SIMULATION OF CONNECTIONS USING COMPONENT-BASED MODEL

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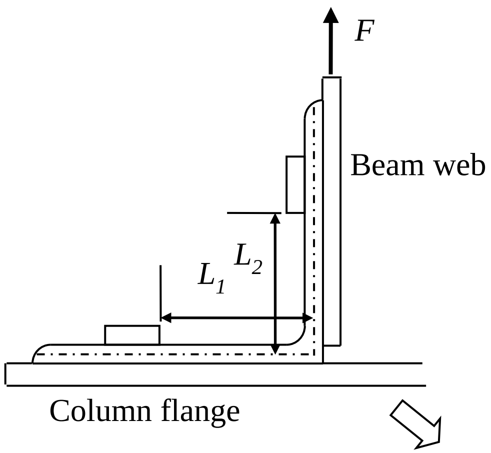
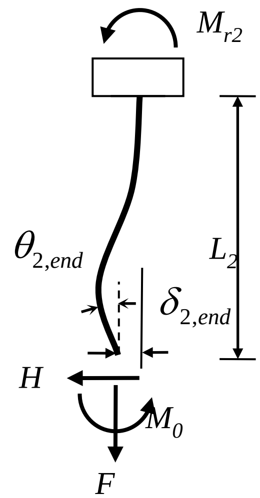
Tsinghua University

