



IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 Issue: VIII Month of publication: August 2017 DOI: http://doi.org/10.22214/ijraset.2017.8139

www.ijraset.com

Call: 🛇 08813907089 🕴 E-mail ID: ijraset@gmail.com



Stress Variation and Total Deformation Study Of 3P-2R Industrial Manipulator all through its Work Cycle

Poonam Zagade¹, Snehal Kamble², Santosh Joshi³

^{1,2} Student, ³Assistant Professor Department of Mechanical Engineering, Vishwakarma Institute of Technology Pune, 411037

(India)

Abstract: The structural analysis focuses on the changes occurring in the behavior of a physical structure under observation when provided with a force or in case of structures, load. Now if this load is quasi (very slow), the inertia forces from the basis of Newton's first law of motion can be neglected and the analysis becomes static. Stress analysis of manipulator is the application of various loads to various links within sustainable limits and checking stresses occurred in the links. The stress analysis is done by ANSYS workbench. Stress variation study gives results of maximum stress value that a particular material can bear for a given manipulator at different positions.

Keywords: Manipulator, Kinematics, Home position, Prismatic, Revolute, End - effector.

I. INTRODUCTION

Robots and manipulators are complicated mechanical systems with highly non linear dynamic behavior. Kinematics deals with the basic geometry of the linkages. If we consider an articulated manipulator as a device for generating position and orientation, we need to know the relationships between these quantities and the joint variables, since it is the latter that we can easily measure and control. Structure analysis is carried out in both static and dynamic condition. Joint limits, material for links can be determined using stress analysis. We define whole body postural control as the property of being able to control the angle of all links of the robot (including the base) relative to the ground. Under these conditions, we determine what forces at the end effector. The orientation of the base of one robot is fixed so that it is perpendicular to the ground. The dynamically stable robot is free to orient its base with respect to the ground. The difference in the range of forces that each of these robots can apply at their end effectors is then determined. The robot model we choose for static analysis is 5 DOF manipulator (3P-2R manipulator)which has 3 prismatic joints and 2 rotary joints. Stress variation along link length is finding out under particular load at different positions using ANSYS. Stress variation analysis gives maximum stress value a given manipulator can bear under applied load. For given stress value we can determine joints limits and suitable material for given manipulator.

II. METHODOLOGY

For the static analysis we choose 5 DOF manipulator having 3 prismatic joints and 2 rotary joints. Stress analysis is done in ansys. Manipulator has base frame (20mm*20mm) and 5 links (100mm*20mm/kl). We calculated the maximum stress value for a given manipulator at different five positions.1)Homeposition 2)End position 3) 3 intermediate position. For given manipulator we selected stainless steel as a base frame and for links. Following fig shows the equivalent stress analysis and strain analysis along link length when load is app ,l lied at end of end effector. For analysis of various links we have used Ansys Workbench 14.0 version. Material selected – Stainless Steel

SR.NO	PROPERTY	VALUE	UNIt
1.	Density	7750	Kg/m^3



International Journal for Research in Applied Science & Engineering Technology (IJRASET)

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887 Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

2.	Poissions ratio	0.31	
3.	Tensile yield strength	2.07e^8	Pa
4.	Compressive yield strength	2.07e^8	Pa

Catia model PPPRR Manipulator using Catia V2R20 is shown below :



Figure 1. PPPRR Catia Model.

A. Different Distances of various Links from Home Position are as follows

	· · · · · · · · · · · · · · · · · · ·		
SR.NO	POSITION	DISTANCE FROM HOMOGENEOUS	
		POSITION	
1	Homogeneous Position	0.00 mm	
2	Intermediate Position 1	25.00 mm	
3	Central Position	50.00 mm	
4	Intermediate Position 2	75.00 mm	
5	End Position	100.00 mm	

- B. Results Evaluated from Analysis in Ansys Workbench 14.0 are as Follows
- 1) Home Position :



Figure 2. Equivalent Stress

Figure 3. Total Deformation



International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887

Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

2) Intermediate position 1:



Figure 4. Equivalent stress

Figure 5. Total Deformation



Figure 5. Equivalent Stress

Figure 6. Total Deformation





Figure 7. Equivalent Stress

Figure 8. Total Deformation



International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887 Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

5) End Position:



Figure 9. Equivalent Stress

Figure 10. Total Deformation

III. RESULT TABLE

Following table gives the value for equivalent stress analysis and strain analysis and maximum stress that a given manipulator can sustain at different five positions.

SR.NO	Manipulator positions	Equivalent stress	Elastic Strain	Total	Max. Load
		analysis	analysis	deformation	manipulator can
		(Pa)	(m/m)	(m)	sustain
					(N)
1.	Home position	2.0457e8	0.00102	0.0015712	44
2.	Intermediate position 1	2.0448e8	0.0010259	0.0015977	44
3.	Mean position	2.046e8	0.0010266	0.0016387	44
4.	Intermediate position 2	2.0461e8	0.0010839	0.0014889	38
5.	End position	2.0463e8	0.0010822	0.0012125	30

IV. SUMMARY

Variation of stress value at different position and maximum value of stress that a given manipulator can sustain at different five positions is carried out. After plotting a table we find out that up to mean position manipulator can sustain maximum 40 N load. At 4^{th} position maximum stress value a manipulator can sustain is 38N. And at end position a manipulator can sustain maximum 30N load. That means as we go upward along the link length the stress value that a manipulator can sustain is constant up to mean position. As we go above mean position maximum stress value that a manipulator can sustain goes on decreasing.

V. CONCLUSION

In this way, from stress variation study we can find out variation of stress along link length at different positions. Also from this analysis we can find out joint limits for given manipulator. We can select a suitable material for particular stress under particular load depending on applications. Hence maximum load can be sustained by PPPRR robotic manipulator is 30 N with safe design.

VI. ACKNOWLEDGEMENTS

"We thank Mechanical Engineering Department of Vishwakarma Institute of Technology, Pune for the facilities, support and guidance provided for the work carried out."

International Journal for Research in Applied Science & Engineering Technology (IJRASET)



ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887

Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

REFERENCES

- Affi, Z., Romdhane, L. and Maalej, A., 2004. Dimensional synthesis of a 3-translational-DOF in-parallel manipulator for a desired workspace. European Journal of Mechanics A/Solids 23:311-324.
- [2] Stress Analysis For Robotic Arm V2analisa Tecasan Bagi Lengan Robotikv2.
- [3] End-Effector Position Analysis Using Forward Kinematics for 5 DOF Pravak Robot Arm by Jolly Shah, S.S.Rattan, B.C.Nakra.
- [4] Kay, J., Introduction to Homogeneous Transformations & Robot Kinematics, Rowan University Computer Science Department.
- [5] V'aclav Hlav'a'c, ROBOT KINEMATICS, Faculty of Electrical Engineering Department of Cybernetics, Czech Technical University.
- [6] Kinematic Analysis and Simulation of 6Dof KukaKr5 Robot For Welding Application by K.Kishore Kumar, Dr.A.Srinath.
- [7] V'aclav Hlav'a'c, ROBOT KINEMATICS, Faculty of Electrical Engineering Department of Cybernetics, Czech Technical University.
- [8] Niku, A.B. (2001). Introduction to Robotics: Analysis, Systems, Applications. Upper Saddle River, New Jersey: Prentice Hall.
- [9] Hartenberg, Richard and Jacques Danavit.(1964). Kinematic Synthesis of Linkages New York: McGraw-Hill











45.98



IMPACT FACTOR: 7.129







INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 🕓 (24*7 Support on Whatsapp)