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COMPUTER-AIDED TEST OF THE DISK HARROW GD 3.2 IN SIMULATED AND ACCELERATED REGIME ON THE HYDROPULSE INSTALLATION AND THE STRESS STATES ANALYSIS

[1]VLĂDUȚ Valentin, [2]BIRIŞ Sorin,
[3]BUNGESCU Sorin, [4]PĂUNESCU Dan, [4]DIMA Ion

[1] I.N.M.A. BUCHAREST
[2] P.U. BUCHAREST,
[3] U.S.A.M.V. OF BANAT TIMIŞOARA,
[4] INMA BUCHAREST

Abstract
For simulating the field stresses during the working process of agricultural machines they are tested in laboratory in a simulated and accelerated duty on the "hydropulse" installation.
This solution was chosen by most of the manufacturers for exactly determining the machines and their subassemblies behaviour without testing them in the field for a long period of time.
In the case of the present paper it is presented the testing in a simulated and accelerated regime of the disc harrow GD 3.2., the analysis of the stress states for determining the critical zones and the conclusions which are drawn after performing these stresses.

Key words:
hydropulse, disc harrow, the stress states, simulated and accelerated regime

1. INTRODUCTION

The disk harrow GD 3.2 comprises four sets of disks, arranged in V, with possibility of varying the angle of sets between the interval 12÷24° and the overall dimensions: length: 3,300 mm; width: 3,200 mm; mass: 950 kg.

The determination of the harrow stress in transport conditions has been performed at a rate of speed of 15 km/h, the running surface being a gravel road. In order to record the displacements in the harrow transport position, there have been utilized, two acceleration moving-coil transducers, mounted on the axle, in front of the left and right wheels.

For simulating the field stresses, in transport position, under the harrow wheels there have been mounted two hydraulic cylinders left/right, of 2.5 tf capacity, the hitch being hinged by the attaching device to the testing stand (figure 1).

The hydraulic cylinders have been commanded, through the driving board, to perform the testing program previously settled.

There has been established at every normal working shift in the field (of 8 hours) that the main transport from the station to the field and viceversa should be performed within a hour term. The conclusion is that at 1000 worked ha there are necessary 69 hours of transport, a stress program of 10^6 cycles being equal to 152,887 sec. (42.5 hours) of transport.

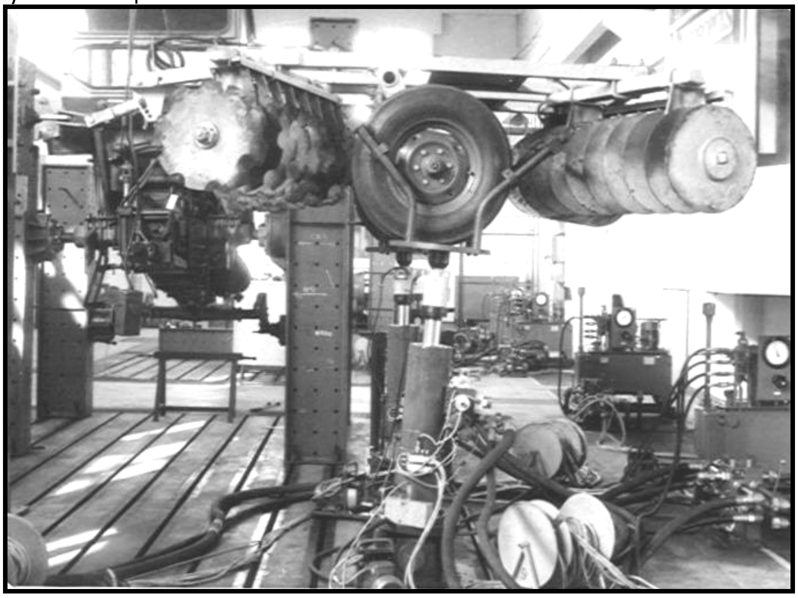


Figure 1- Simulated and accelerated test of the disk harrow GD 3.2, in the transport

2. RESULTS OF THE TESTS

- **The necessity of the analysis**

The usual evaluation criteria of the resistance, for the component parts of an unit/equipment/aggregate employ the effective stress in all the operating situations, beginning with the design stage for the checked hypothesis or through the measuring/control during the product working.

We can determine the effective stress by its calculus, or it can be measured, when we dispose of the appropiate apparata and processing devices, the admissible stress being presented alongside with the material specifications. The results of the resistance analysis can give useful information, even for the test its self.

