SCRUTINIZE THE ABRASION PHENOMENON WITH THE BRUNT FORCES IN THE JOINTS OF THE ROBOTS AND PROPOSED A NEW WAY TO DECREASE THAT

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ABSTRACT
In this paper the influences of the brunt forces on the Robots' joints is studied. Moreover, the efficacious ways that we can use to have a little corrosion in the joints are suggested. We know that through the movements of the robots we have a lot of friction phenomenon between the main body and the articulation. We propose this way that: when we use one viscoelastic material between the articulation and the main body, we can decrease the corrosion phenomenon when brunt or sudden hit forces have occurred. To avoid the exasperation of this problem we already studied on the forces of unpredictable and we shown that how can we eradicate this problem. At the end of this article we conclude that viscoelastic materials have more useful traits to use them in many cases especially at the joints of the robots, because one of the best natures of them are rebounded if any forces act on those.

KEYWORDS: *Articulation, Brunt Forces, Viscoelastic Material (VEM), Joint, Torque, Shoulder roll*

I. INTRODUCTION

In any robots we have many articulations that are rotating between the joints, and through this processes, abrasion phenomenon has occurred. Especially when we have brunt or hit forces in the legs or hands of the robots corrosion phenomenon is going to be increased.

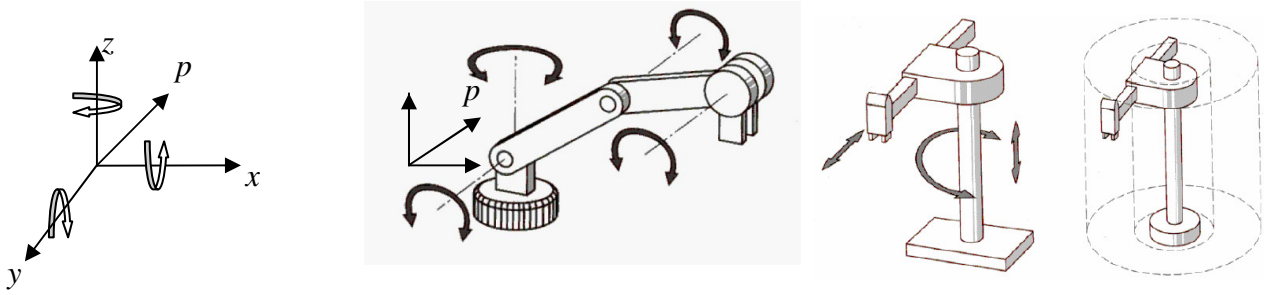


Figure.1: Species forces and torques can be applied in the joints [1], [2, 6]

All the hit forces that are happened in the form of unpredictable event can be jeopardous for the articulations, because friction should be happen and cause of amputate the members of the body. To exasperate this problem, at the first we try to realize forces and their working, after that we proposed a new way that is use of VEM. We exemplify our new way with the ANSYS software result and finite element analysis.

I.1 Joints and their structures:

Fig.1. shows the joints and their working in the normal position. [7] In the static state, all the forces and the torques that we have (related to the dynamic and static positions) can be showed by

Five equations that are clearly introduced the works of articulations, when they are rotating, but these equations are stated just for static analysis of the joints.

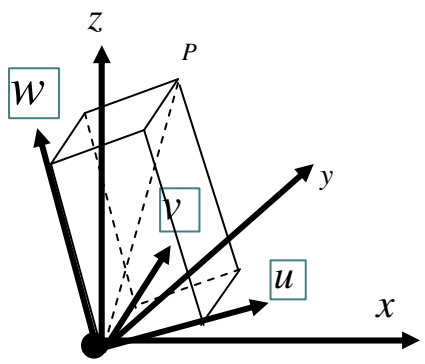


Figure.2: Rotation with respect to the origin [1,6]

1. $\sum_{i=1}^{n} F_{xi} = 0$, → **Eq.1** : shows the sum of the forces in x direct
2. $\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n} M_{xi} M_{yj} M_{zk} = 0$, → **Eq.2** : shows the Torques in the free space
3. $\vec{P}_{xyz} = p_x \mathrm{i_x} + p_y \mathrm{j_y} + p_z \mathrm{k_z}$, → **Eq.3** : situation of each points in the spaces
4. $\vec{P}_{uvw} = p_u \mathrm{i_u} + p_v \mathrm{j_v} + p_w \mathrm{k_w}$, → **Eq.4** : as the same with 3 in the different coordinate
5. $P_{xyz} = RP_{uvw}$! → **Eq.5** : way of translate of two coordinates

