Drilling Pipe Seismic Controls

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Abstract

To study the vibration effect on the drilling process and discuss the results, using a three-dimension model contain three parts represented the actual drilling process. The three parts are [the drilling pipe, drilling pit and the rocks]. The hallow pipe which made from carbon steel used to transfer the torque from the drilling machine to the drilling bit. The bit which used to crush the rocks. It's made of titanium. Finally, the rocks. It's the main point in this study. There're three types of rocks in this research the sand stone, lime stone and granite. Which deferent in the physical properties like the density. After preparing this model sent it to the ANSYS workbench to analyses and extract the results. The results which included in this paper for the three different cases. Each case study different type of formation rocks layer. The sand stone rocks formation layer was in the first case. The lime stone rocks formation layer was in the second case. And the granite rock's formation was in the third case. This paper stud the maximum and minimum effects of the physical properties in the drilling process. The concentration point of The maximum deformation, equivalent elastic strain, maximum principal elastic strain , normal elastic strain, minimum total deformation, minimum equivalent elastic strain, minimum principle elastic strain and minimum normal elastic strain, shear stress, normal stress, minimum shear Stress and minimum normal stress. on the drilling pipe, drilling pit and the rocks of the formation layer.

Keywords: Drill pipe, Seismic, stabilizers, Damage, Controls

1-Introduction

With increasing demand for oil and gas, conventional oil and gas production is declining. The trend of the global oil and gas exploration is from conventional to unconventional oil and gas resources [1], from deep well to ultra-deep well, from the deep water to ultra-deep water [2]. In order to achieve industrial production capacity of unconventional oil and gas, directional well, horizontal well, and rotary steering system must be used in the drilling process. Vibrations are unavoidable since drilling is the destructive process of cutting rock either by chipping or by crushing. Different drill vibrations and shocks occur in complex drilling environments, especially the poor drill ability formation with extreme drill, deep well and ultra-deep well with the long drill, the deep water to ultra-deep water with vortex-induced vibration of slender marine structures, coal and shale formation with borehole instability, irregular borehole diameter, and well trajectory increasing the level of drill [3]. Drill cause serious failures of drilling tools and while-drilling-monitoring equipment such as drill pipe, drill collar, logging while drilling, measuring while drilling, pressure and temperature while drilling, engineering parameters while drilling, pressure while drilling, and drill. Typical drilling tools failure due to the different drill are presented in. On the other hand, the application of drill can bring immeasurable economic benefits for the oil industry. Consequently, the research and investigation of drill are an important and interesting problem [4]. The vibration measurements detect and drill dysfunctions in real time can improve drilling efficiency. Production has developed a surface sub to detect vibrations in the drill in the well. This drilling dynamics sub, or dynameter, measures resonance phenomena (axial, torsional, and lateral vibrations) from the bit, bottom hole assembly, and drill. A description of how this sub is used to identify and help eliminate stick-slip will appear in the concluding article in this series. During stick-slip, the bit stalls and accelerates cyclically as the rotary speed at the surface remains constant. During stick-slip drilling, penetration rates are low and the bit wears faster. In addition to identifying stick-slip, the measurement of these vibrations can also help identify downhole drilling problems such as bit bouncing, bit wear, blocked cones, bit or stabilizer balling, stabilizer hang up, and backward whirl. Surface measurements of weight-on-bit and torque alone cannot measure these phenomena. For example, conventional surface torque measurements may show constant torque. During stick-slip, however, the torque period is low; too low for detection on ordinary gauges. With bit bouncing, the small up-and-down movements are dampened by the elasticity of the drill. Previously, drillers could only suspect bit bouncing after analyzing a worn bit at the surface-too late to alter parameters to improve drilling or prevent damage. With drilling dynamics measurements, the driller can detect bouncing as it occurs and can modify drilling conditions to eliminate the dysfunction.

When vibration measurements indicate a specific problem, or for that matter an unknown source of inefficient drilling, the driller can modify the drilling parameters (weight-on-bit, rotational speed, flow rate) to attempt to eliminate the dysfunction before severe problems develop. Drill dysfunctions can reduce the energy transfer between the surface and bit, increase metal fatigue, increase premature bit wear, decrease the rate of penetration, and cause well bore damage [5].

