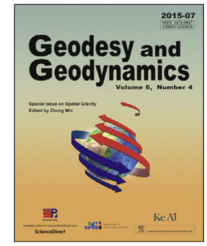
GEODESY AND GEODYNAMICS 2015, VOL 6 NO 4, 299–306

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.keaipublishing.com/en/journals/geog; http://www.jgg09.com/jweb_ddcl_en/EN/volumn/home.shtml



Progress on the use of satellite technology for gravity exploration

Ding Yanwei[a,*], Ma Li[b], Xu Zhiming[a], Li Ming[a], Huo Hongqing[c], Tan Shuping[d], Gou Xingyu[d], Wang Xudong[d], Yang Fuquan[c], Mao Wei[d], Liu Yingna[e], Zhong Xingwang[f], Xi Dongxue[c], Hu Lingyun[a], Huang Lin[a], Li Songming[a], Zhang Xiaomin[a]

[a] DFH Satellite Co. Ltd, Beijing 100094, China
[b] Beijing Satellite Manufacturing Factory, Beijing 100080, China
[c] Lanzhou Institute of Physics, Lanzhou 730000, China
[d] Beijing Institute of Control Engineering, Beijing 100080, China
[e] Space Star Co. Ltd, Beijing 100080, China
[f] Academy of Space Electronic Information Technology, Xi'an 710004, China

ARTICLE INFO

Article history:
Received 7 April 2015
Accepted 16 May 2015
Available online 15 July 2015

Keywords:
Ultra-stable structure
Precision thermal control
Drag-free
Micro-thruster
K-band ranging
Aerodynamics
Micro-vibration
Gravity satellite

ABSTRACT

In this paper, the technological progress on Chinese gravity exploration satellites is presented. Novel features such as ultra-stable structure, high accurate thermal control, drag-free and attitude control, micro-thrusters, aerodynamic configuration, the ability to perform micro-vibration analyses, microwave ranging system and mass center trimmer are described.

* Corresponding author.
E-mail address: dingyanwei@tsinghua.org.cn (Ding Y.).
Peer review under responsibility of Institute of Seismology, China Earthquake Administration.

Production and Hosting by Elsevier on behalf of KeAi

http://dx.doi.org/10.1016/j.geog.2015.05.008

1. Introduction

In China, studies for the preparation of gravity satellite missions, in addition to research and development of new technologies, scientific instruments and spacecrafts, began more than 15 years ago. Under the guidance of the China National Space Administration, satellite gravity measurement missions have been conducted. Certain key research projects related to the development of scientific instruments and spacecrafts have been funded. This paper highlights the technological progress that has been observed to date.

2. Ultra-stable material and structure

2.1. *Near-zero CTE carbon–carbon composite material*

Carbon–carbon composite materials were selected for the fabrication of key bench sustaining payloads. The advantages of carbon–carbon composite structure include near-zero coefficient of thermal expansion (CTE), low moisture sensitivity, and high specific stiffness.

To simultaneously realize near-zero CTE in X, Y, Z directions, the bench thickness direction should also have a near-zero CTE. Taking into consideration the two preferential qualities (i.e., rigidity and minimal weight), four types of carbon–carbon structures were developed as potential prototypes of the final bench structure. Figs. 1–4 illustrate the three-dimensional (3D) woven integrated, truss core, carbon honeycomb core, and carbon honeycomb core sandwich structures that were proposed.

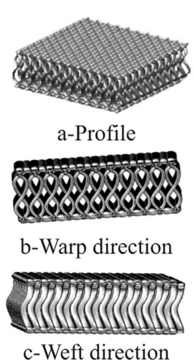


Fig. 1 – 3D woven integrated sandwich structure.

Fig. 2 – Sample of 3D structure.

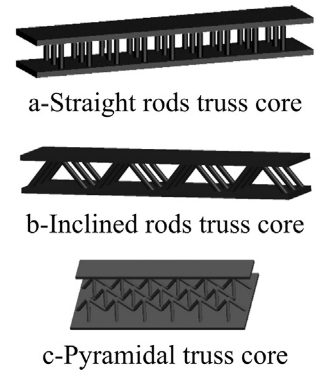


Fig. 3 – Truss core sandwich structure.

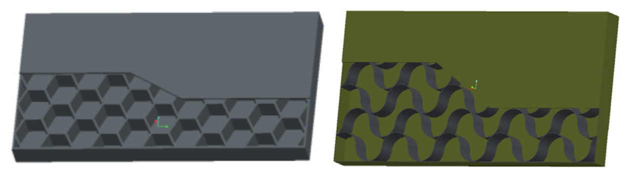


Fig. 4 – Carbon honeycomb core sandwich structure.

2.2. *A composite truss structure model*

Satellites that are designed for gravity measurement missions need to maintain orbital stability to ensure a relatively fixed position and pointing of each precise payload stable. Fig. 5 provides an example of a truss structure model. The low thermal expansion coefficient that characterizes composite truss structure designs compromises the payload. Fig. 6 illustrates a finite element-based (FE) model of the truss structure that was built to facilitate thermal distortion analysis.

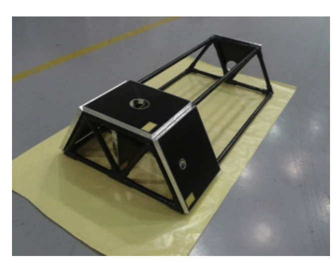


Fig. 5 – The model of truss structure.

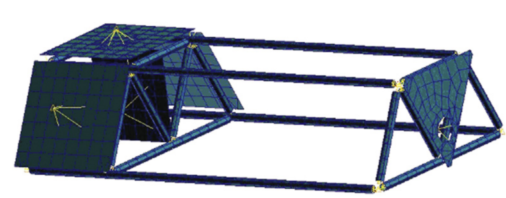


Fig. 6 – The FE model of composite truss structure.