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# NUMERICAL AND EXPERIMENTAL INVESTIGATION FOR THE STRESS CONCENTRATION FACTORS IN MULTIPLANAR JOINTS.

Period 01-01-93 / 31-06-93

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**Project number:** DCT80.1457
**Project leader:** Prof. dr. ir. J. Wardenier

Investigation with financial aid of the Technology Foundation STW

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| | | |
|---|---|---|
| Project number | : | DCT80.1457 |
| Title research programme | : | Numerical and Experimental investigation for the Stress Concentration Factors in multiplanar joints. |
| Research team | : | Paid by STW:<br>ir. E. Panjeh Shahi: 01-01-1989 - 01-06-1993<br>ing. A. Romeijn : 01-04-1989 - 01-06-1993<br>Both are full time academic staff members.<br><br>Other members research team:<br>Prof.dr.ir. J. Wardenier (Project leader)<br>dr. R.S. Puthli |
| Start project | : | 01-01-1989 |
| End of project | : | 01-02-1994 |
| Reporting Period | : | 01-01-1993 - 31-06-1993 |
| Research location | : | Delft University of Technology<br>Faculty of Civil Engineering<br>Stevin II laboratory for Steel Structures |

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# 1 INTRODUCTION

Hollow sections offer many economical application possibilities e.g. in buildings, bridges, offshore structures and cranes. In the past ten years their use has been grown rapidly. This increase may even be larger if in future robot welding is used, since the hollow sections have relatively small tolerances and a simple geometry compared to that of other sections.
For an optimal design of structures loaded in fatigue evidence is required regarding the stress concentration factors. Especially in hollow section joints, the stress distribution is rather complicated resulting in high peak stress. These so called "hot spot" or geometry stresses determine the fatigue behaviour.
For uniplanar joints considerable research has been carried out. Since most structures are loaded in a multiplanar way, information about the multiplanar behaviour is urgently required.
This is the reason for setting up this STW project which concentrates on a numerical modelling of the problem considered.

# 2 EQUIPMENT AND SOFTWARE

The numerical investigations have been performed using the following general purpose computer programs:

Preprocessor : - Pretube (SESAM package)
- Ideas Supertap

Solver : - Ideas Model Solution
- Diana (TNO Building and Construction Research)

Postprocessor : - Ideas Supertap

The investigations have been carried out on a Sun Sparc station.
During the reporting period no investments have been done and no new software has been installed.

# 3 RESULTS OBTAINED IN THIS PERIOD

## 3.1 Introduction

The main activities in this period were:
- Parameter research for the various influencing parameters.
- Writing two papers for the Fifth International Symposium on Tubular Structures held in Nottingham, UK. One for RHS and one for CHS joints.
- Presentation of one paper for RHS and one paper for CHS at the ISOPE93 In singapore.
- Writing of thesis chapters.

## 3.2 Parameter research for the various influencing parameters factors

In this period, a numerical investigation by means of a parametric study have been carried out.
For the analyses, solid elements are used only, and the weld shape is included in the FE models. The results will be given in a databank, from which for a certain load combination, the maximum hot spot stress/strain

can be found. Several uniplanar as well as multiplanar joints have been considered. See table 1. SCFs and SNCFs are determined for 20 positions in case of RHS and 16 positions in case of CHS joints.

Table 1: Number and types of joints analysed during parameter study.

| Parameter Study : (Number of Analysed joints) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Joint Type | Y | K | YY | KY | KK | T | X | XX |
| RHS | 47 | 47 | 47 | 47 | 47 | - | - | - |
| CHS | ≈ 800 | | | | | | | |

As an example, figures 1 and 2 show FE results in case of a RHS multiplanar KK-joint and figure 3 and 4 shows FE results in case of a CHS uniplanar X-joint.

## 3.3 Writing thesis report

Some chapters of both PhD thesises have been prepared and are being reviewed. Both thesises are expected to be ready before the end of 1993. Appendix 1 shows the proposed layout of the final thesis.
Theses thesises shall contain recommendation on fatigue behaviour of uniplanar as well as multiplanar joints.