Beijing, China

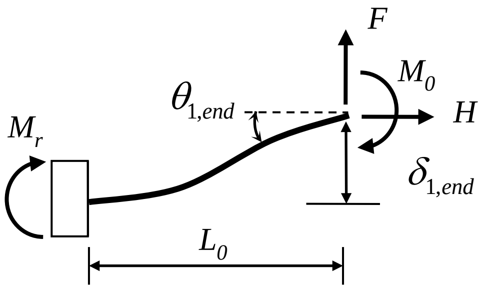
CONTENTS

DEVELOPMENT OF A MODEL FOR ANGLE

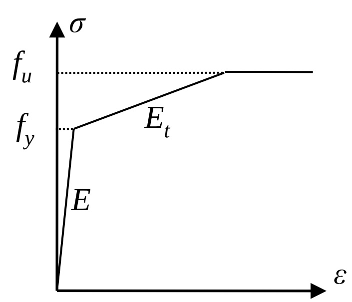




Beam 2

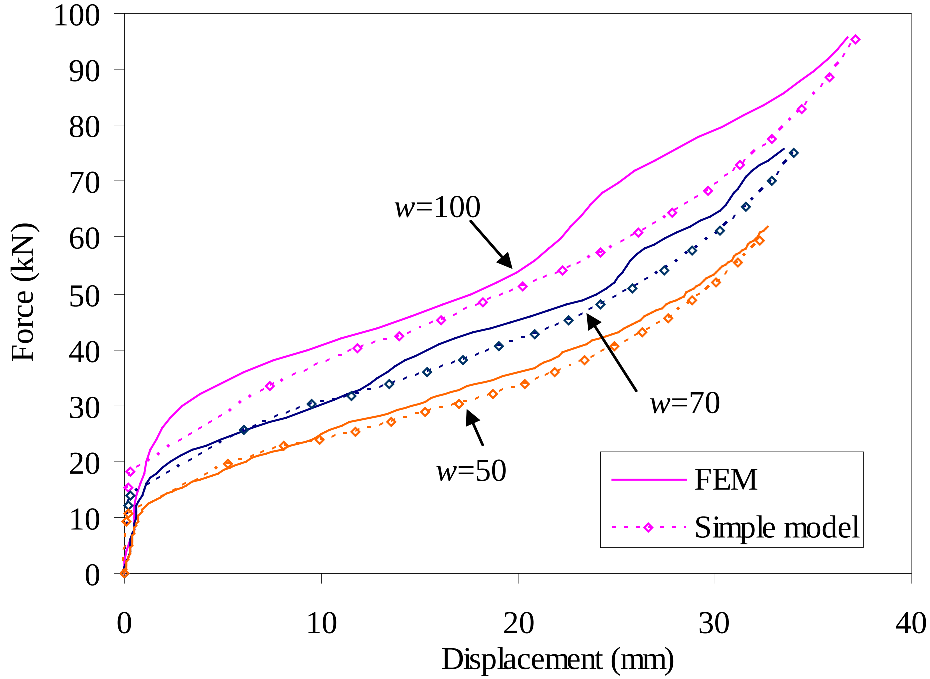


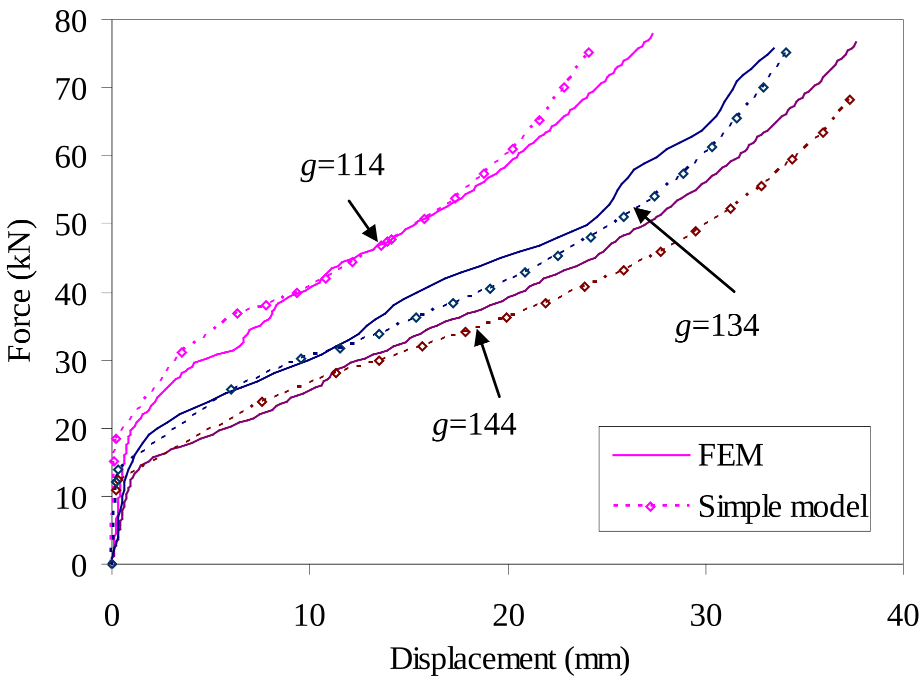
Beam 1