2 Ansys Workbench

In this research we will study how to build geometry in Ansys workbench and prepare it for analysis after set engineering material, drawing, meshing, and explicit geometry setting. Then solve this geometry by using Ansys workbench to find the total deformation areas and the maximum and minimum changing in properties and study the effected properties in three cases. The first case I will use limestone rocks with properties explained in the table [1-1],[1-2]&[1-3].and study all the properties [total deformation, equivalent elastic strain, maximum principle elastic strain, minimum principle elastic strain, shear elastic strain, maximum principle stress, minimum principle stress, maximum shear stress, minimum shear stress, normal elastic strain. Then keep same data of the geometry but changing the rocks type.in the second case sand stone rocks used and finally third case granite rocks used. After that compare between the three cases to find the maximum effect on the drilling string.

3. Project Geometry:

The Geometry contain three parts, drilling pipe, drilling pit and the rocks.

General Equation of Motion

The generalized equation of motion describes the structure used in this paper can be writes as:

$$M\ddot{q}(t) + C\dot{q}(t) + K\,q(t) = f\,(t)$$

Where [M], [C], [K] mass, damping and stiffness matrices

$\ddot{q}(t)$=acceleration vector

$\dot{q}(t)$=velocity vector

$q(t)$=displacement vector

f(t)=External Excitation

The hallow pipe which made from carbon steel used to transfer the torque from the drilling machine to the drilling bit. The bit which used to crush the rocks. It’s made of titanium. Finally, the rocks. It’s the main point in this study. There’re three types of rocks in this research the sand stone, lime stone and granite. Which deferent in the physical properties like the density. This geometry has two types of motion.

Rotating motion refers to the rotation drilling pipe and drilling bit in the drilling process. And the axial motion refers to the raise and down the drilling string during the process. The coordinate system which used in our geometry. We used Cartesian coordinate system to describe the axial motion of the geometry during drilling process. And Cylindrical coordinate to describe the rotating motion.

The three body is connected together to represent the geometry. The state of connections is fully defined by using Generate Automatic Connection on Refresh.

