THE STRESS VARIATION BY CHANGING THE SUPPORTING POINT LOCATION IN THE MOTOR VEHICLE CLUTCH ASSEMBLEY

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Abstract: *The diaphragm spring as one of the most important parts of the motor vehicles clutch assembly provides the compressive force on the pressure disk. This force is needed for generating friction between the coupling of the flywheel and the pressure disk and transmitting the torque from the engine to the transmission. Therefore the diaphragm spring is subjected to complex loads. The nominal stress for dimensioning the spring is the tangential stress, which is calculated by the terms of Almen and Laszlo. The aim of this research is analyzing the location of the diaphragm spring supporting points of the clutch assembly and its effect on the caused stresses by using the Finite Element Method.*

Keywords: DIAPHRAGM SPRING, FRICTION CLUTCH, EXPRESSIONS OF ALMEN AND LASZLO, TANGENTIAL STRESS

1. Introduction

The clutch coupling allows the engaging and disengaging of the vehicle transmission. The required compressive force for creating the friction necessary for torque transmission is achieved by the diaphragm spring. When performing its function, the diaphragm spring is subjected to dynamic loadings. The stresses occurring at the spring are compression and extension, figure 1. [1],[2].

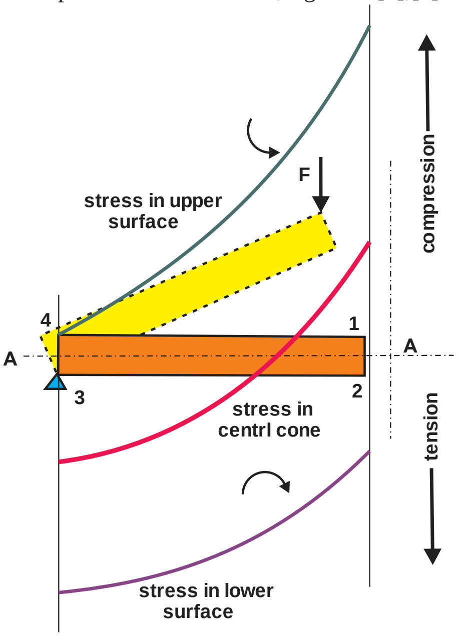


Fig. 1 *Spring stresses*

The diaphragm spring use the clutch assembly couplings has the location of the supporting points as shown on the picture or in the case of a vehicle those are a supporting edges, figure 2.

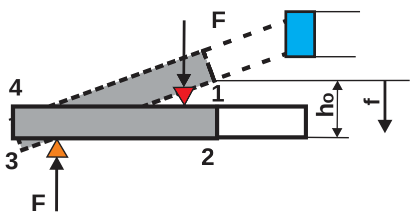


Fig.2 *Diaphragm spring with its supporting points*

By mounting the clutch in the vehicle, the shape of the spring changes, from its conical shape it becomes flat (it makes a deviation f = h_o), and then the process of spring loading starts. The spring has two points of interest. Point 1 where the force F acts (created by the spring deflection) and the point 3 where the spring is supported, where the force is also equal to F. When the spring is in the flat position, the compression force allows the torque to be transmitted. Moving the release bearing for a certain path (deflection) causes the clutch to disconnect [3], [4].

2. Researching

The purpose of this research is by using the finite element method to determine the spring stress depending on the location of the supporting points in both the flat or mounted position and at the maximum deviation or disengaged position.

The analysis were carried out on a diaphragm spring for commercial vehicles with next dimensions : internal diameter of a diaphragm spring D_i = 313 [mm], outer diameter of a diaphragm spring D_a = 395 [mm], spring thickness s = 5.2 [mm], Module of elasticity of the steel E = 206000 [N /mm^2], Poison number of spring steel μ = 0.3, internal diameter of the diaphragm spring with supporting points D_{ip} = 336 [mm], outer diameter of the diaphragm spring with supporting points D_{ap} = 392 [mm], path of the clutch while disengaging ℓ = 12 [mm], release bearing diameter d = 120 [mm]. [5], [6]

Figures 3 and 4 shows the distribution of forces acting on the spring, with one and two supporting points used for the clutches.