# 4 BUDGET INFORMATION

Expenditure for this period:

1. Investments
   --
2. Operating costs
   --
3. Travelling costs.
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| Statement of Expenditure as at 31 June 1993 | | | | | |
|---|---|---|---|---|---|
| Items of Expenditure | Original Budget | Saldo as on 01/01/93 | Expences from 01/01/93 to 31/06/93 | Saldo as on 01/06/93 | Estimated Expences from 01/07/93 to 31/12/93 |
| Investments | 107500.00 | 0.000 | 0.00 | 0.00 | 0.00 |
| Operation costs | 103000.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Traveling costs | 35000.00 | 23500.00 | 0.00 | 23500.00 | 20000.00 |
| Total | 245500.00 | 23500.00 | 0.00 | 23500.00 | 20000.00 |

## 5 PLANNING SCHEDULE

**July - December 1993:**

- Presentation of one RHS and one CHS paper at 5th International Symposium on Tubular Structures in Nottingham, UK
- Finishing final report.

Figure 1 FE model multiplanar KK-joint (RHS)

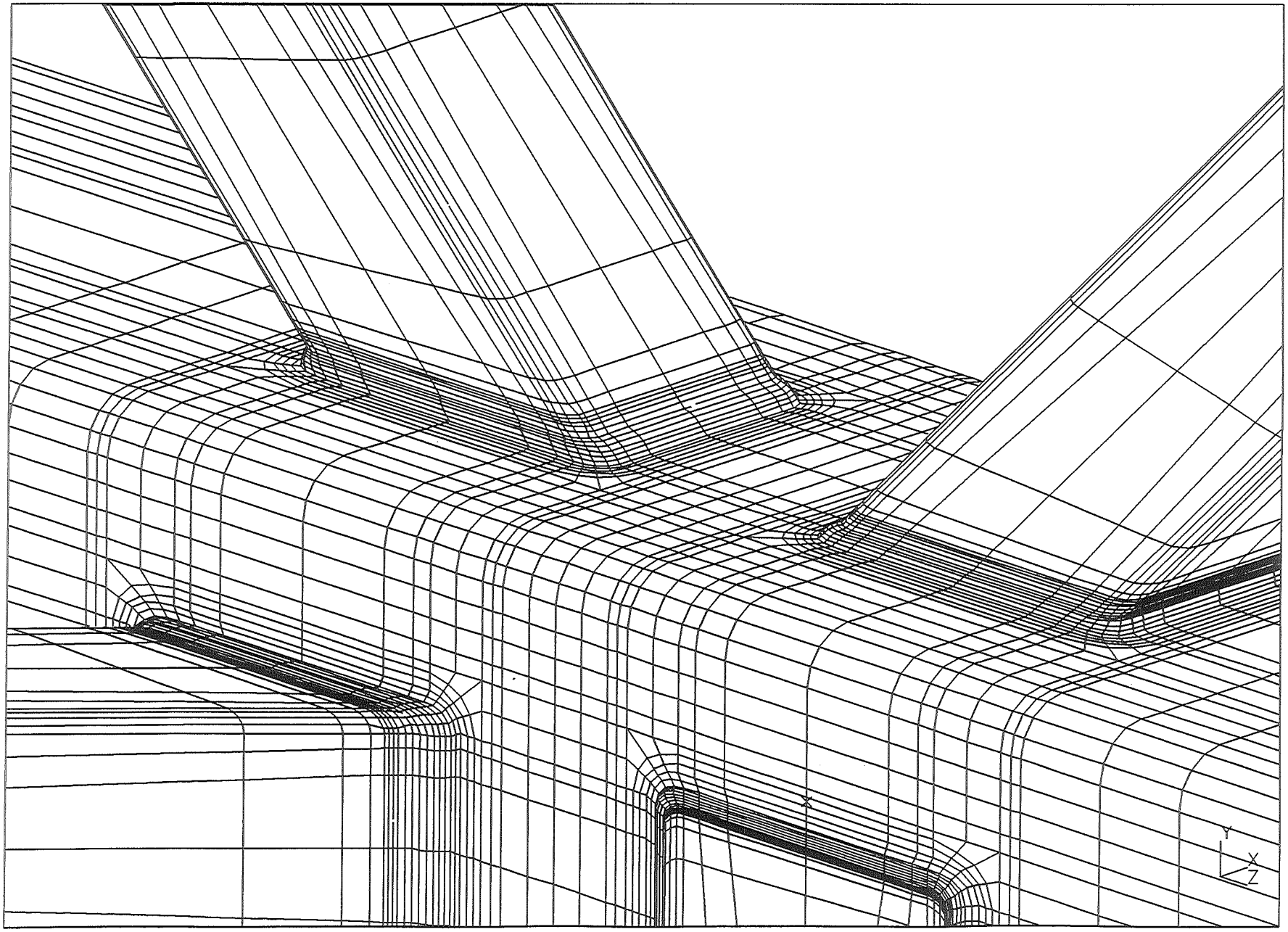


Figure 2 Analysis results multiplanar KK-joint (RHS)

