Master Thesis

Capacity Methods for Steel Connections
- Analysis of Bolted Double Gusset Plate Connection

Lærke Mikkelsen, s052812

March 1st 2011

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30 ECTS points

Supervisor:

Jeppe Jönsson, Professor, BYG DTU

Submitted March 1st 2011 by:

Lærke Mikkelsen, s052812

Department of Civil Engineering

Technical University of Denmark, DTU

Abstract

The design of connections involves great complexity which inevitably induces time consumption. This thesis therefore deals with execution of formulas, tables and a MatLab programme that ease the determination of the capacity of a connection with a bolted double gusset plate connection used as example.

By studying EN 1993-1-8 the resistances to be considered when determining the capacity of a bolted connection are listed and it is found that for eccentric loading of a connection, EN 1993-1-8 does not take the moment contribution into account in formulas for the block tearing resistance. Also, the approach for computation of the bearing resistance of the bolt for an eccentric loaded structure is investigated and it is found that using the EN 1993-1-8 stated method gives very unconservative bearing resistances in comparison to defining a resulting force by radius in an ellipse.

Investigation of the shear and tension capacity shows that small capacities are obtained for minimum end distance, edge distance and spacings as these give a low bearing resistance of the bolts. Hence, optimal end distance, edge distance and spacings should be applied in stead along with a somewhat large thickness of the gusset plate.

General capacity of the connection is found by the theory of plasticity due to the complicated loading situation of shear, tension and bending acting interaction. Because of lack of information in EN 1993-1-8 regarding block tearing to this loading condition, different statically admissible plastic distributions of forces and moment for two types of block tearing are applied.
Comparison of the shear capacity for block tearing by using the EN 1993-1-8 formula for eccentric loading and the plastic distributions of forces shows very large differences explained by insufficient consideration to the moment contribution from the shear force in the EN 1993-1-8 formula. It is found that only for connections of size rarely seen in building constructions the EN 1993-1-8 formula gives results equal to those from the plastic distribution of forces. However, experimental testing of these distributions is required.

Investigation of the impact of choice of an elastic, approximate plastic or plastic distribution of bolt forces for shear capacity determination yields that the maximum capacities are obtained for the approximate plastic due to either inappropriate assumptions or a not optimal chosen plastic distribution.

Resumé

Design af samlinger er en kompleks proces hvilket uundgåeligt medfører tidsforbrug. Dette speciale omhandler derfor udarbejdelse af formler, opslagstabeller samt et MatLab program, der gør kapacitetsbestemmlse af en samling lettere. Til dette er en boltet dobbelt laskepladesamling brugt som eksempel.

Ved studering af EN 1993-1-8 er modstande, der er relevante for kapacitetsbestemmelse af en samling, oplistet, og det er erfaret, at for blokforskydning medtager EN 1993-1-8 ikke momentbidraget i de respektive formler. Ligeledes findes det, at den i EN 1993-1-8 angivne fremgangsmåde for bestemmelse af hulrandsbæreevnen for en eccentrisk belastet samling, er på den usikre side i forhold til at definition af den resulterende kraft som radius i en ellipse.

Undersøgelse af kapaciteten for forskydning og træk viser, at små kapaciteter opnås for minimums endeafstande, kantafstande og mellemrum grundet lav hulrandsbærevne. I stedet skal optimale endeafstande, kantafstande og mellemrum anvendes sammen med en forholdsvis tyk laskeplade.

Den komplicerede belastningssituation, der opstår af interaktion af forskydning, træk og moment, medfører introduktion af plasticitetsteori. Forskellige statisk tilladelige plastiske fordelinger af kræfter og moment for to slags blokforskydning er anvendt pga. utilstrækkelig information i EN 1993-1-8 for denne belastningssituation.
Sammenligning af forskydningskapaciteten for blokforskydning ved benyttelse af EN 1993-1-8 formlen for eccentrisk belastede samlinger og de plastiske kraftfordelinger viser store forskelle, da EN 1993-1-8 ikke tager tilstrækkelig hensyn til momentbidraget fra forskydningskraften. Det er fundet, at kun for samlinger af en størrelsesorden, som er sjældent set i bygningskonstruktioner, giver EN 1993-1-8 formlen resultater lig dem fundet ved de plastiske kraftfordelinger. Disse skal dog valideres ved forsøg.

Undersøgelse af indflydelsen på forskydningskapaciteten for valg mellem en elastisk, en tilnærmet plastisk og en plastisk fordeling af boltekræfter viser, at de maksimale kapaciteter opnås for den tilnærmede plastiske fordeling. Dette skyldes enten fejlagtige antagelser for den tilnærmede plastiske fordeling eller en ikke optimal plastisk fordeling.

Preface

This project is a master thesis credited 30 ECTS points created in the period September 1st 2010 to March 1st 2011. It is the closing 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 Jeppe Jönsson (BYG,DTU) and a great appreciation for involvement and guidance is dedicated to him.

Also, a great thanks to external lecturer Jesper Gath for sharing his knowledge of the practical aspects of the design of steel connections.