing for desmopan membrane.

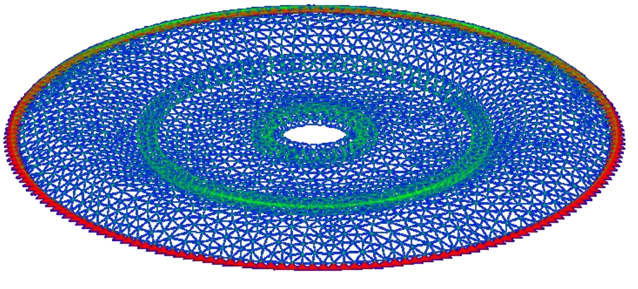
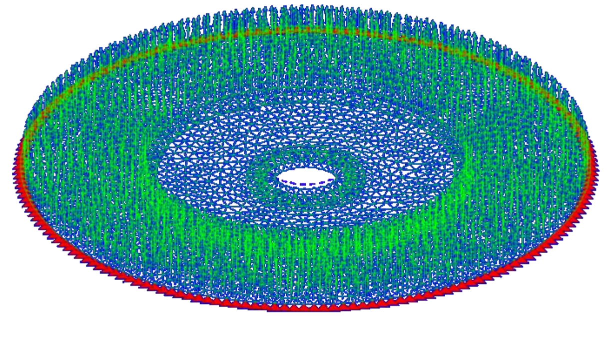


Fig-4. Charging for desmopan membrane with pressure p.



Modeling by FEM was done with Résistance Des Matériaux (RDM) Program, for three load cases with uniform pressure (0,5 MPa; 1,5 MPa; 2,5 MPa) – Fig-3. In each of the three cases, the soft gave equivalent stresses after Tresca, $\sigma_{ech\,Tresca}$, main stresses σ_{xx} and σ_{yy}, and deformations.

Membrane loading with RDM modeling program is shown in Fig-4.

4. RESULTS AND INTERPRETATION

Of the three loading cases, we presented an example for the pressure p=1,5 MPa.

Fig-5. shows the equivalent stresses after Tresca on the membrane section and Fig-6. shows the diagram variation of this stresses for p=1,5 MPa.

Fig-5. Breakdown stresses $\boldsymbol{\sigma_{ech\ Tresca}}$ on membrane section for p=1,5 MPa.

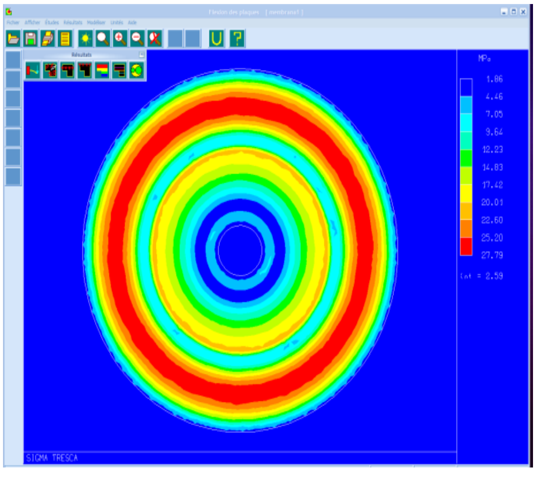


Fig-6. Variation stress diagram for $\boldsymbol{\sigma_{ech\ Tresca}}$ on membrane section for p=1,5 MPa.

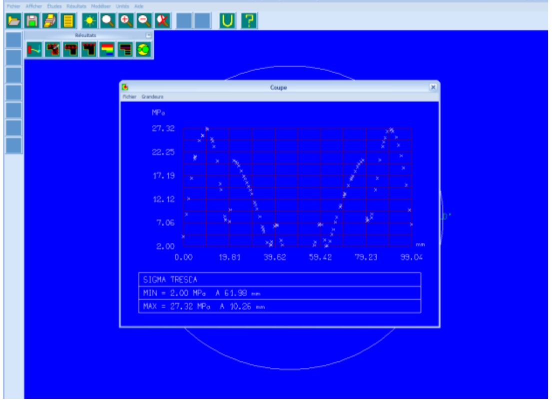


Fig-7. shows the main stresses $\boldsymbol{\sigma_{xx}}$ on the membrane section and Fig-8. shows the diagram variation of this stresses for p=1,5 MPa.

Fig-7. Breakdown main stresses σ_{xx} on the membrane section for p=1,5 MPa.