Material model

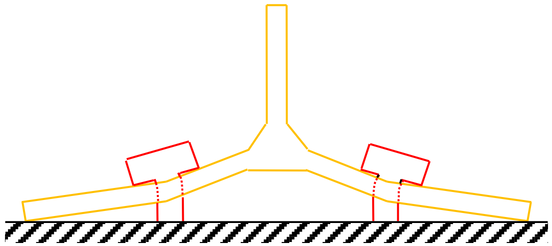
COMPARISON WITH FEM



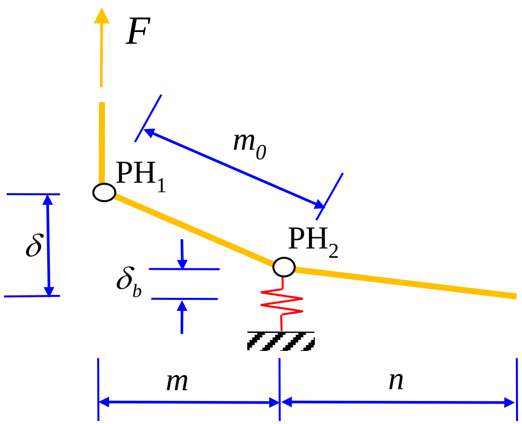


DEVELOPMENT OF A MODEL FOR ENDPLATE

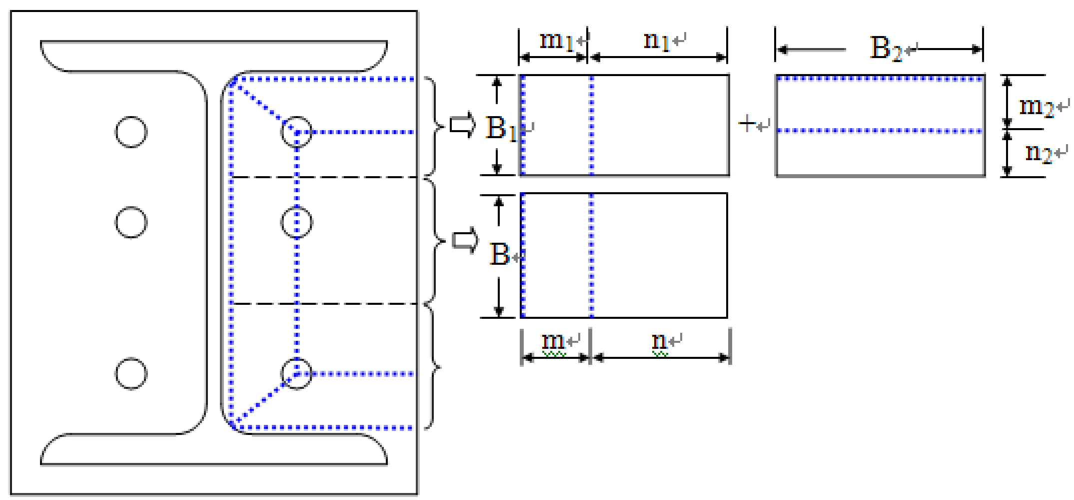
$$E_{PH1} + E_{PH2} + E_{spring} = P\delta$$