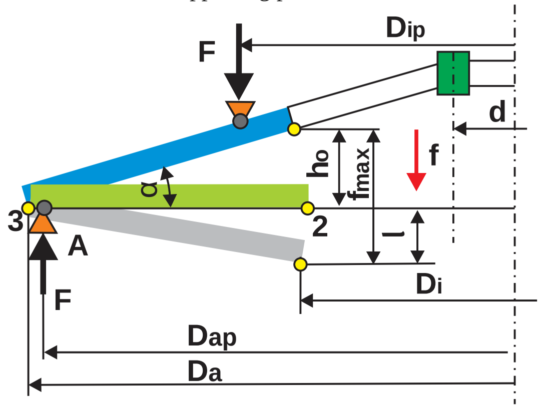


Fig. 3 *Spring with one supporting point*

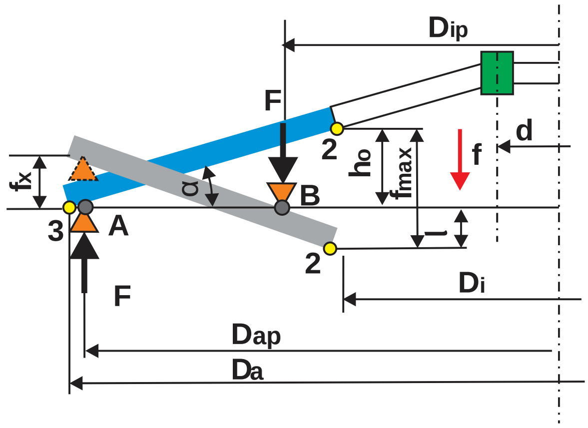


Fig. 4 *Spring with two supporting points*

In order to note the influence of the supporting points, the spring calculation was performed:

- supporting point A, by moving the spring from the initial or zero position to the flat position, the spring makes a deviation h_o.

The supporting point A is stationary, and the release bearing moves the spring from the flat position for the path ℓ that disengages the spring (maximum deviation is achieved).

- From the two supporting points A and B, in the flat position of the spring, the supporting point B is stationary. The release bearing moves from the flat position for the path ℓ, and the point A travels the distance fx, and within this displacement the pressure disk is raised and the clutch is disengaged.

By using a Finite Elements Method (commercial software package), the spring cross-section is divided into 21 elements (Fig. 5) in which the stress is calculated. From the simulation results, the following diagrams for the tangential stress for two cases (Fig. 6 and 7) were obtained:

• The support point A is on a diameter of Ø392[mm], and the internal diameter D_i = 313[mm] moves from the initial position to the flat position f (h_o) and to a maximum deviation of f_{max}.

• The support point A is on a diameter of Ø392, and the supporting point B is on the diameter of Ø336[mm]. From the flat spring position, point B is stationary and point A moves in opposite direction from the direction of the release bearing that travels the distance ℓ, [7].