6. $\theta = (\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6, \cdots \theta_n)$

7. $Y = (x, y, z, O, A, T)$

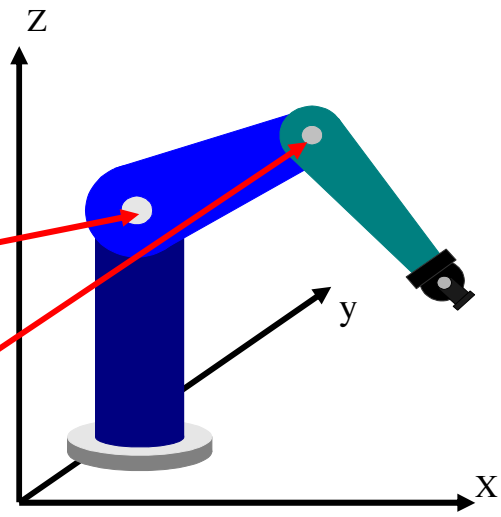


Figure.3: End-effectors position and orientation, Formula

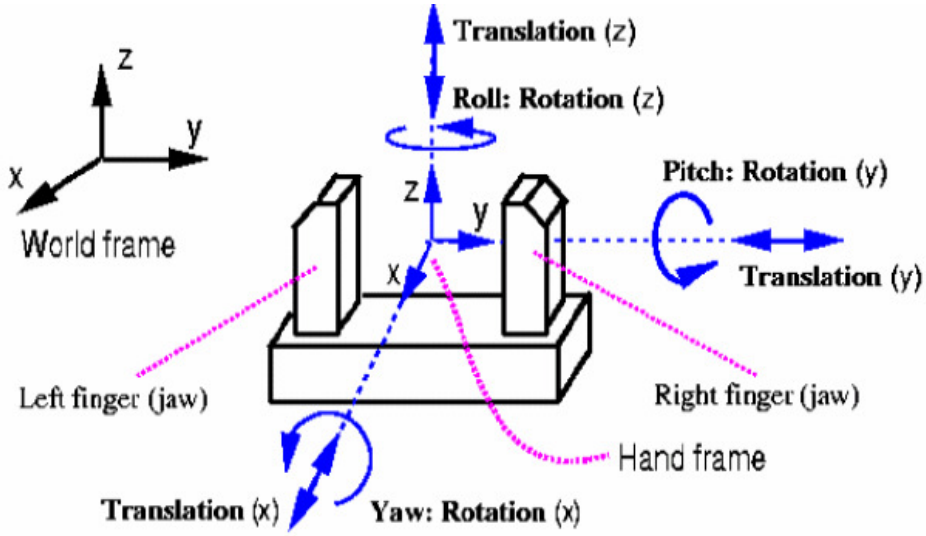


Figure.4: Way of the rotation, translation about the coordinates with the frame hand [7, 4]

And rotation of the hands or legs of the robots respect to the origin can be represented by Fig.3. [3]

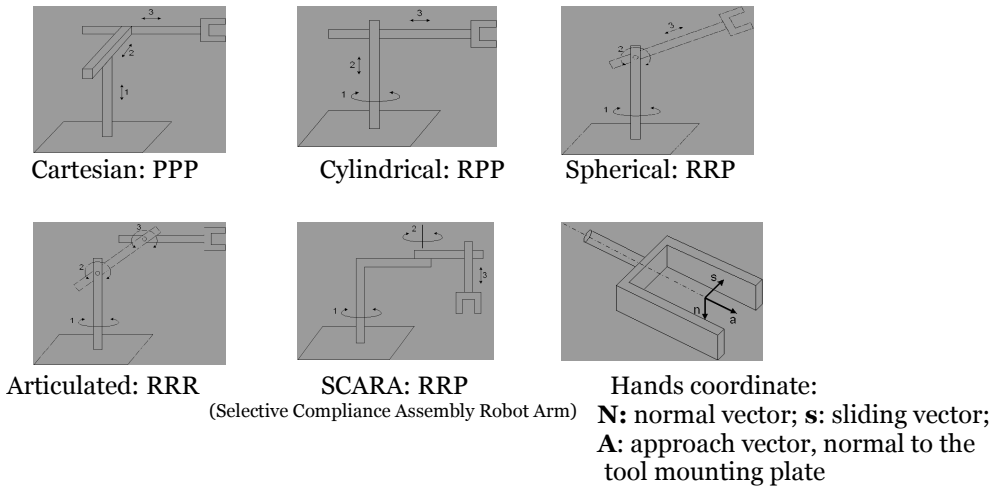
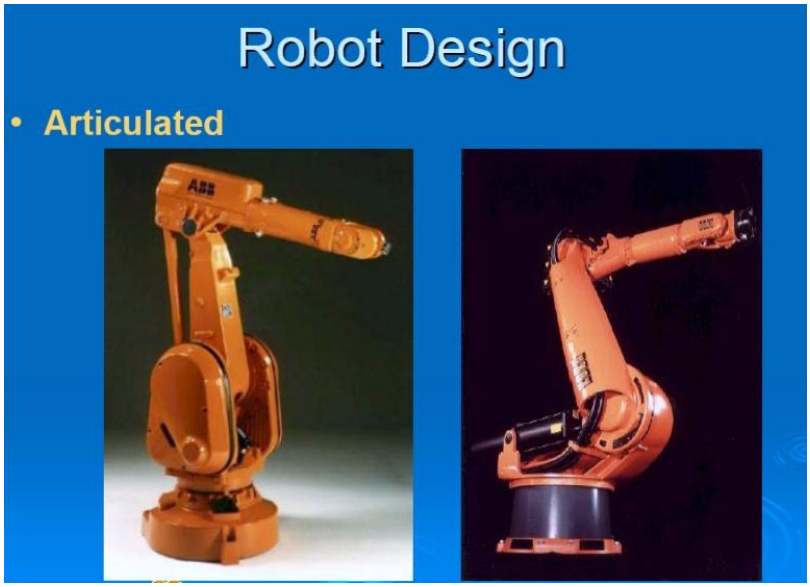


