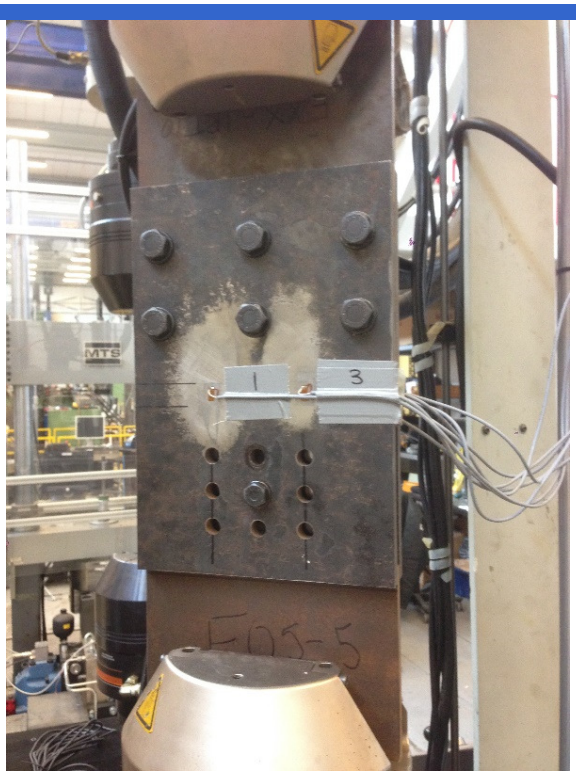
Gusset Plate Connections in Tension



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Preface

This project is a BSc project credited 20 ECTS points written in the period 2014-02-03 to 2014-06-13.

This is the final project of the Bachelor of Civil Engineering on the Building study line.

Both the project and the BSc has been carried out at the Technical University of Denmark (DTU) in the Department of Civil Engineering (BYG).

The project has been carried out in cooperation with BEng student Thomas Holm Skov who has been responsible for the data processing and has written a test report of the performed tests.

The supervisor of the project is Professor and Head of Section for Structural Engineering Jeppe Jönsson (BYG, DTU). Great appreciations is dedicated to him for guidance throughout the project.

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Abstract

Designing connections in structural constructions is done using certain calculation standards. These standards are based on experimental verifications of known theory. However, it can be argued that the design standards and the theoretical knowledge used today are rather conservative. It may therefore be possible to optimize these.

This project investigates the possibility of optimizing these standards within the specific area of preloading of bolts in gusset plate connections.

In order to investigate this subject six different test configurations were designed. Each configuration consisted of a bolted gusset plate connection designed to fail from either bearing resistance, capacity of cross section or block shear capacity. Each configuration would then be subjected to three different kinds of preloading; loose, snug tight and fully preloaded according to DS/EN 1090-2. Each with a repetition of 3 times for the different degrees of preloading – making a total of nine repetitions for each test configuration.

Throughout this report the relevant theory is introduced. Furthermore, the design and the results of the test configurations are presented and compared to the theory along.

The test results indicated an increase in total capacity of the preloaded connections. However, it was observed that this mainly was due to friction which was not accounted for. This along with the fact that the material properties for each test specimen could not be determined made it hard to reach any final conclusion. Further research is therefore necessary, hence a series of suggestions for future research was proposed.

Based on some of the test results this report also suggests that the tearing of a single bolt should be treated as a simplified block tearing failure instead of failure due to lack of bearing resistance.

Furthermore, a simplified model of one of the test configurations was implemented in the finite element program ABAQUS in order to test the possibility of implementing preloading of bolts. This project shows that this is possible, however further research is necessary in order to investigate this subject further.

Resumé

Design af samlinger i bygningskonstruktioner er lavet ud fra visse beregningsstandarder. Disse standarder er baseret på eksperimentel verificering af allerede kendt teori. Der kan dog argumenteres for at disse standarder sammen med den teoretiske viden er noget konservativ. Det kan derfor være muligt at optimere disse.

Dette projekt undersøger muligheden for at optimere standarderne inden for området forspænding af bolte i laskepladesamlinger.

Seks forskellige forsøgsopstillinger blev designet for at undersøge dette emne. Hver forsøgsopstilling bestod af en laskepladesamling designet til at bryde ved enten hulrandsbæreevne, kapacitet af tværsnit eller blokforskydningskapacitet. Hver samling ville så blive udsat for tre forskellige slags forspænding; løs, "snug-tight" og fuldt forspændt ifølge DS/EN 1090-2. Hver med en repetition på 3 for hver af de forskellige grader af forspænding – sammenlagt 9 repetitioner for hver forsøgsopstilling.

Igennem denne rapport er den relevante teori introduceret. Ydermere er design og resultater fra forsøgene præsenteret og sammenlignet med teorien.

Forsøgsresultaterne indikerede en større kapacitet af de forspændte samlinger. Dog blev det observeret at dette skyldtes friction, hvilket der ikke var regnet med. Dette sammen med faktum at materialeværdier for hver enkelt forsøgselement ikke kunne bestemmes gjorde det svært at opnå en endelig konklusion. Yderligere forskning er derfor nødvendigt, hvorfor en række foreslag til fremtidig forskning er fremstillet.

Baseret på nogle af forsøgsresultaterne foreslår denne rapport også at udrivningen af en enkelt bolt skal behandles som forsimplet blokforskydning i stedet for brud grundet manglende hulrandsbæreevne.

Ydermere blev en simplificeret model af en af forsøgsopstillingerne modelleret i finite element programmet ABAQUS for at undersøge muligheden for at implementere forspænding af bolte. Dette projekt viser at dette kan lade sig gøre, dog er yderligere forskning nødvendig for at undersøge emnet nærmere.