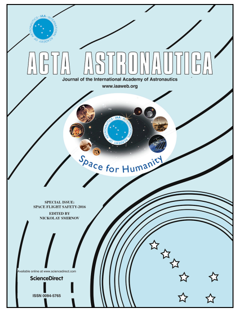
Accepted Manuscript



Design and analysis of flexure revolute joint based on four-bar mechanism

Jing Zhang, Hong-wei Guo, Juan Wu, Gui-jun Gao, Zi-ming Kou, Anders Eriksson

PII: S0094-5765(18)30157-7

DOI: 10.1016/j.actaastro.2018.06.046

Reference: AA 6964

To appear in: *Acta Astronautica*

Received Date: 20 January 2018

Revised Date: 21 May 2018

Accepted Date: 20 June 2018

Design and analysis of flexure revolute joint based on four-bar mechanism

Jing Zhang [a, c,] *, Hong-wei Guo [b,] **, Juan Wu[a, c], Gui-jun Gao[a, c], Zi-ming Kou[a, c], Anders Eriksson[d]

[a] *College of Mechanical Engineering, Taiyuan University of Technology, Taiyuan 030024, China*

[b] *School of Mechatronics Engineering, Harbin Institute of Technology, Harbin 150001, China*

[c] *Shanxi Provincial Engineering Laboratory (Research Center) for Mine Fluid Control, Taiyuan 030024, China*

[d] *KTH Mechanics, Royal Institute of Technology, Stockholm SE-100 44, Sweden*

** Corresponding author.*

E-mail addresses: free1985216@163.com (Jing Zhang)；guohw@hit.edu.cn (Hong-wei Guo).

Abstract: In order to avoid the stress concentration and increase rotational angle of a flexure joint, the method of partial separation of storage elements in the motion transmission elements is proposed. A type of flexure revolute joint with large rotational angle is designed based on the block approach. By setting a four-bar mechanism as the intermediate block which connects the outer ring and the inner ring of the revolute joint, and replacing the rigid bar by a flexible beam, large rotational angles of the joint can be achieved. The basic size of the joint is designed by setting the initial and the constraint condition of the four-bar mechanism. Then, influence analyses of the size of the linkage joint and large flexible beam on the stress, the torque, and the torsional stiffness are conducted by using nonlinear static analysis method. Based on the requirements for torque and rotational stiffness, the size of the flexure revolute joint is defined. Experiments on the joint, which can rotate 90 degrees, are conducted.

Keywords Deployable structure; Flexure revolute joint; Block approach; Four-bar mechanism

1. Introduction

Given the constraint of the launcher's capability in spacecraft design, deployable structures which can change their size significantly by changing shape have been widely used in space missions [1]. The dimension of the deployable structure can reach 19m×17m to meet the requirements of the aperture diameter of the antenna reflector of Engineering Test Satellite-VIII [2]. The structures frequently contain several joints to satisfy the need of the space mission. However, free-play and friction in joints often cause nonlinearity of the mechanical properties [3]. Typically, clearance in joints can result in impact in the elements of a structure under dynamic excitation, and affect the positional accuracy and stability of a spacecraft [4, 5].

To avoid impact and clearance, it is meaningful to design one-piece flexure joints without clearance and friction. Previous work has developed several surrogate folds using compliant mechanisms [6]. Flexure revolute joints, as one type of them, can be divided into two classes by considering the relative locations of the flexure and rigid segments. The different segments of the first class exist in the same plane in the initial state, such as Lamina Emergent Torsional (LET), Tensile Lamina Emergent Torsional (T-LET), and Lamina Emergent Mechanism (LEM) [7-9]. The second class is when the flexure and rigid segments exist in different areas. Reflectors are deployed by the means of compliant mechanisms known as tape springs [10]. The tape spring has high deployed