Figure.5: Robot Configuration with the positions of coordinates [4]

Now we can scrutiny in the distances between the articulations and the main wall of the body that is important to study on the abrasion phenomenon. Spaces between two fingers or two joints are illustrated in the Fig. 4. In every rotation or any sudden hit we have a lot of excess forces that are occur between them, and we should prevent from that problem to arise. [7] This occurrence is extremely affected on the articulations of the robots. At this moment we should focus on the abrasion phenomenon. To decrease this problem in this position we should proposed to design one of the materials for filling the lacuna and after that trying multifarious Materials, Finally we chose Viscoelastic material in many reasons. Now we try to show why VEM is a good material for using it between the joints.

After try to design one sample joint in ANSYS software we pictured Fig.5 from the result of the program to find out that we have maximum principal elastic strain in the brunt or excess hit forces, when we utilize VEM. This way can produced more convenient conditions to rotating and decreased friction and excess torques while they can cause of the exhaustion.



Picture1. An articulated robot, that is showed to illustrated a situation of the joints [6].

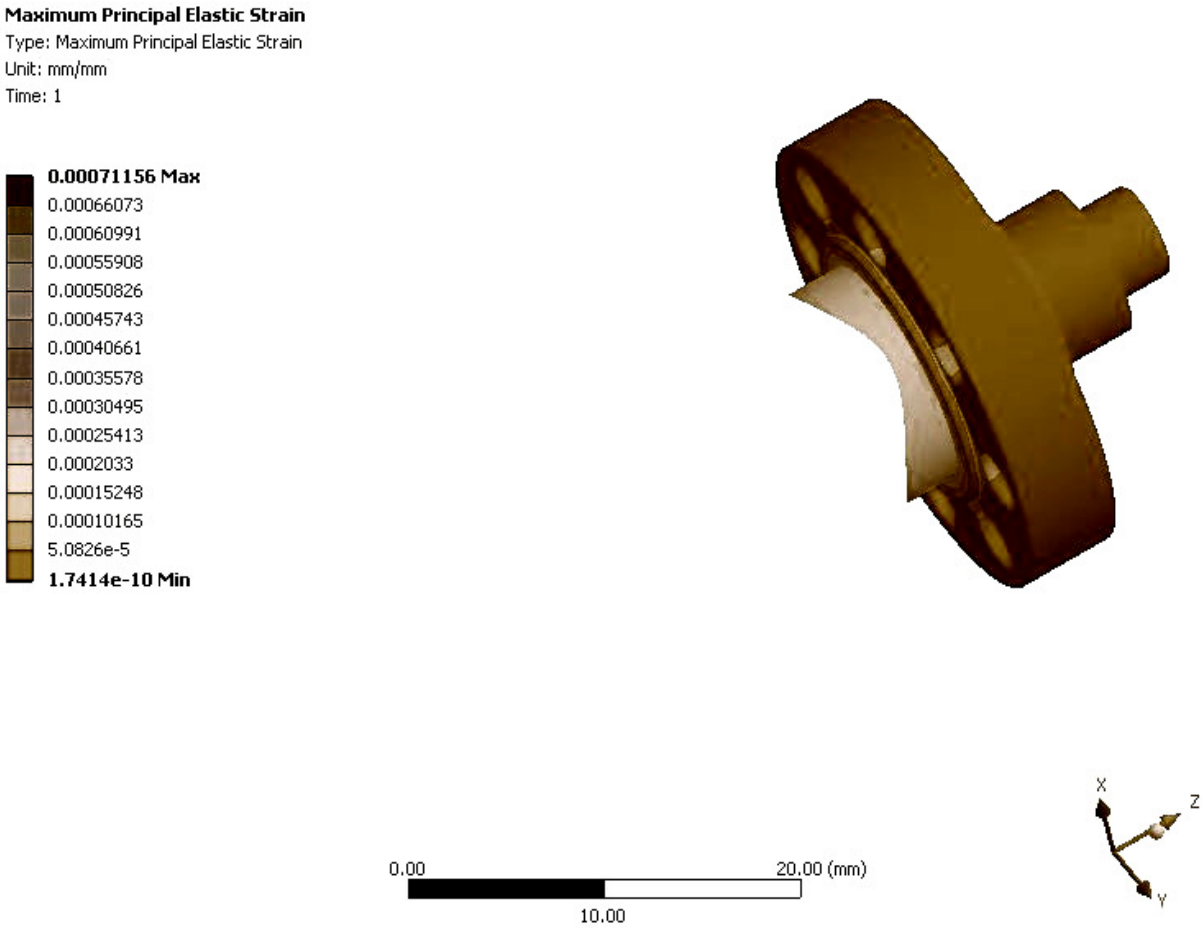
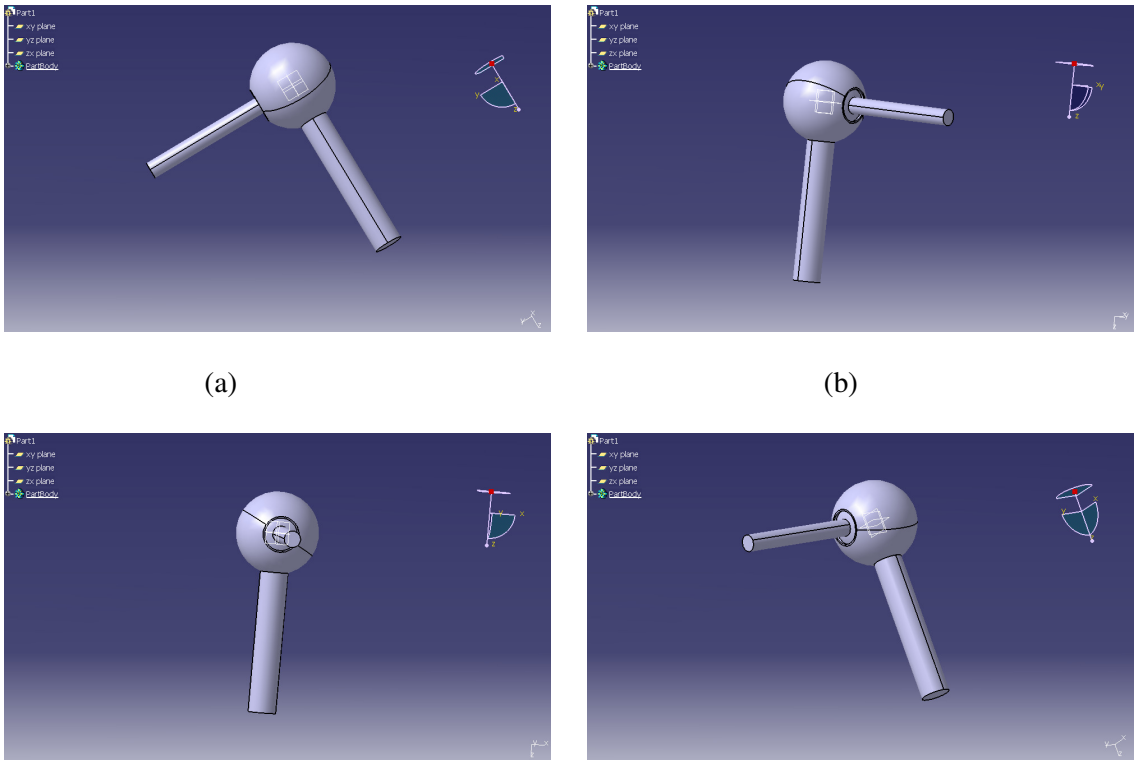