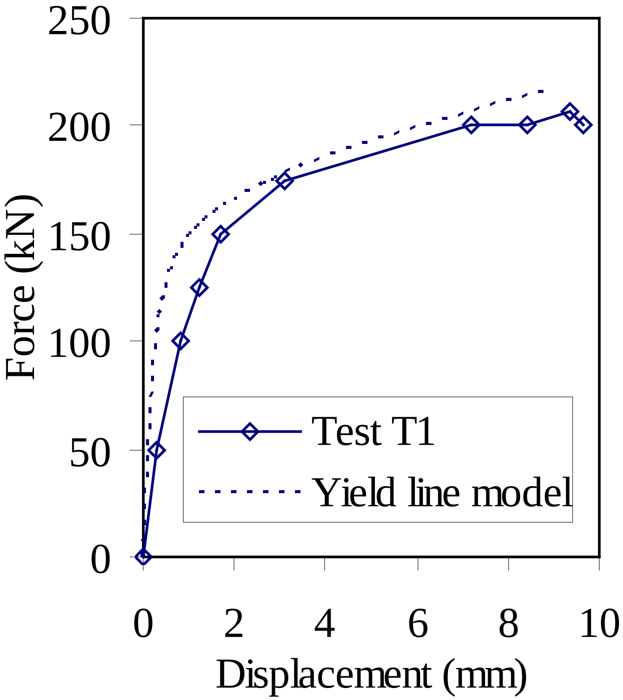


a. T-stub

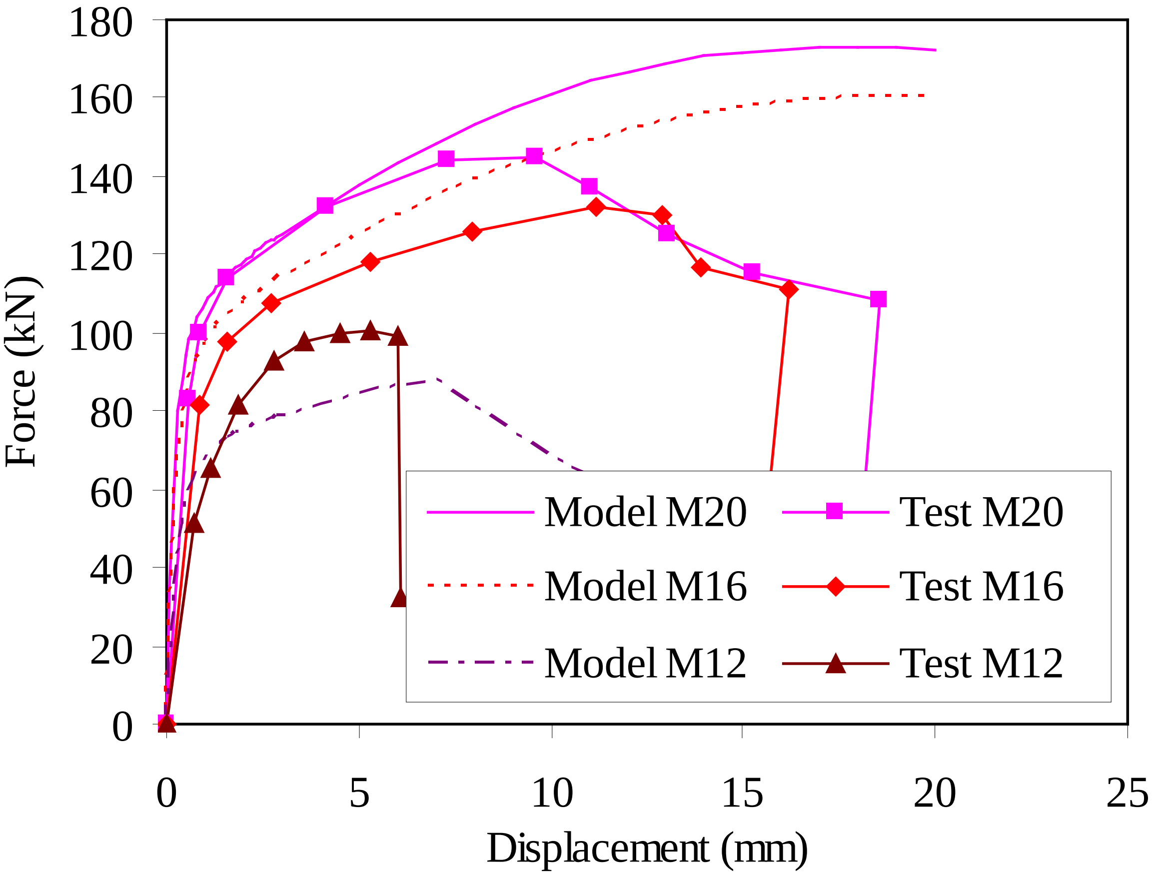


b. The yield-line model

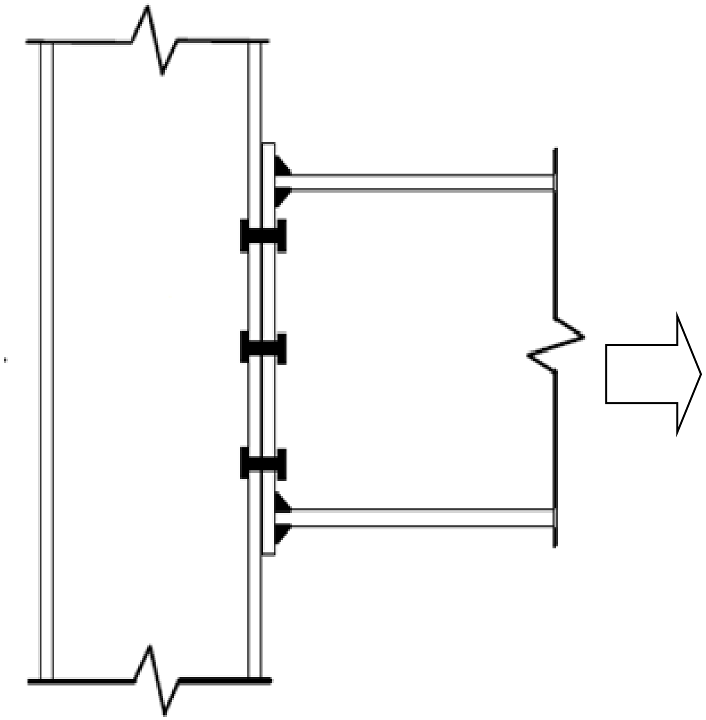