For the present analysis it has been used a computer P I 133 MHz, 32 Mb RAM, 1,2 Gb HD and a specialized program of structural analysis ANSYS 2.0A.

- **Input Data**

The performance of the resistance analysis comprises the following input data: 2 general drawings of the harrow GD 3.2; the material of what is made the harrow; the curve SMITH of the fatigue resistance; the real stress, measured in the field, given in "ASCII" from (F45.ASC, F55.ASC, F65.ASC, F75.ASC) including the significant records during the work, respectively the aleatory traction force and (T13D.ASC, T15D. ASC, T1A3D.ASC, T1A5D.ASC0 the significant records in transport regime, respectively the accidental displacement to the wheel axle. The usual load of the advancement direction: FY = 5·FX,

where:

FX - is the traction force distributed on a bearing battery;

FY - the force on a lateral direction distributed on a bearing respecting to the approach angle of the harrow disk (α = 15°).

- **Analysis of the stress during the transport**

In order to analyse the stress in transport regime, connected to the procedure of the dynamic response analysis, the program ANSYS, the model of the static analysis has been supplied, in order to analyse the dynamic response.

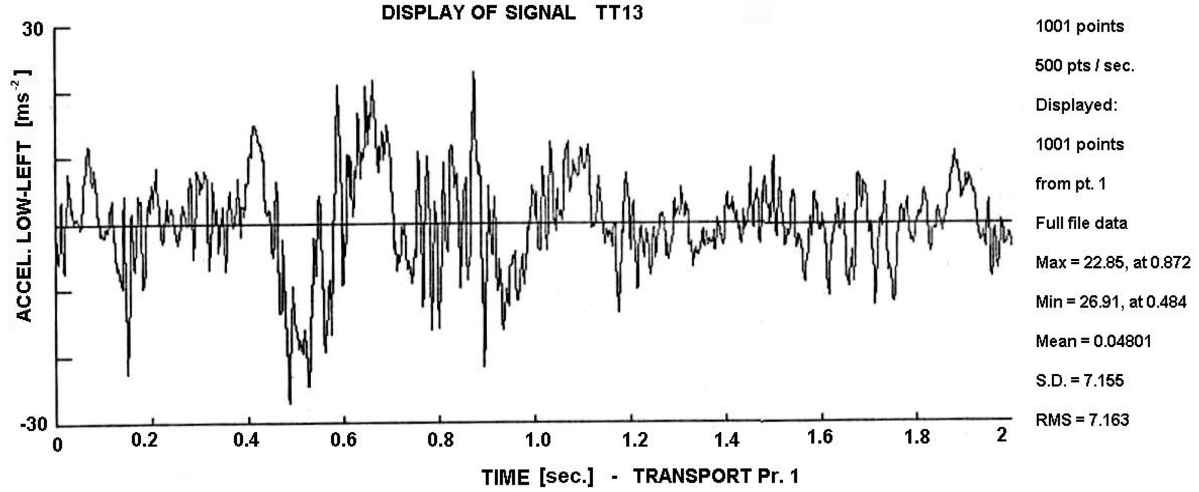


Figure 2 - Zone 6÷8 sec. (Brought to 0) comprising the peaks

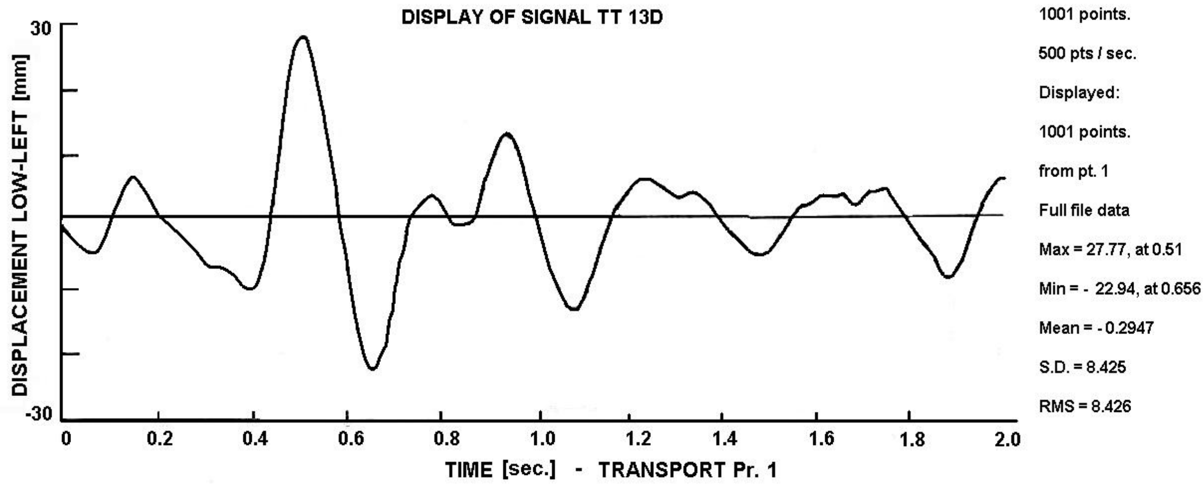
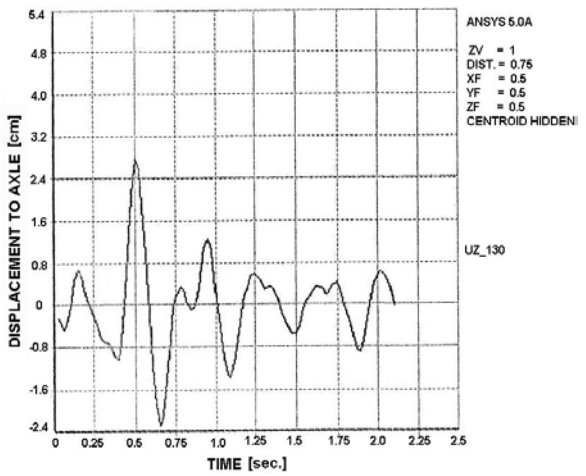


Figure 3 - Zone 6÷8 sec. (Brought to 0) comprising the peaks



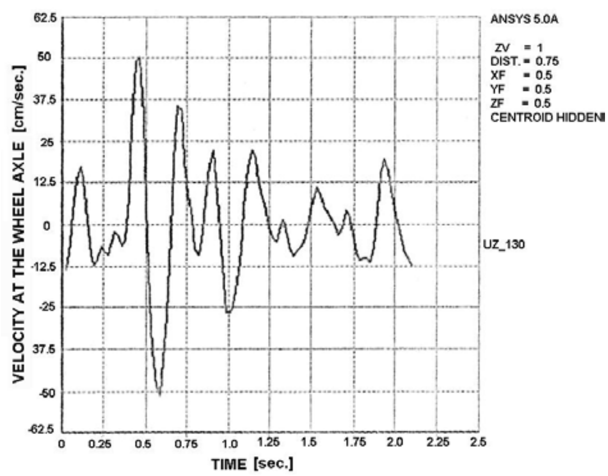
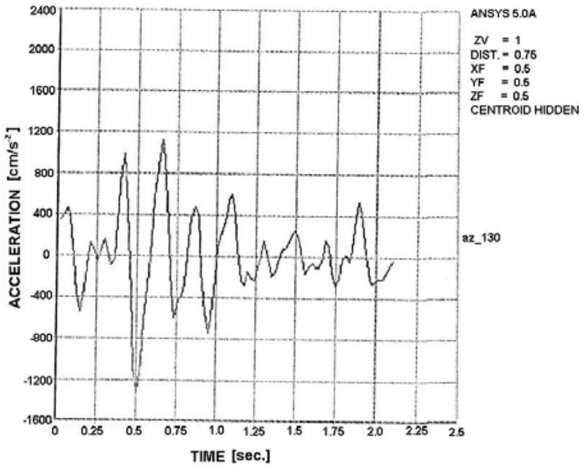


Figure 4 - The wheel axle displacement Figure 5 - Velocity at the wheel axle
(Disk harrow GD 3.2 during the transport)

In order to reproduce the real stress generated during the harrow transport, due especially to the forces of inertia has been applied as an impulse the displacement to the wheel axle.

The displacemnt signal has been introduced exactly as it has been provided by the measurements, in order to avoid the unnecessary ambiguites. Because of the external memory restrictions, the interval has been considered 6 until 8 seconds, comprising the maximum displacement: 2.77 cm. The signal has been applied into the point 130 on the wheel axle, the soil reaction in time being presented in figure 7.