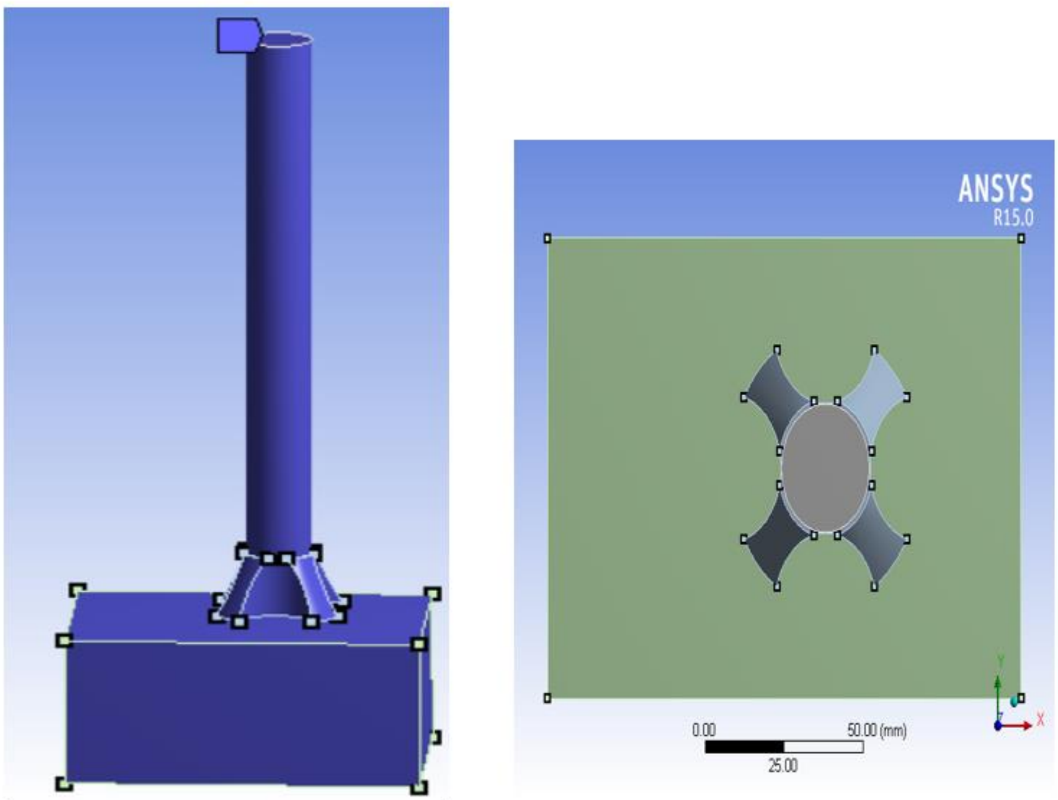


Fig. (1-1) Geometry of drill pipe (a) Isometric (b) top view

4. Results and Discussion.

The results section is a section containing a description about the main findings of a research, whereas the discussion section interprets the results for readers and provides the significance of the findings.

From table [4-1], [4-2] & [4-3]. we can get this result for the three cases:

For case 1 Table [4-1]:

The maximum deformation, equivalent elastic strain, Maximum Principal Elastic Strain and normal elastic strain, minimum total deformation, minimum equivalent elastic strain, minimum principle elastic strain and minimum normal elastic strain on the rock. The shear stress and the normal stress, minimum Shear Stress and minimum normal stress on the hallow pipe. This information leads to the results that almost of the deformation accrue on the formation rocks. And the minimum normal stress and minimum shear stress occurs on the drilling pipe. That means increasing life time for the drilling pipe and decreasing drilling time process.

For case 2 Table [4-2]:

The equivalent elastic strain, minimum principle elastic strain, shear elastic strain, normal elastic strain and normal stress, minimum total deformation, minimum equivalent elastic strain, minimum principle elastic strain, minimum normal elastic strain, minimum Shear Stress and minimum normal stress on the rock. The maximum principle elastic strain and shear stress, on the hallow pipe. Total deformation on the bit. This information leads to the results that almost of the deformation accrue on the formation rocks. And maximum principle elastic strain and shear stress occurs on the drilling pipe and the total deformation occurs on the drilling bit. That means the life time for the drilling pipe in the lime stone formation layer will be shorter than sand stone formation layer. In this case the drilling pipe needs to monitor and the drilling time process will be longer than case one.

For case 3 Table [4-3]:

The equivalent elastic strain and normal elastic strain, minimum total deformation, minimum equivalent elastic strain, minimum principle elastic strain, and the minimum normal stress on the rock. The shear stress and normal stress, minimum shear stress and minimum normal stress on the hallow pipe. The total deformation and maximum principle elastic strain on the bit. This information leads to the results that almost of the deformation accrue on the formation rocks. And The shear stress and normal stress, minimum shear stress and minimum normal stress occurs on the drilling pipe. That means the life time of the drilling pipe will be shorter than case one and case two due to the comparation in the stresses between the three cases. The maximum principle elastic strain on the bit cause to increasing in the temperature. The high temperature leads to the wear and failure in the drilling pit. In this case the drilling pipe and the drilling bit need to monitor and the drilling time process will be longer than case one and case two. The Fig (4-8) represent the three-dimension relation between stress, time and frequency. the stress is maximum value at the point which has maximum frequency and time. Then the stress started decreasing with the decreasing of time and frequency.

Table [4-1] Results of Case one solutions

Object Name	Total Deformation	Equivalent Elastic Strain	Maximum Principal Elastic Strain	Minimum Principal Elastic Strain	Shear Elastic Strain
Minimum	0. mm	1.8886e-005 mm/mm	-1.4044e-002 mm/mm	-0.6324 mm/mm	0. mm/mm
Maximum	181.31 mm	1.6521 mm/mm	0.73789 mm/mm	6.458e-002 mm/mm	0. mm/mm
Minimum Occurs On	rock	rock	rock		hallow pipe
Maximum Occurs On	rock	rock	rock		hallow pipe
Minimum	0. mm	0. mm/mm	-2.8614e-002 mm/mm	-0.6324 mm/mm	-0.66132 mm/mm
Maximum	0. mm	1.8886e-005 mm/mm	0. mm/mm		
Minimum	7.9441e-015 mm	0. mm/mm	0. mm/mm		
Maximum	181.31 mm	1.6521 mm/mm	0.75285 mm/mm	6.458e-002 mm/mm	0.86845 mm/mm
Time	1.5345e-004 s	1.5345e-004 s	1.5345e-004 s		1.1755e-038 s
Set	5	5	5		1