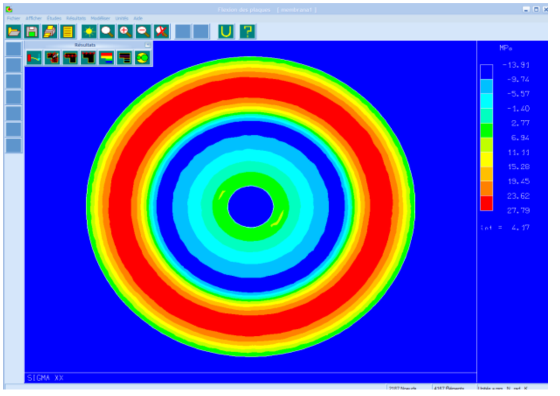


Fig-8. Variation of main stress diagram for σ_{xx} on membrane section for p=1,5 MPa.

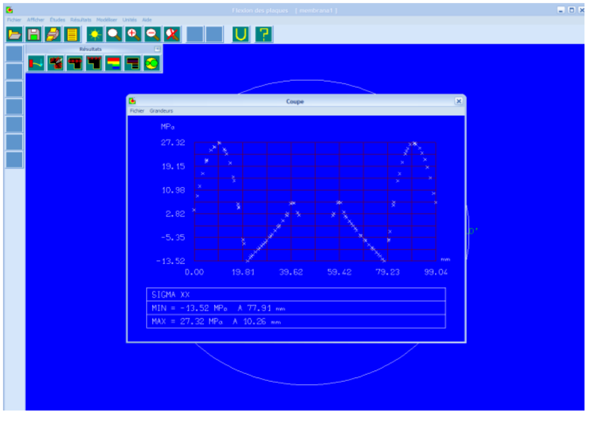


Fig-9. Shows the main stresses σ_{yy} on the membrane section and Fig-10. shows the diagram variation of this stresses for p=1,5 MPa.

Fig-9. Breakdown main stressess σ_{yy} on the membrane section for p=1,5 MPa.

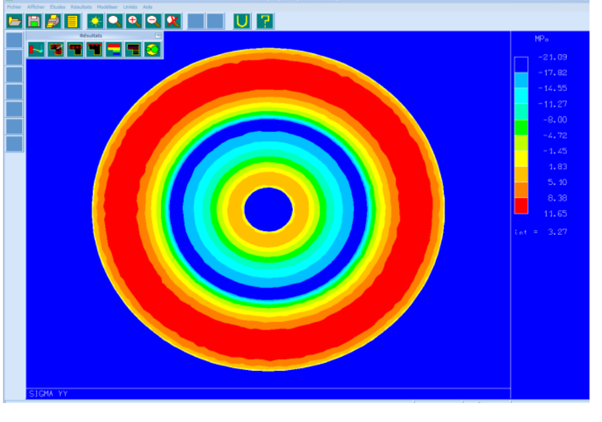
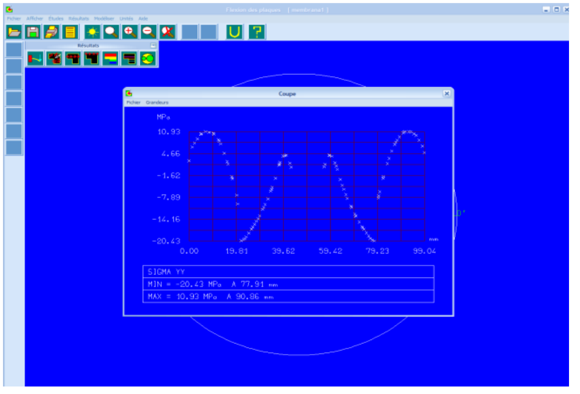


Fig-10. Variation of main stress diagram $\boldsymbol{\sigma_{yy}}$ on membrane section for p=1,5 MPa.



Similarly, figures and diagrams were obtained for the other two sets of pressure. Table-1. gives numerical values read from figures and diagrams.

Table-1. Numerical values for equivalent stresses after Tresca and principal stresses, calculated by FEM.

Pressure p [MPa]	**Equivalent Stresses after Tresca [MPa]**		**Principal Stresses σ_{xx} [MPa]**		**Principal Stresses σ_{yy} [MPa]**	
	max	min	max	min	max	min
0,5	9,44	0,06	9,24	-5,27	3,71	-6,86
1,5	27,32	2,00	27,79	-13,92	11,65	-21,09
2,5	45,36	4,17	46,23	-22,8	19,63	-35,4

This results summarized in Table-1., will be used for the calculus of fatigue resistance to limited durability for the desmopan membrane in real operation.

5. CONCLUSIONS

Values deduced by Finite Element Method are very important for future research, because the desmopan membrane is the least resistant component leading to decommissioning diaphragm pumps. The stresses values will be used for the calculus of fatigue resistance to limited durability for the desmopan membrane in real operation After, we can do reliability studies of desmopan membranes, that diaphragm pumps are equipped.

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