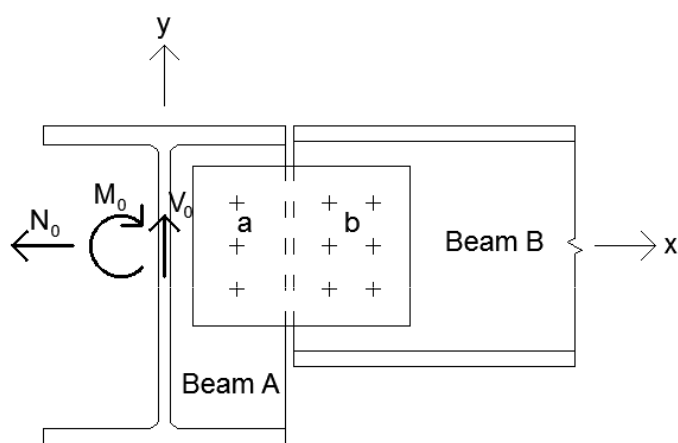


# Bolted gusset plate connections and block shear failure



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**Master Thesis**

Department of Civil Engineering  
2013

DTU Civil Engineering  
February 25<sup>th</sup> 2013

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Master Thesis  
30 ECTS points

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# Preface

This project is a Master Thesis credited 30 ECTS points and written in the period September 1<sup>st</sup> 2012 to February 25<sup>th</sup> 2013. It is the final project of the Master in Civil Engineering with the building structures study line.

Both the Thesis and the Master have been carried out at The Technical University of Denmark (DTU) in the Department of Civil Engineering (BYG).

The supervisor of the project is Professor and Head of Section for Structural Engineering Jeppe Jönsson (BYG, DTU). A great appreciation for involvement and guidance is dedicated to him.

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Lyngby  
February, 2013



# Abstract

The design of connections involves great complexities which induces time consumption, due to the many capacity verifications. In the present project the bolted gusset plate connection is investigated in order to clarify relevant capacity verifications and to develop helpful design tools to ease this process.

The connection is exposed to a complex load situation, which involves a tension and shear force combined with a moment. EN1993-1-8 fails to provide sufficient information on how to verify the capacity in block shear for this complex load situation, the literature is investigated to obtain the knowledge. In this process relevant experimental data is collected and compared to the literature. In addition the experimental data is used to develop simple formulas for block shear capacity.

A bolted gusset plate connection is likely to fail by bolt fractures, block shear failures or cross section failures. The bolt fractures are shear fracture, bearing fracture in the plates or for Category C connections slip resistance failures. Block shear failures are either C-cut outs or L-cut outs. To simplify the cross section verifications these are verified in the net areas.

For the block shear failures different statically admissible plastic distributions of the forces are suggested. These are compared and the optimal is recommended. For all the capacity verifications interaction formulas are developed that are to be fulfilled for any design.

On the basis of this project it is concluded that the current experimental data within block shear failures is insufficient. Thus a series of test setups are recommended in order to obtain more relevant knowledge. Based on the current experimental data for block shear failure that has been found in this project it is concluded that the current method in EC1993-1-8 is more conservative than the rest of the relevant standards and the literature. Hereby it is recommended to review the current method for block shear capacity determination in EN1993-1-8.



# Resumé

Design af samlinger er en kompliceret og tidskrævende proces, da mange delelementers bæreevne skal eftervises. I dette projekt er en boltet laskepladesamling undersøgt med henblik på at klarlægge relevante kapacitetseftervisninger, samt at udvikle hjælperedskaber for hurtig eftervisning af disse.

Samlingen kan være udsat for en kompleks belastning, hvor den skal overføre en kombination af en træk- og forskydningskraft, samt et moment. Da EN1993-1-8 ikke giver tilstrækkelig information om, hvordan man bestemmer blokforskydningsbæreevne i denne situation, er faglitteraturen undersøgt for at finde frem til den nyeste viden. I denne forbindelse er relevant eksperimentelt forsøgsdata indsamlet og udover at sammenholde dette med litteraturen er data også brugt til at komme med simple bud på at beskrive blokforskydningsbæreevnen.

For en boltet laskepladesamling er der tre hovedgrupperinger af brud, nemlig boltebrud, blokforskydningsbrud og tværsnitsbrud. Boltebrudene er overklipning, hulrandsbrud og for kategori C-samlinger friktionsbrud. Blokforskydningsbrudene kan være som C- eller L-blokudrivninger. For at simplificere tværsnitsbrudene er kapaciteten verificeret i nettoarealet.

For blokforskydningsbrudene er opstillet forskellige statisk tilladelige plastiske distributioner af kræfterne. Disse er blevet sammenholdt og de bedste er blevet anbefalet. For alle kapacitetseftervisninger er opstillet interaktionsudtryk, som skal overholdes for eftervisning af bæreevnen for det givne design.

På baggrund af dette projekt er det konkluderet, at der ikke er tilstrækkelig eksperimentelt data til rådighed til at beskrive alle former for blokforskydningsbrud. Derfor anbefaler dette projekt en række forsøgsopstillinger, som bør testes, før end at det kan konkluderes, at alle aspekter af blokforskydningsbrud er forstået og verificeret ved eksperimentelle tests. Ud fra det forsøgsdata, der er fundet gennem dette projekt, kan det konkluderes, at den måde blokforskydningskapaciteten bestemmes på via EN1993-1-8 er meget mere konservativ end hvad andre standarder og faglitteraturen anbefaler. På baggrund af dette anbefales det at den nuværende metode til at bestemme blokforskydningskapaciteten tages op til revision.