Table [4-2] Results of Case two solutions

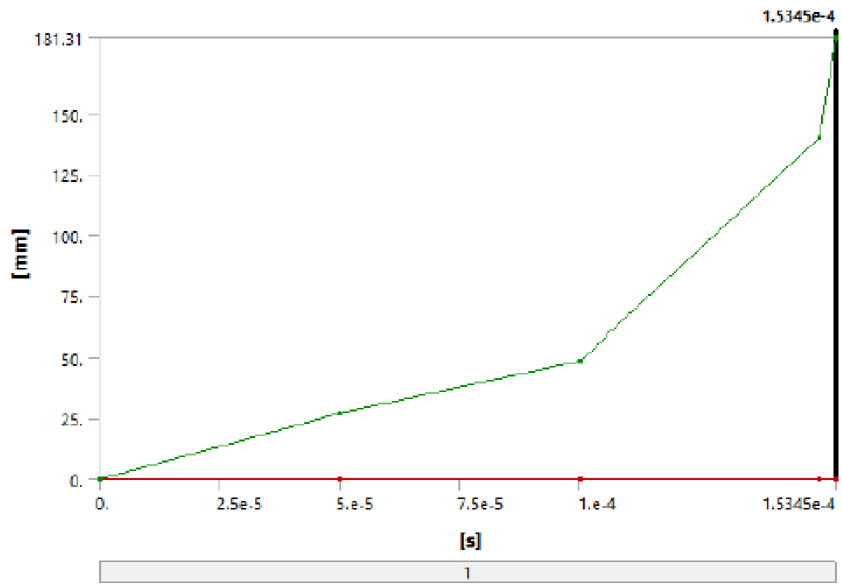
Object Name	Total Deformation	Equivalent Elastic Strain	Maximum Principal Elastic Strain	Minimum Principal Elastic Strain	Shear Elastic Strain
Type	Total Deformation	Equivalent Elastic Strain	Maximum Principal Elastic Strain	Minimum Principal Elastic Strain	Shear Elastic Strain
Minimum	0. mm	9.8037e-006 mm/mm	-1.025e-002 mm/mm	-0.73145 mm/mm	-0.35863 mm/mm
Maximum	57.433 mm	0.87527 mm/mm	0.72701 mm/mm	3.3822e-003 mm/mm	0.63821 mm/mm
Minimum Occurs On	rock				rock
Maximum Occurs On	pit	rock		hallow pipe	rock
Minimum	0. mm	0. mm/mm	-1.025e-002 mm/mm	-0.73145 mm/mm	-0.35863 mm/mm
Maximum	0. mm	9.8037e-006 mm/mm	0. mm/mm		0. mm/mm
Minimum	7.9441e-015 mm	0. mm/mm			0. mm/mm
Maximum	57.433 mm	0.87527 mm/mm	0.72701 mm/mm	3.3822e-003 mm/mm	0.63821 mm/mm

Table [4-3] Results of Case three solutions

Object Name	Total Deformation	Equivalent Elastic Strain	Maximum Principal Elastic Strain	Minimum Principal Elastic Strain	Shear Elastic Strain
Type	Total Deformation	Equivalent Elastic Strain	Maximum Principal Elastic Strain	Minimum Principal Elastic Strain	Shear Elastic Strain
Minimum	0. mm	3.7216e-005 mm/mm	-1.2137e-002 mm/mm	-0.50431 mm/mm	0. mm/mm
Maximum	58.47 mm	0.95933 mm/mm	0.6844 mm/mm	1.4717e-003 mm/mm	0. mm/mm
Minimum Occurs On	rock				hallow pipe
Maximum Occurs On	pit	rock		pit	hallow pipe
Minimum	0. mm	0. mm/mm	-1.2137e-002 mm/mm	-0.50431 mm/mm	-0.49754 mm/mm
Maximum	0. mm	3.7216e-005 mm/mm	0. mm/mm		
Minimum	7.9441e-015 mm	0. mm/mm			
Maximum	58.47 mm	0.95933 mm/mm	0.6844 mm/mm	2.6238e-003 mm/mm	0.56461 mm/mm