Figure.6: Finite element analysis. The figure symbolize the simulated strain field or brunt field for the shoulder roll

To illustrated more facts about of the advantages of this material we Designed one sample arm (shoulder roll) that contains it joint's. In the 4 section Fig. 6. the positions of the arm (shoulder roll) has showed.[5,6]

In these pictures we use one VEM between the joints and then we can conclude from 4 sections (a-d) it has more convenient to rotating with this material but if we didn't use this material maybe we had a friction or break in this joint (but this problem is showed after many movements for example the break event in this joint maybe happened after 2 year or 20000 moving around the all orientations). [6]



(a) (b)

(c) (d)

Figure.7: Sample positions of the shoulder roll joint in a free field of hit: a), d) rotation of the joints about x-y plane, b) rotation of the joint about the –x-y plane, c) rotation of the joint about y-z plane

I.2 RESULTS:

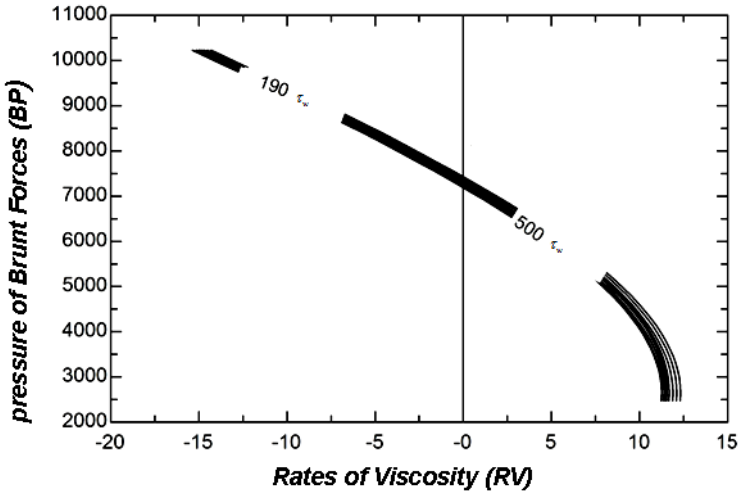


Figure.8: Effect of the Viscosity of the main material that we use in the spaces of the joints [8]

Finally we plotted Fig.7 to show how the viscosities of the materials effects on the joints can decrease the abrasion phenomenon with increase the friction when the brunt forces acting on those. At the moment we should mention this advantage point that is the critical point (RV=0), when it shows us while the rates of the viscosity exceeded the mentioned level, it would be effect less, and we should reconsider to choose the better one according to our response in any situation.[9]

II. ANALYSIS OF RESULTS AND DISCUSSION

As a brief conclusion of our working we should explicated our new achievement in one Table that is clearly demonstrated the application of our proposed material (VEM). As an example we introduced four models that are shows us this fact: how can we choose the best material to have a few shear rates and shear stresses in the articulations rotation, while we don't have any way to check this exactly. In this diagram differences between the effects of the three models are showed. Then it has caparisoned between the rheological constants through Newton's, Bingham plastic, Power law and Herschel-Bulkley models that all of them can be choose as a best model.

Table.1: Effects of the Rheological Constants on the shear rates and shear stresses that are occur when the articulations are going to rotating. [9]

NEWTON	BINGHAM PLASTIC	POWER LAW	HRSCHEL-BULKLEY
$\mu = 0.022 pas$	$\tau_y = 3.57 Pa$ $\mu_p = 0.0167 Pas$	$k = 0.671$	$\tau_y = 1.15 Pa$ $k = 0.362$

We can use a lot of models to choose the best material for our working, Table 1. says each joints of the robots can easily simulated by ANSYS software and it is very comfortable to use one of the above models in that software for analyzing the shear rates and shear stresses that are occurs when the Brunt forces or sudden Forces acting on the joints. [10] By doing this way we can choose our suitable material to decrease the abrasion phenomenon between the joints. [11]

III. CONCLUSIONS AND FUTURE SCOPE

In any rotations of an articulations about the joints of the robots, we have a lot of corrosion phenomenon and this problem is going to be increase in every movement, but we can easily decrease this problem even if going to be zero in many situations by using one viscoelastic material between the spaces that are exists between the joints and bulbs. But if we have a good outcome to get to this target, we should design an applicatory space between the main body and joints, or we should try to find reasonable materials to accommodate in them, and this action should be scrutiny exactly to have a few abrasion phenomenons. Finally, in this paper we attempted to illustrate many facts about that we can use Viscoelastic materials, because they can prepare more convenient to rotating and it is more reasonable way to use them.

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