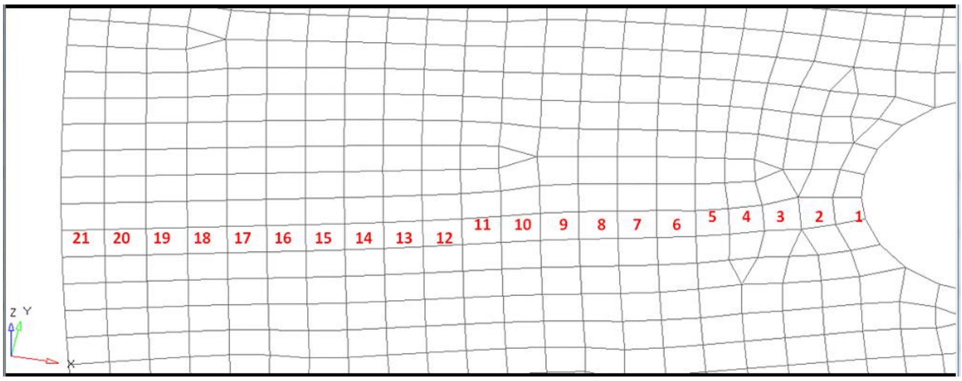


Fig. 5 *FEM elements for stress calculation*

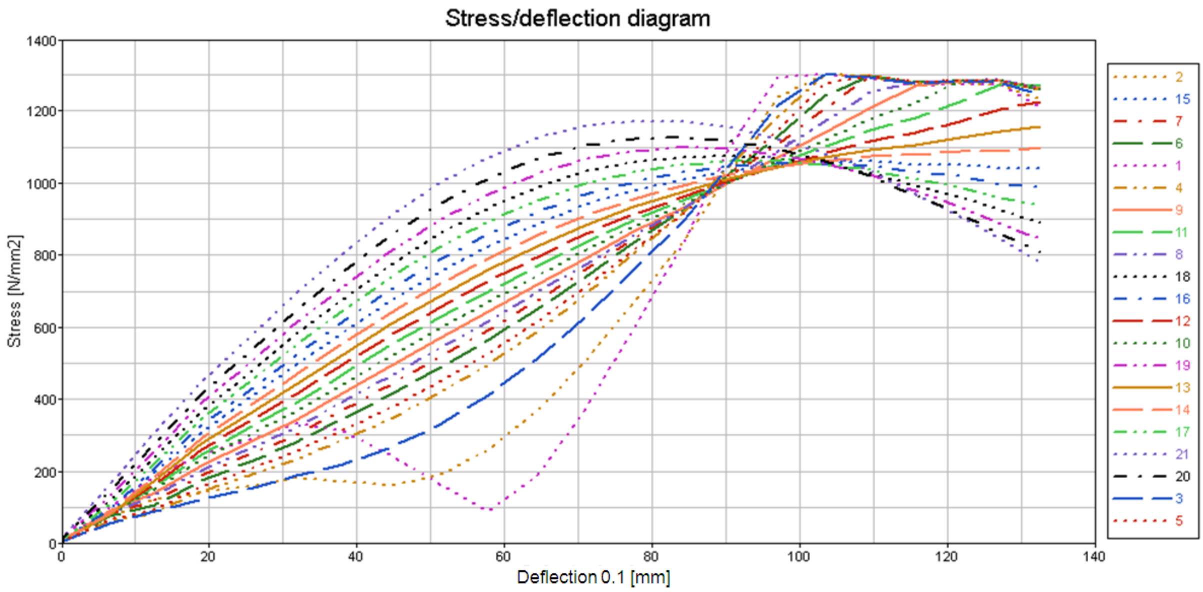


Fig. 6 *Diagram of tangential stresses with a support point A,*