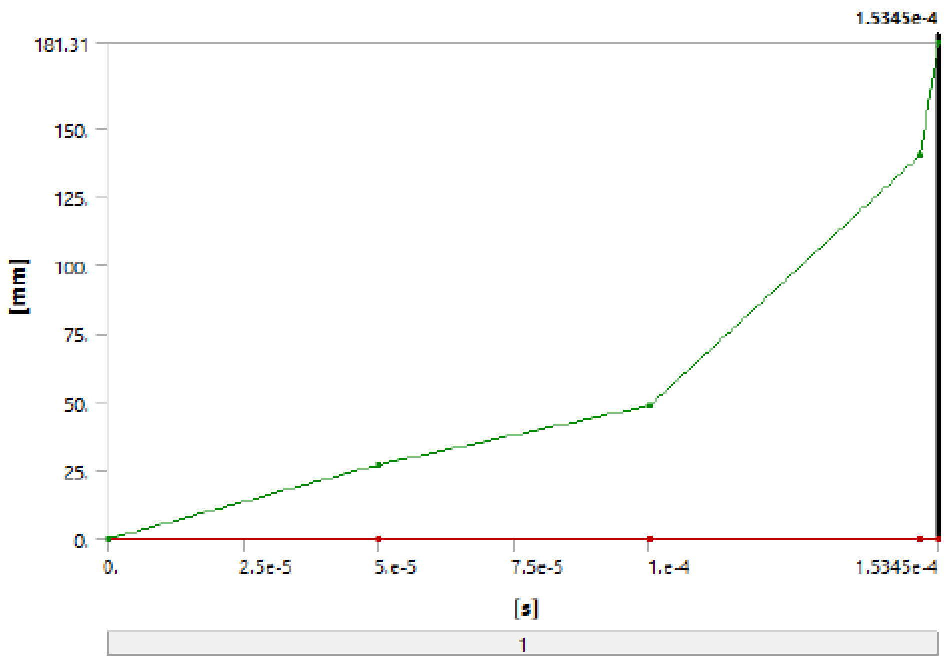
From the comparison between the three results of the total deformation in the three cases we find the maximum value of the deformation in the case one when sand stone rocks layer used shown in the tables and figures (4-2), (4-3) & (4-4).

And the comparation of the Equivalent elastic strain results of the three cases we find the maximum value in the case one when sand stone layer used as shown in the tables and figures (4-5), (4-6) & (4-7).



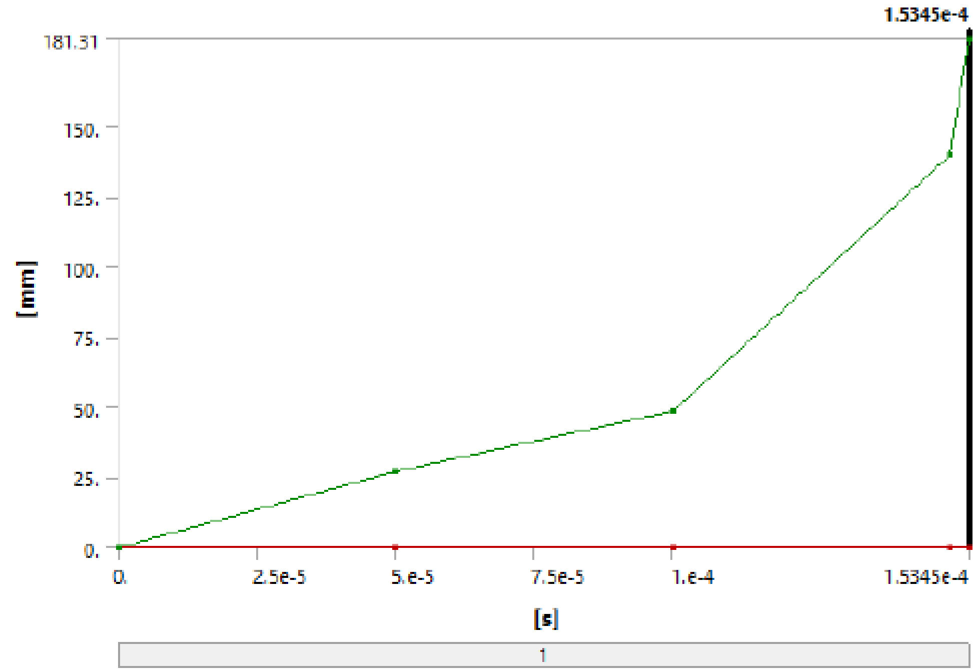
Time [s]	Minimum [mm]	Maximum [mm]
1.1755e-038	0.	7.9441e-015
5.0001e-005		27.333
1.e-004		48.75
1.5e-004		139.96
1.5345e-004		181.31