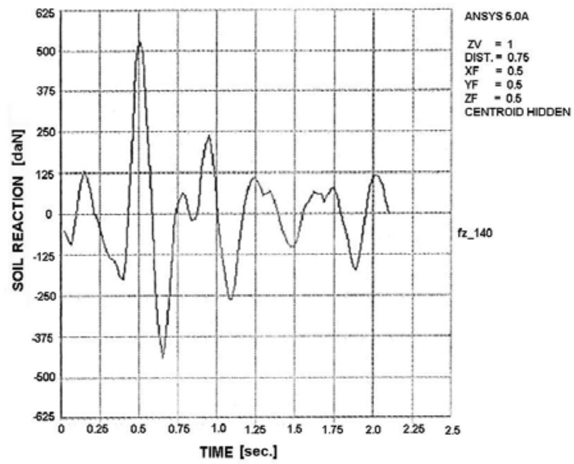


Figure 6 - Acceleration at the whee axle Figure 7 - Soil reaction during the transport

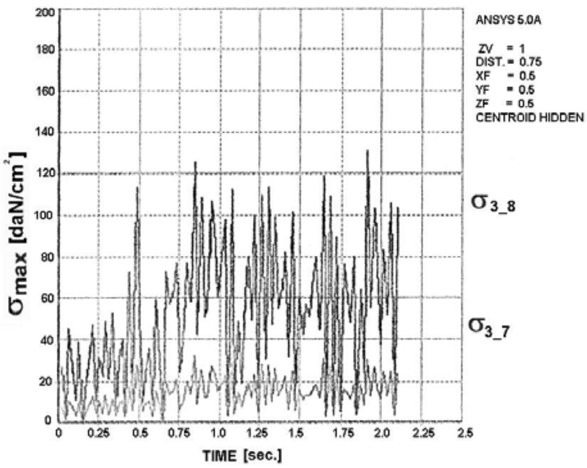
(Disk harrow GD 3.2 during the transport)

- **Stress analysis in transport regime**

There have been extracted in order to be shown following areas:

a) Rear battery joint - internal frame, for which it has been represented in time the stress (figures 8 and 9), from which it results:

$$\sigma_{max\_din} < 140 \text{ daN/cm}^2$$



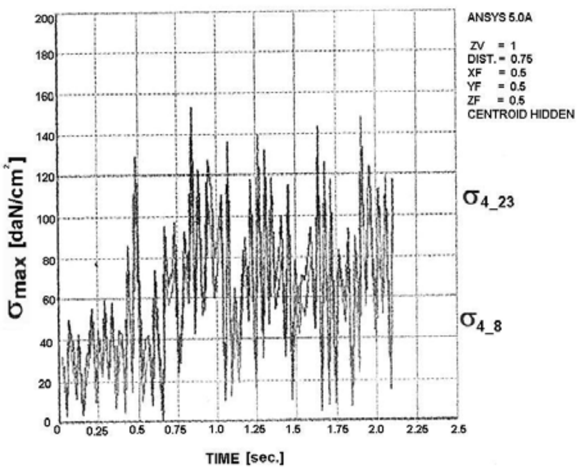


Figure 8 - Stress in element 3 Figure 9 - Stress in element 4

b) Rear battery attaching - external frame, for which the stress of the adjacent elements is presented in figures 10 and 11, resulting in:

$$\sigma_{max\_din} < 225 \text{ daN/cm}^2$$

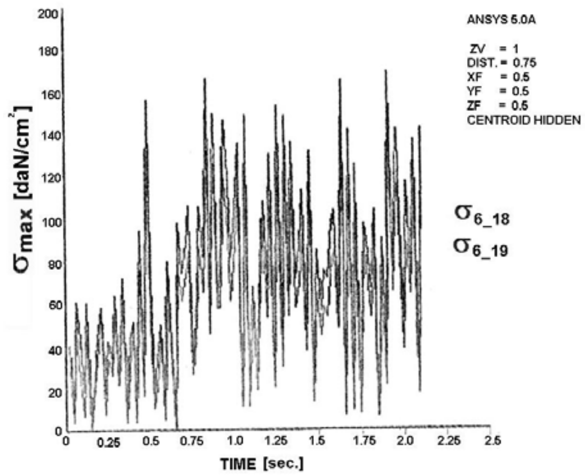


Figure 10 - Stress in element 6

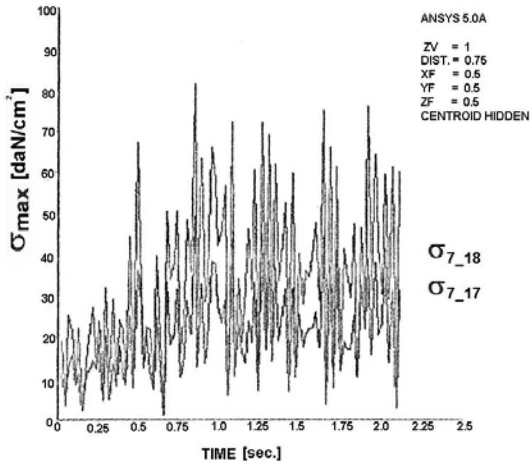


Figure 11 - Stress in element 7

c) Joint between the train axle - external frame, for which the dynamic stress is presented in figures 12 and 13, resulting in:

$$\sigma_{max\_din} < 170 \text{ daN/cm}^2$$

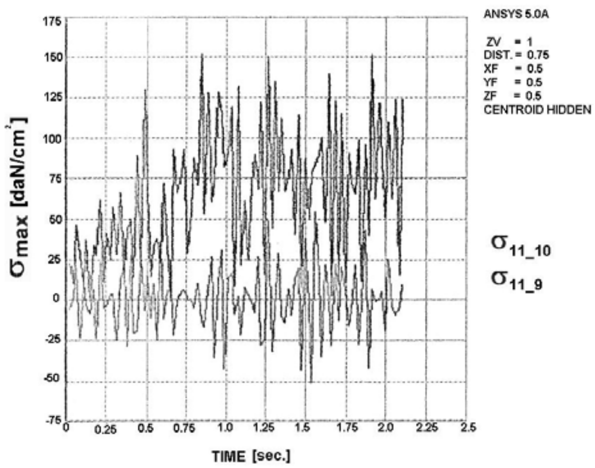


Figure 12 - Stress în element 11

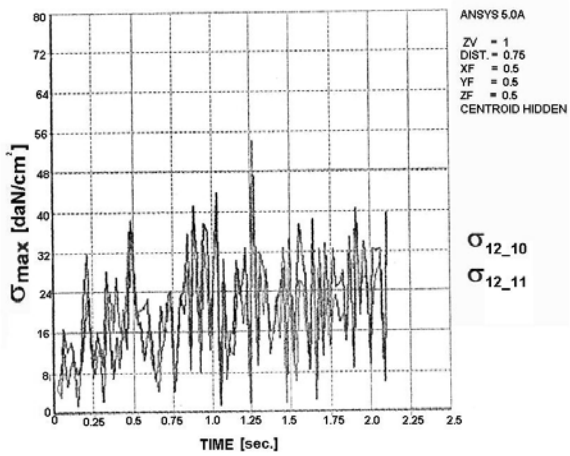


Figure 13 - Stress in element 12

d) Joint between the train-axle and the external frame, for which the dynamic stress is presented in figures 14 and 15, resulting in:

$$\sigma_{max\_din} < 113 \text{ daN/cm}^2$$

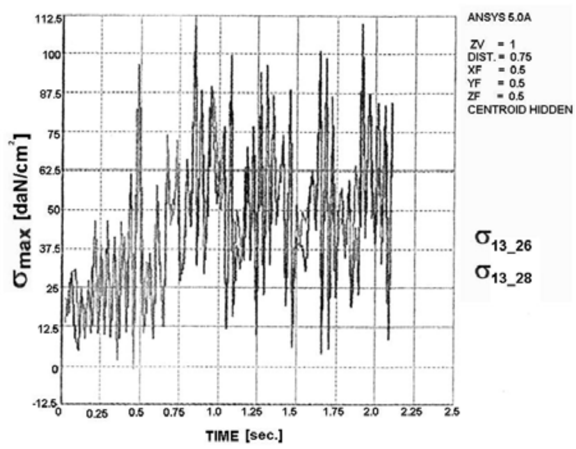


Figure 14 - Stress in element 13

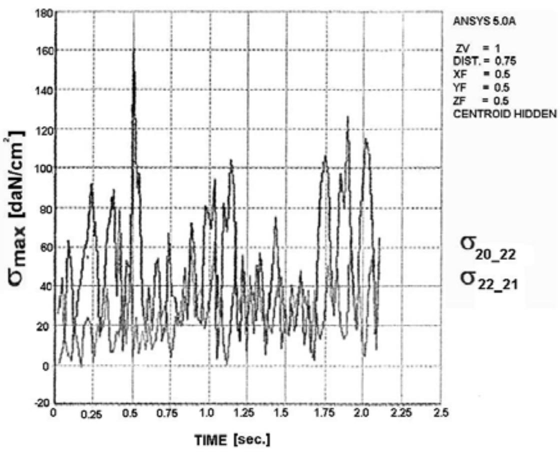


Figure 15 - Stress in element 14

e) Front battery articulation - internal frame, for which has been represented in time the stress for figure 13, resulting in: $\sigma_{max\_din} < 60$ daN/cm^2.
f) Front battery attachement - external frame for which the strss in the adjacent elements presented in figures 15 and 16, resulting in: $\sigma_{max\_din} < 160$ daN/cm^2.

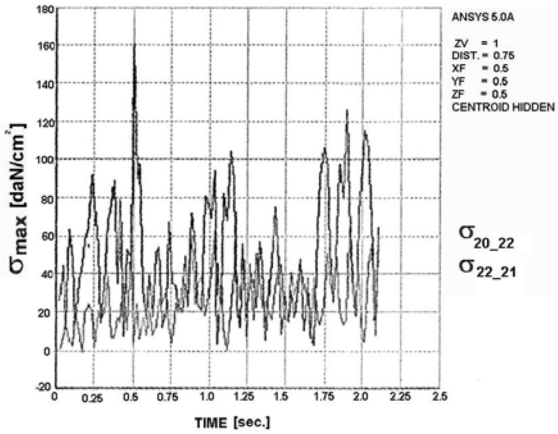


Figure 15 - Stress in element 14

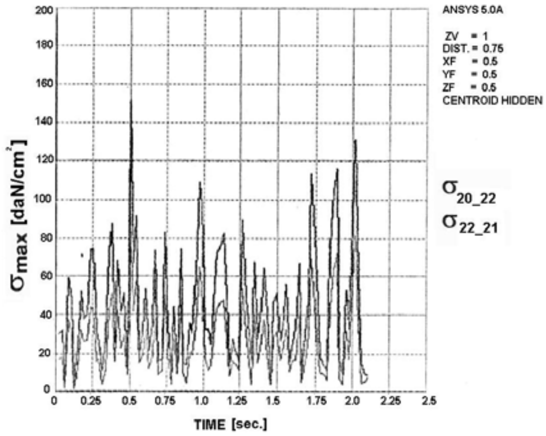


Figure 16 - Stress in element 20

As is results from above, the dynamic stress doesn't surpass the value of 225 daN/cm^2, calculated for the signal that was considered as significant for the analysis. It is also possible that in transport position should obtain accidentally a resonance situation, but testing the aggregate in such regime is impossible because that regime can not be approximated.

- **Results of the tests in simulated and accelerated regime on the Hidropuls instalation**

After having covered the whole volume of tests there has been found that, in case of stress in the transport position of the harrow GD 3.2, having run 1.5×10^6 cycles of stress there haven't been any remanent deformations or cracks into the harroe structure.

3. CONCLUSIONS

Following the analysis of the displacements, deformations and stress in the harrow structure through the method of finite elements ANSYS and on the hidropulse it has been found that:

- for the transport loading has been performed the analysis of the induced stress in critical areas through the method of the dynamic response of the program ANSYS, taking into consideration as a critical case - the recording T13D.ASC (figure 17), the values of this stress being presented in the diagrams from figures 7...16; the maximum value of the dynamic loadings is of 225 daN/cm^2;
- after having covered the whole cycle of loadings, in transport position, there haven't been found any remanent deformations, breakings or cracks in the harrow structure.

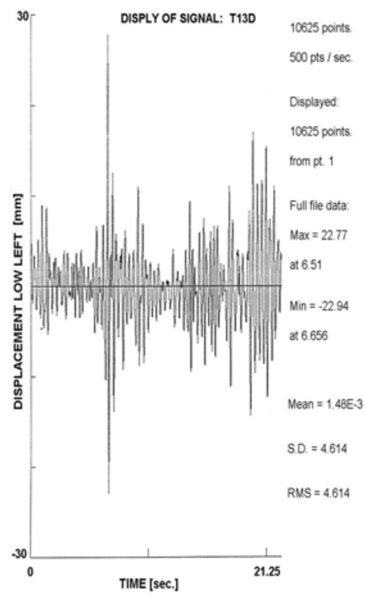


Figure 17 - Critical case

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