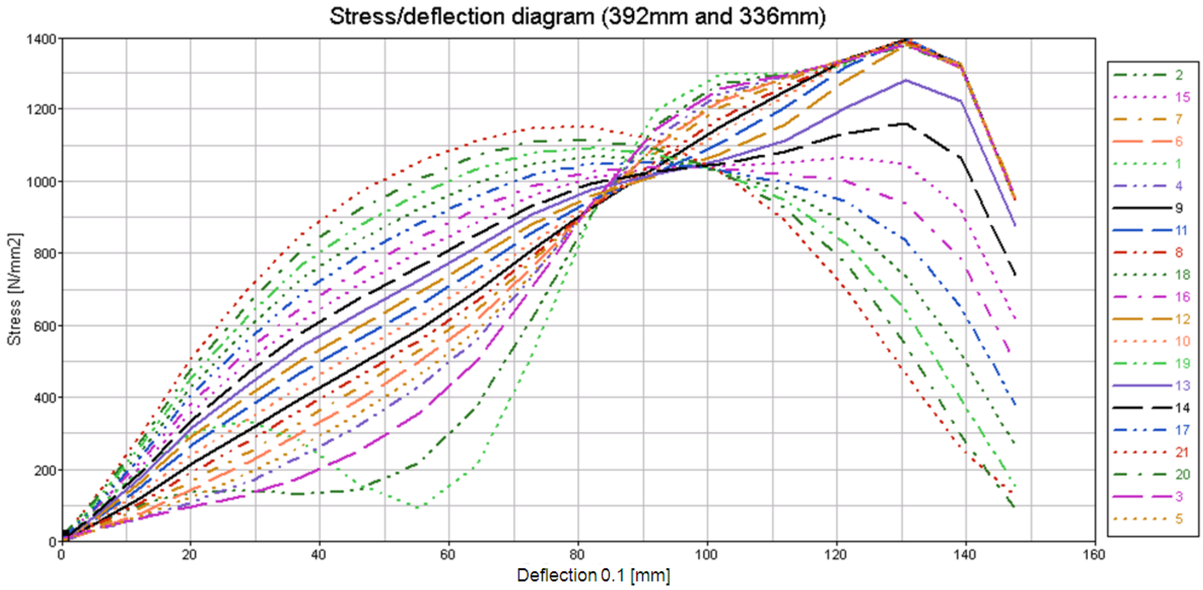


Fig. 7 *Diagram of tangential stresses with two supporting points, A and B*

Complex stresses are presented at figures 8 and 9 :