Fig. (3-2) Total Deformation Case 1



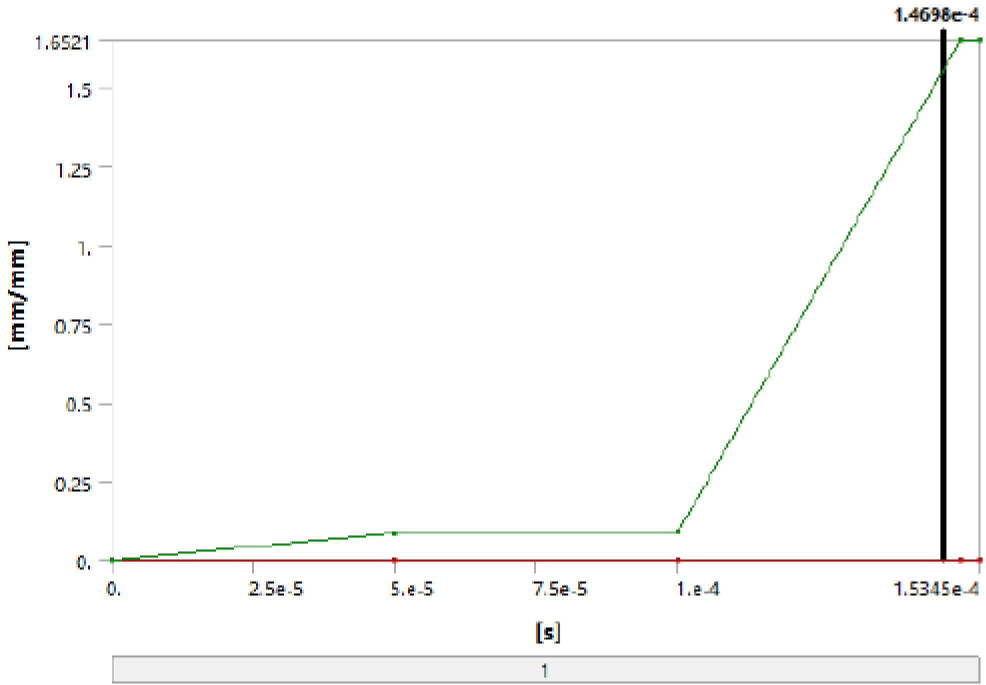
Time [s]	Minimum [mm]	Maximum [mm]
1.1755e-038		7.9441e-015
5.0001e-005	0.	27.333
1.e-004		48.75
1.3364e-004		57.433

