CYCLIC BEHAVIOUR OF HIGH STRENGTH FRICTION GRIP BOLT SUBJECTED TO REPEATED TENSILE LOADING

BY

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The successful completion of this research is the result of good co-ordination and co-operation by all parties involved. This research has created a pool of experience in Fatigue Analysis. It does not mean that the result of this research are necessarily forthcoming as this depends on the capability of the researchers and perhaps a bit of luck as well.

It is a great pleasure to extend fraternal greetings and best wishes to Mr. Abu Kassim Saleh and Miss Aniza Alias for their assistance, effort and determination to the success of this research.

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ABSTRACT

Fatigue is a common failure in Civil Structure that have not fully explored in researched, particularly for structures connected by bolts. Furthermore, there are many uncertainties in determining fatigue failure as mention by many researchers regarding fatigue parameters. However, discerning from the researched pattern most of the study based on S-N Curve. This could well mean that S-N Curve needs to be developed.

The aims of this research are to propose a design monograph S-N Curve and to study the behavior of 12 mm diameter of High Strength Friction Grip Bolt under repeated loading. The objectives of the studies were concentrated on the influence of Stress Ranges, Mean stress and the diameter of bolt with respect to the fatigue life.

The methodology of research was a series of laboratory experiment. It started from Static Tensile Test, Fatigue Sensitivity Test and finally to conduct Fatigue Test on three levels of Mean Stresses at four different Stress Ranges.

The finding from the experiment lay out in this paper were a proposal of the S-N Curve for 12 mm diameter HSFG Bolt and the effect of Stress Ranges and Mean Stresses to the bolts. The paper had discussed about a common point of endurance limit found in the experiment and the significant effect of Stress Range compared to the Mean Stress in fatigue life. The research had also determined under repeated loading that the smaller diameter of bolt can survive longer than bigger diameter. Finally, base on experiment conducted it is concluded that in fatigue design the pulsating tensile mode analysis is more critical than alternating mode.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

Fatigue is a common mode of failure for a broad range of civil engineering structures, particularly when such structures are made up of members connected by bolts. Highway bridges, gas piping vessel and offshore structure are examples of structure that are generally made up of bolts members and for which fatigue failure can be disastrous.

The important of repeated loading was first recognised in the first half of the eighteenth century. J.V. Poncelot (1788-1867), a French professor of engineering mechanics, mentioned the failure of a spring by fatigue in a book published in 1839. Also W.J. M Rankine (1820-1872), a Scots engineer, discussed the fracture of railroad locomotive axles in a paper published in 1843. Throughout 1843 to 1870, there was a great debate as to whether metal crystallised in service. The greatest single contribution to the investigation is that of A Wohler (1819-1914), a German engineer who designed fatigue testing machine and conducted many fatigue tests, which included the effect of stress concentration due to change in cross-section. Whereby, the argument that iron changed from fibrous to crystalline structure under repeated loading was successfully refuted.

Due to engineering application nowadays, fatigue consideration must be taken into account at the design stage. Unfortunately there are many uncertainties involved in predicting fatigue failure for such structures and connections under service load condition. One of the practical methods for use in welding jobs as proposed by Gurney is by establishing S - N curve. Published in BS 5400, Part 10 as shown in fig 1.1 (A.B Clarke, S.H Coverman, 1983).