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SOI: 1.1/TAS DOI: 10.15863/TAS

International Scientific Journal

Theoretical & Applied Science

p-ISSN: 2308-4944 (print) **e-ISSN:** 2409-0085 (online)

Year: 2024 **Issue:** 04 **Volume:** 132

Published: 14.04.2024 **http://T-Science.org**

Issue Article

Denis Chemezov
Vladimir Industrial College
MEng, Honorary Worker of the Education Field of the Russian Federation, Academician of International Academy of Theoretical and Applied Sciences, Lecturer, Russian Federation
https://orcid.org/0000-0002-2747-552X
vic-science@yandex.ru

Natalya Zezina
Vladimir Industrial College
Foreman of vocational training, Russian Federation

Grigoriy Klimenko
Vladimir Industrial College
Student, Russian Federation

Yaroslav Baranov
Vladimir Industrial College
Student, Russian Federation

Danil Ilyushin
Vladimir Industrial College
Student, Russian Federation

Aleksandr Klyauzov
Vladimir Industrial College
Student, Russian Federation

Maksim Eremtsov
Vladimir Industrial College
Student, Russian Federation

Dmitriy Voronich
Vladimir Industrial College
Student, Russian Federation

Talabsho Kamilov
Vladimir Industrial College
Student, Russian Federation

TRACTION IN LOADED SIMPLE BOLTS

Abstract: *Visualization of the loaded state of a simple bolt in a joint was demonstrated by the authors in the article. The degree of deformation of the standard product was displayed by vectors of the ratio of force to the area of the working surfaces of the bolt.*

Key words: *bolt, traction, joint, load.*
Language: *English*

Citation: Chemezov, D., et al. (2024). Traction in loaded simple bolts. *ISJ Theoretical & Applied Science, 04 (132),* 159-161.
Soi: http://s-o-i.org/1.1/TAS-04-132-16 ***Doi***: https://dx.doi.org/10.15863/TAS.2024.04.132.16
Scopus ASCC*: 2201.*

Introduction

The bolted joint provides a detachable coupling of several parts with bolts of various configurations. Bolts are standard products that must be manufactured in accordance with official documents [1-4].

During operation, the bolts are subjected to various deformations (shearing, crumpling, and stretching). Depending on the loading conditions of the bolted joint, the dimensions, material, accuracy and other characteristics of the bolts are selected by calculating analytical equations, conducting an experiment or modeling in computer programs of engineering analysis [5-10]. By changing the shear force of the jointed parts, the intensity of the contact deformation of the bolt surfaces is determined. The degree of bolt loading can be represented by the force/area ratio, which allows us to estimate not only the magnitude of the acting force on a specific surface, but also to determine the type of deformation.

In this article, a vector array of the load distribution of simple bolts with constant shear force of the mated parts was obtained using the computer program.

Materials and methods

The intensity of loading of the bolts that connected the flange to the pipe was studied. A constant transverse force acted on the flange. All parts of the joint were made of structural steel having the following properties: density – 7850 kg/m^3, Young's modulus – 200 GPa, Poisson's ratio – 0.33. The fastener was a simple bolt without a thread with the following dimensions: diameter of the head – 38 mm, thickness of the head – 15 mm, nominal diameter – 21.2 mm, bolt length – 34 mm. A washer with a thickness of 4 mm and a hole diameter of 25 mm was placed under the bolt head. The bolt stress area was 353 mm^2. The calculation was carried out in the Comsol Multiphysics software.

Results and discussion

The traction is the ratio of the acting force to the area of the contact surfaces of the bolt. The traction vectors in the loaded bolt were shown in the Fig. 1. The vector length determines the amount of force. It is noted that the maximum forces occur along the bolt rod and at the junction of the rod and the head. At the same time, forces act at a certain angle at the boundary, thereby causing a shift in the layers of the bolt material. The forces act in two directions, causing both tensile and compression deformation. At the same time, the compression deformation of the bolt is smaller in magnitude than the tensile deformation (vectors at the boundary of the end face of the bolt rod). A lower intensity of loading is noted on the surfaces of the bolt head. Thus, the greatest deformation of the material occurs along the axis of the bolt with a predominance of stretching.

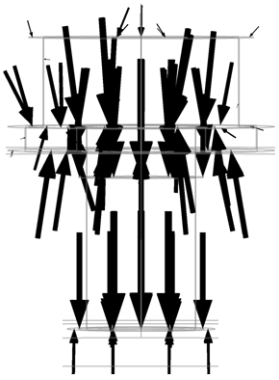

Figure 1. Traction vectors in the loaded simple bolt.

Conclusion

Loaded bolts experience tensile, compression and shear deformations. A visual representation of the traction ratio makes it possible to analyze the approximate effect of tensile, compressive and shear forces on the contact surfaces of the simple bolt without a thread. The results obtained will be useful to design engineers when designing fasteners for technological equipment.

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