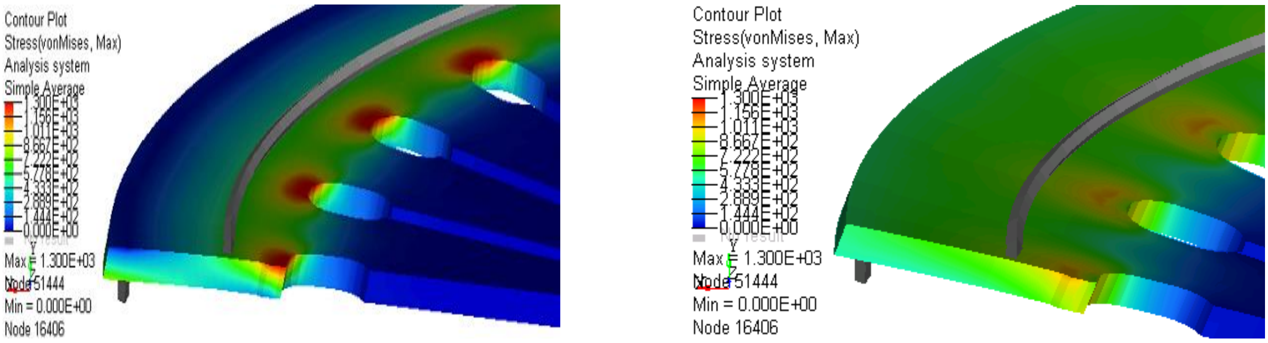


Fig.8 *Complex stress at the flat and disengaged position Ø392/0*

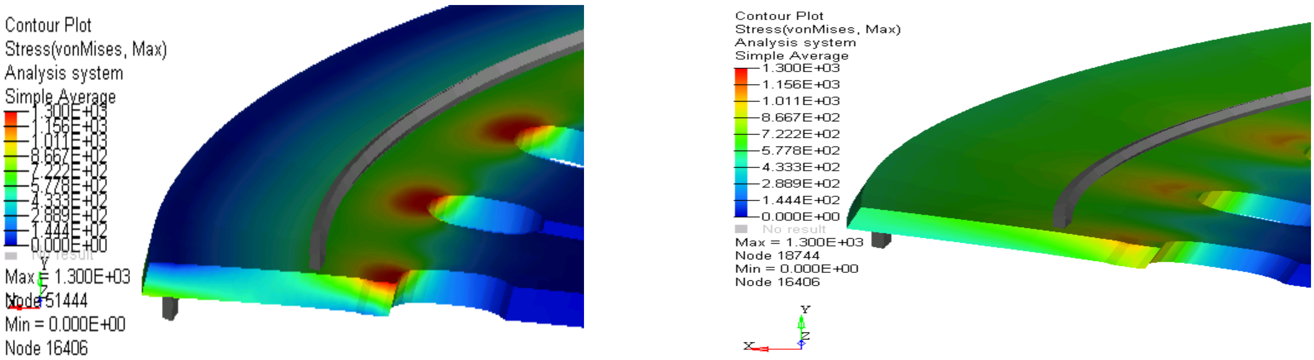


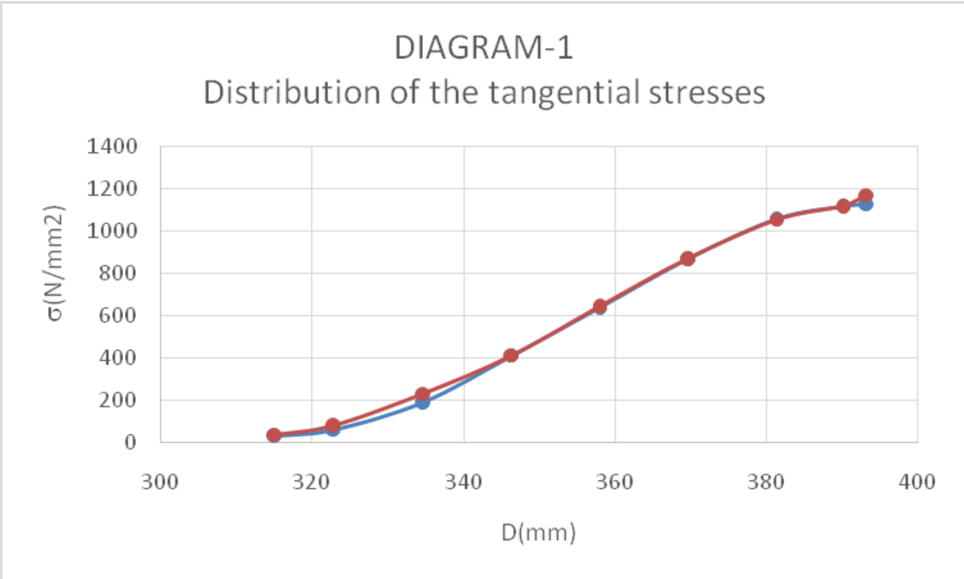
Fig.9 *Complex stress at the flat and disengaged position Ø392/336*

3.Analisys of the results and discussion :

The calculations were carried out by the FEM and the obtained diagrams (Fig. 6 and 7), for the change in the tangential stresses of the diaphragm spring body shown on the diagrams (Fig. 10 and 14) and the tables (1and 2) were analyzed [4], [7].

Table 1: Tangential stresses at the spring flat position

393,0	392,0	390,2	381,3	369,5	358	346,2	334,5	322,7	315	D(mm)
8,86	8,75	8,55	7,57	6,27	5,0	3,7	2,4	1,1	0,22	f(mm)
1130		1120	1060	870	640	410	190	60	30	Ø392/336 σ(N/mm²)
1170		1120	1055	870	645	410	230	80	35	Ø392/0 σ(N/mm²)