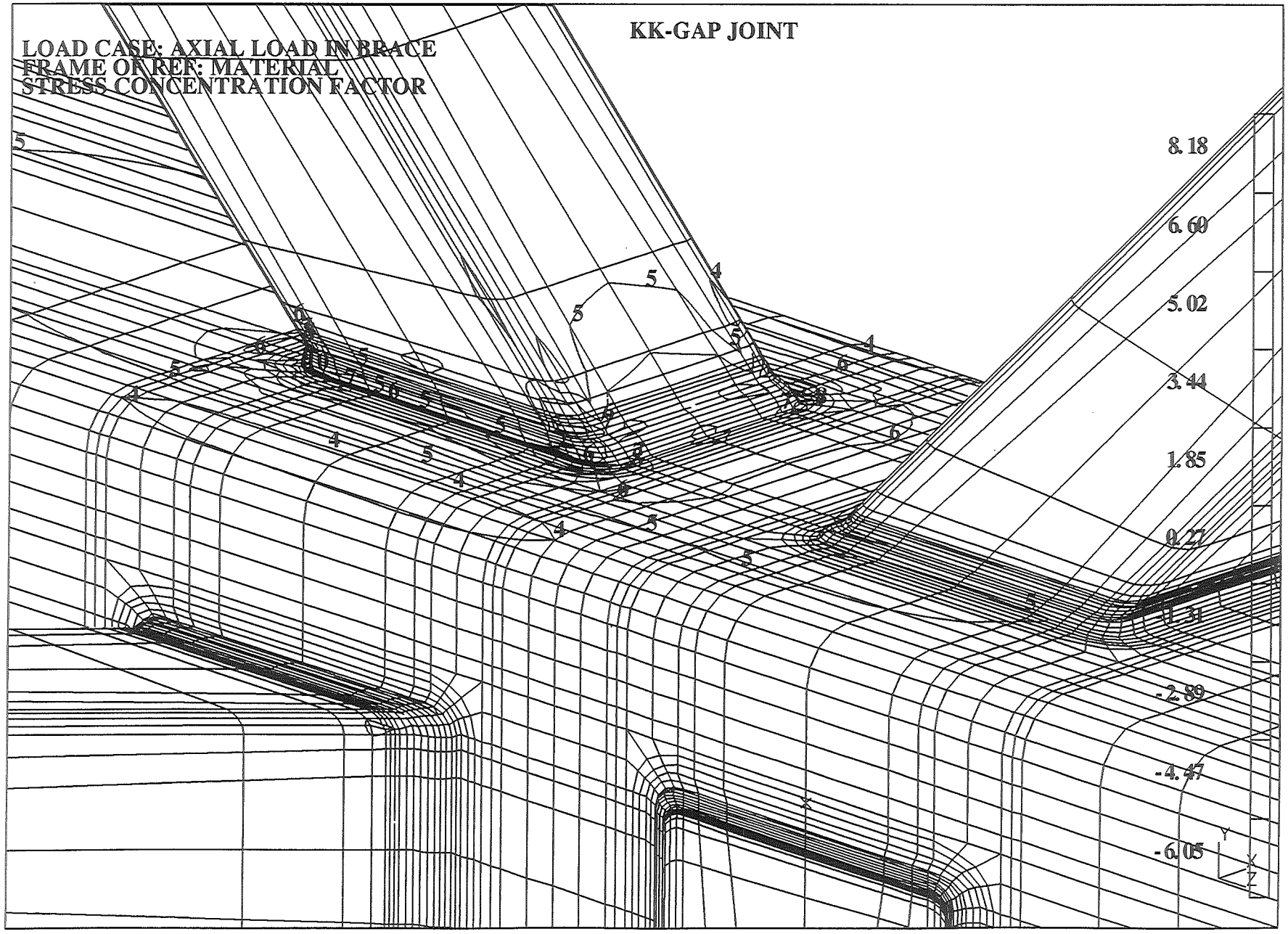


Figure 3 FE model uniplanar X-joint (CHS)