Fig. (3-3) Total Deformation Case 2



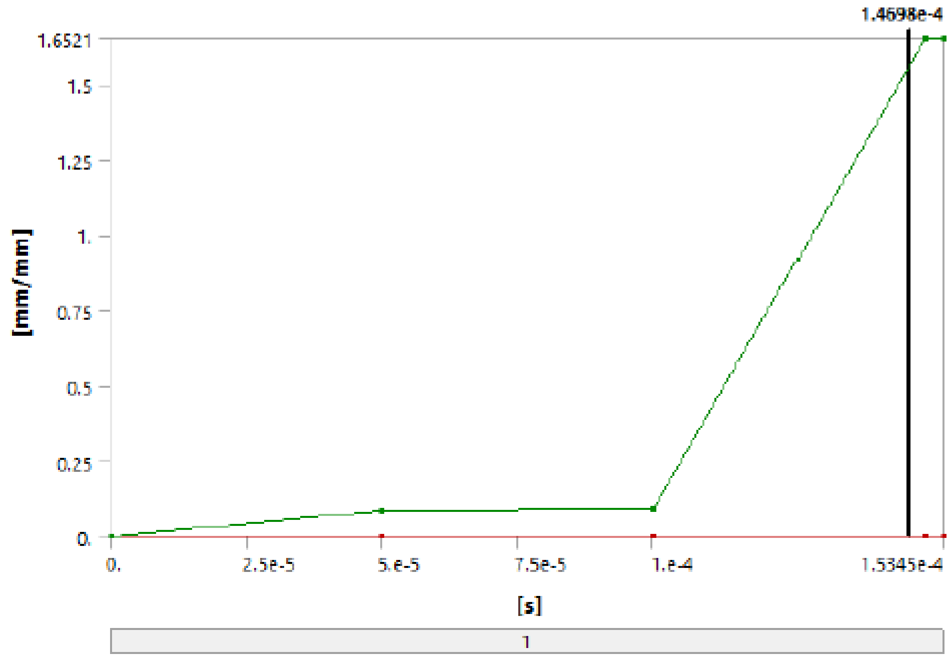
Time [s]	Minimum [mm]	Maximum [mm]
1.1755e-038	0.	7.9441e-015
5.0001e-005		27.333
1.e-004		48.75
1.401e-004		58.47

Fig. (3.4) Total Deformation Case 3



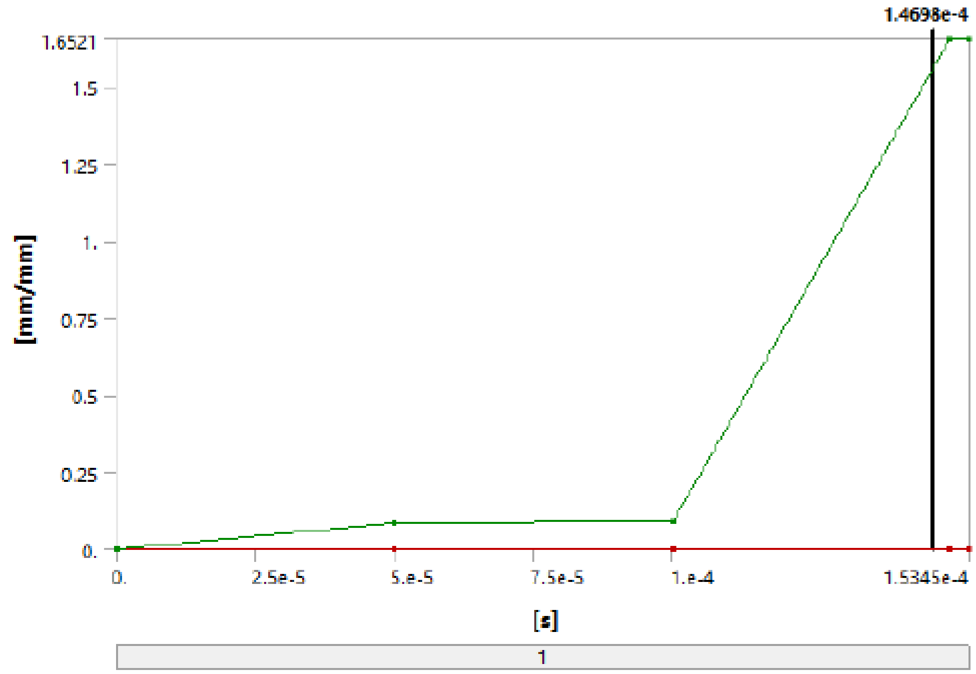
<table>
<tr><th>Time [s]</th><th>Minimum [mm/mm]</th><th>Maximum [mm/mm]</th></tr>
<tr><td>1.1755e-038</td><td rowspan="3">0.</td><td>0.</td></tr>
<tr><td>5.0001e-005</td><td>8.3927e-002</td></tr>
<tr><td>1.e-004</td><td>9.0909e-002</td></tr>
<tr><td>1.5e-004</td><td>9.1032e-006</td><td rowspan="2">1.6521</td></tr>
<tr><td>1.5345e-004</td><td>1.8886e-005</td></tr>
</table>