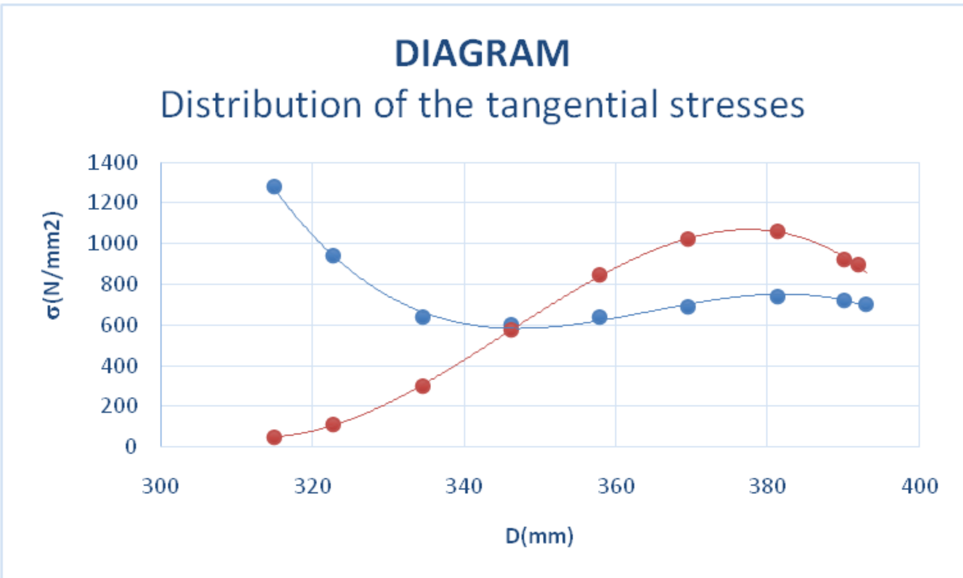


With one support ______, with two supports _______

***Fig. 10** Distribution of the tangential stress at the flat position of the spring*

Table 2: Tangential stresses at the spring disengaged position

393,0	392,0	390,2	381,3	369,5	358	346,2	334,5	322,7	315	D(mm)
2,8		3,2	3,7	4,3	5	5,6	6,5	8,13	9,8	f(mm)
120		370	500	620	540	570	740	1120	1280	Ø392/336 σ(N/mm²)
12,35	12,23	12,0	10,57	8,77	7,0	5,15	3,33	1,51	0,28	f(mm)
885		920	1060	1020	850	575	300	110	50	Ø392/0 σ(N/mm²)



With one support ______, with two supports _______

Fig. 11 Distribution of the tangential stress at the disengaged position of the spring, The highest tangential stress occurs in point 2 (if the supporting point is placed on the location of point 2), then it has the greatest deviation plus the deviation from the displacement of the release bearing traveling the distance of ℓ = 12mm (f_{max} = 7,85 + 4,9 = 13,7mm). This can be seen from the picture of the complex stress (Fig.12).

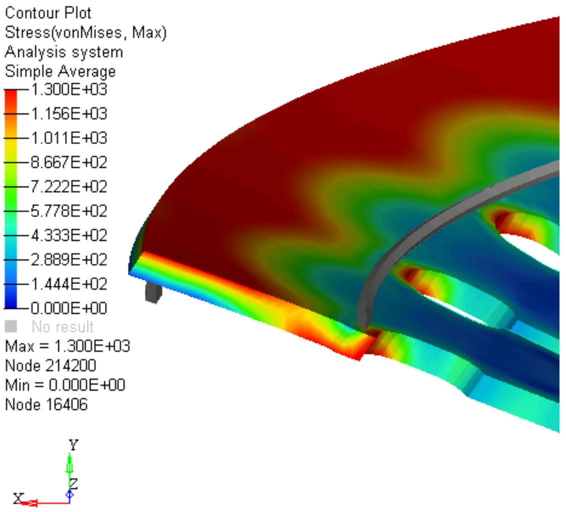


Fig.12 *Complex stress at the disengaged position Ø392/ Ø313*

4. Conclusion :

The following conclusions can be given:

• The stress at flat spring position with one and two supporting points has small deviation of one curve compared to the other.

• The stress at the maximum spring deflection has the mutual variation of the curves. With one support, the maximum stress occurs in the region of the point 3, and with two supports around the location of the point 2. The reason for this is that in the first case, the diaphragm spring is reclined like a beam fixed on one of its sides, and in the second case the spring is reclined on two supports.

References

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