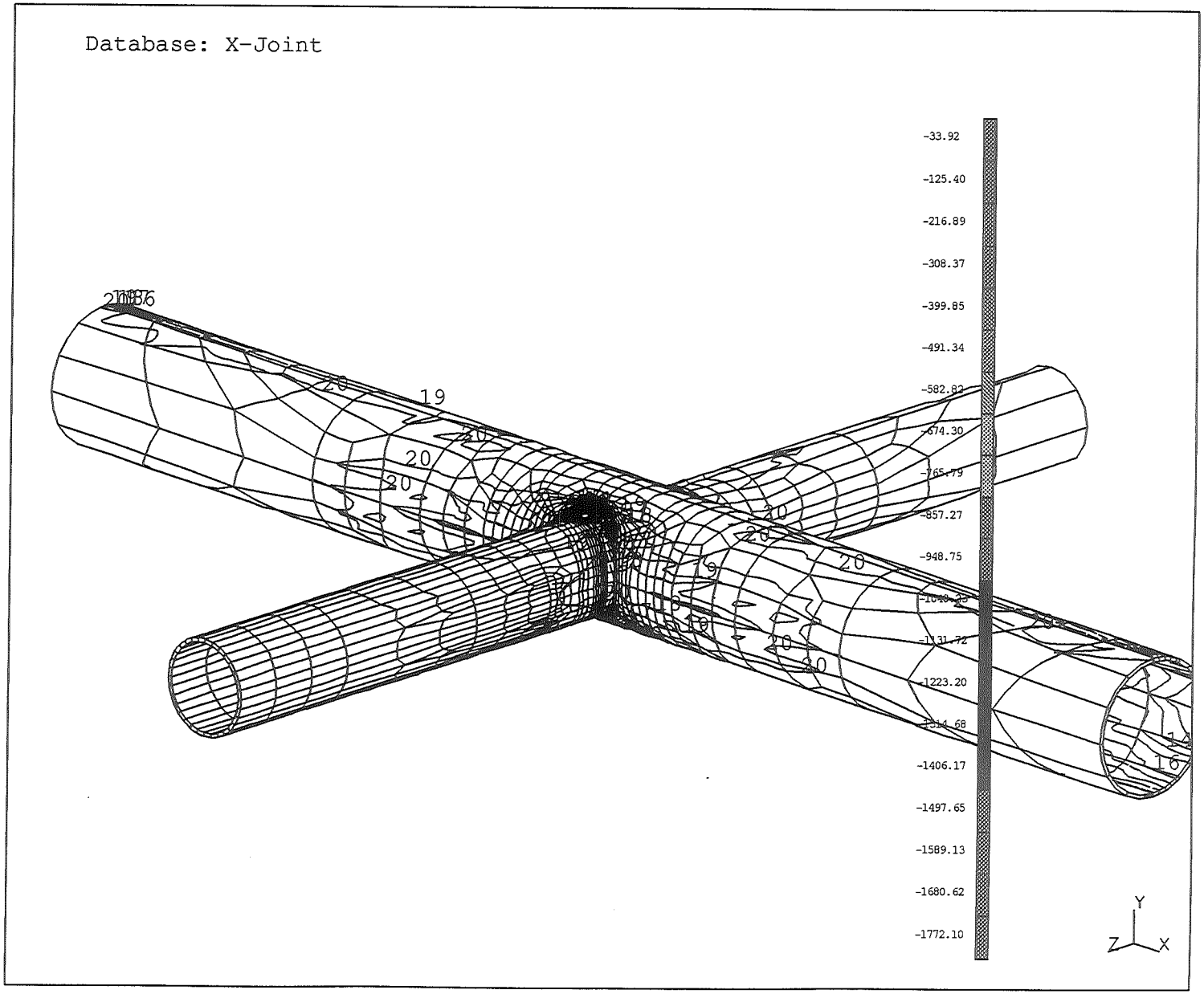
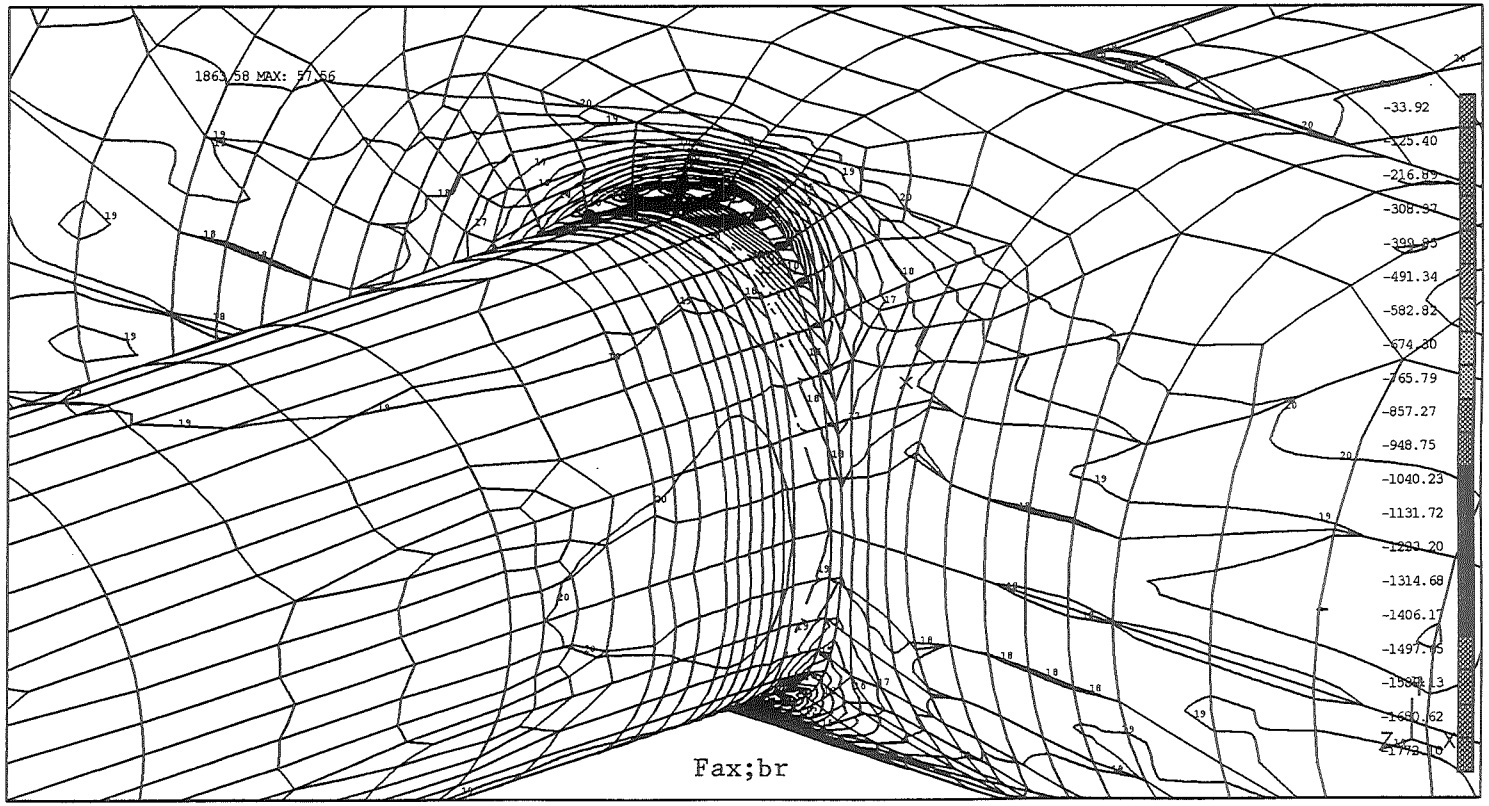


Figure 4 Analysis results uniplanar X-joint (CHS)




Stress pattern X-joint (max. principal stresses)

# Appendix 1: Contents for PhD Thesis

# THE FATGUE BEHAVIOUR OF MULTIPLANAR JOINTS MADE OF SQUARE HOLLOW SECTION