Fig. (3.5) Equivalent elastic strain case 1



<table>
<tr><th>Time [s]</th><th>Minimum [mm/mm]</th><th>Maximum [mm/mm]</th></tr>
<tr><td>1.1755e-038</td><td rowspan="3">0.</td><td>0.</td></tr>
<tr><td>5.0001e-005</td><td>8.3927e-002</td></tr>
<tr><td>1.e-004</td><td>9.0829e-002</td></tr>
<tr><td>1.3364e-004</td><td>9.8037e-006</td><td>0.87527</td></tr>
</table>

Fig. (3.6) Equivalent elastic strain case 2



Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.1755e-038	0.	0.
5.0001e-005		8.3927e-002
1.e-004		9.0909e-002
1.401e-004	3.7216e-005	0.95933

Fig. (3.7) Equivalent elastic strain case 3

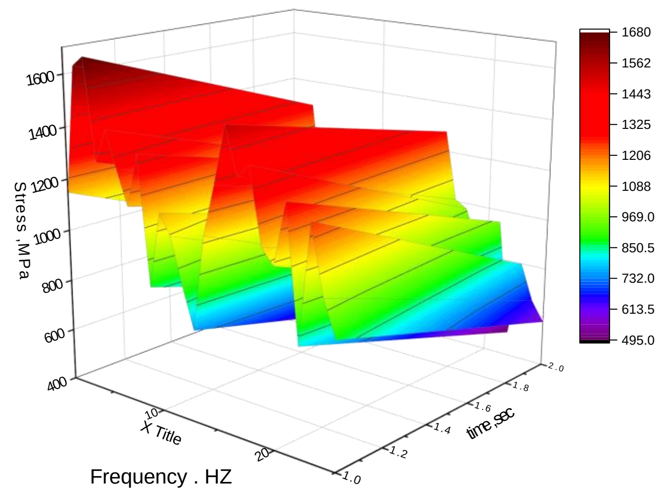


Fig (4-8) Three-dimension relation between stresses

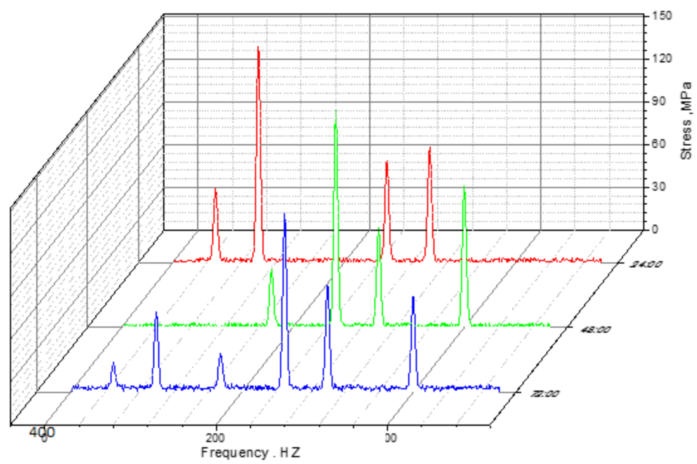


Fig. (4.9) 3D graph of the relation [stress, time & frequency]

5. Conclusion

According to the Ansys workbench results, the titanium drilling bit effected and get more damage when the drilling reaches the ground layer which contain the granite rocks. And less damage when the drilling process reach the layer which contain the lime stone rocks. Finally, the less damage in the drilling bit in the sand stone layer.

We have to monitor the type of rocks to calculate the wear time of the drilling bit to replace it at the proper time to avoid the failure during the drilling process. This study helps the drilling engineers and the designers to select the suitable material for the drilling equipment. and helps the drilling engineer to monitor the drilling bit wear and damage during the process to replace the bit.

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