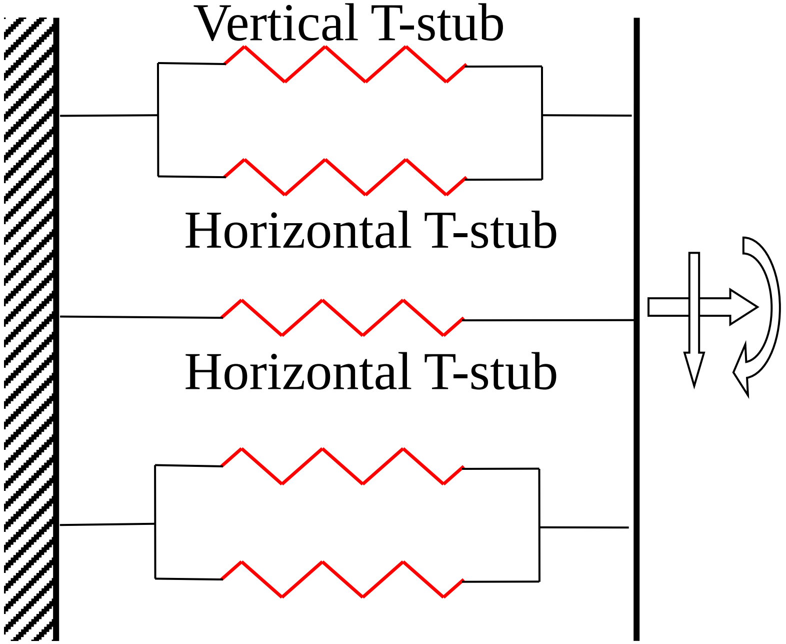
VALIDATION AGAINST TEST



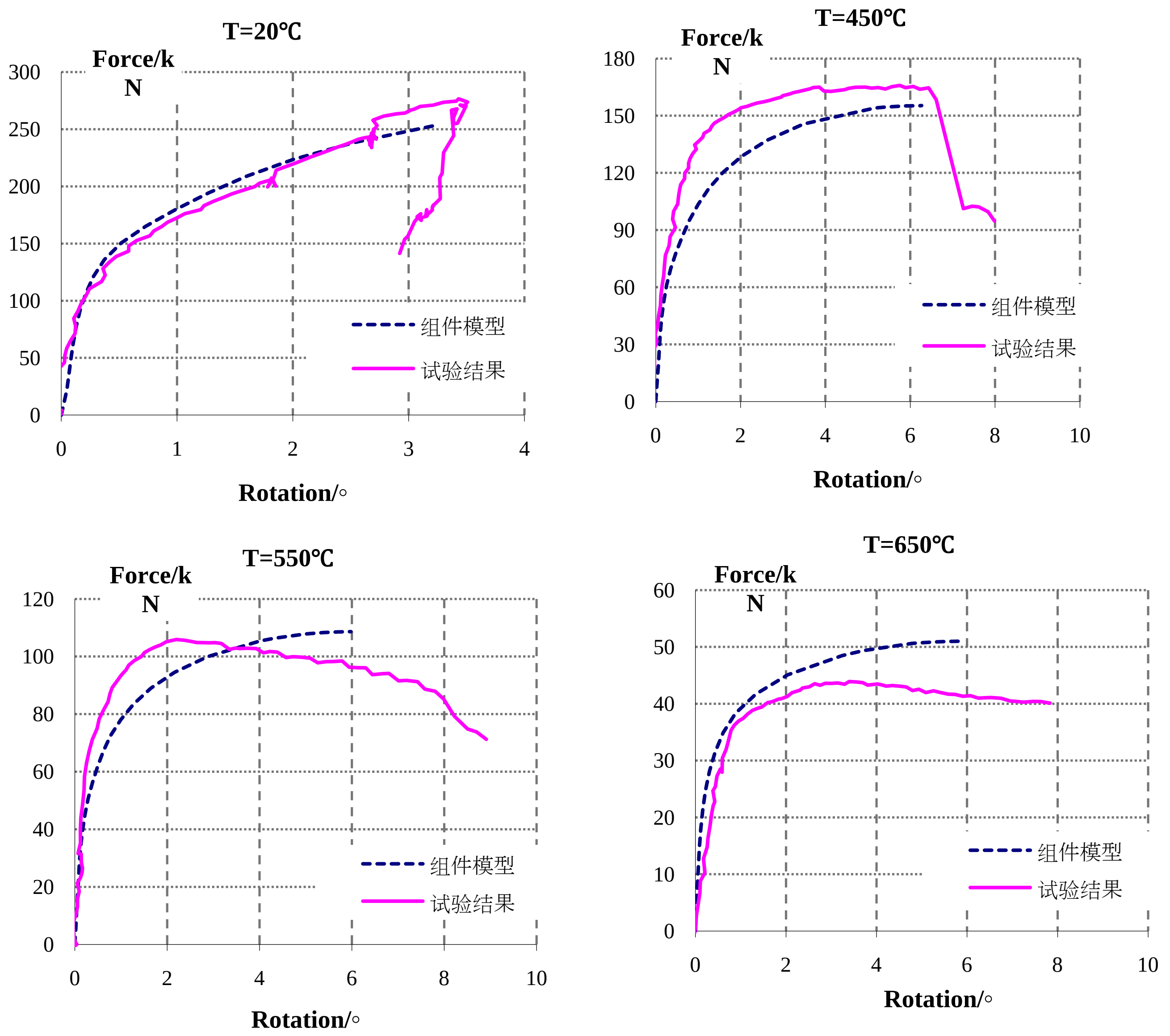
CONSTRUCTION OF THE MODEL



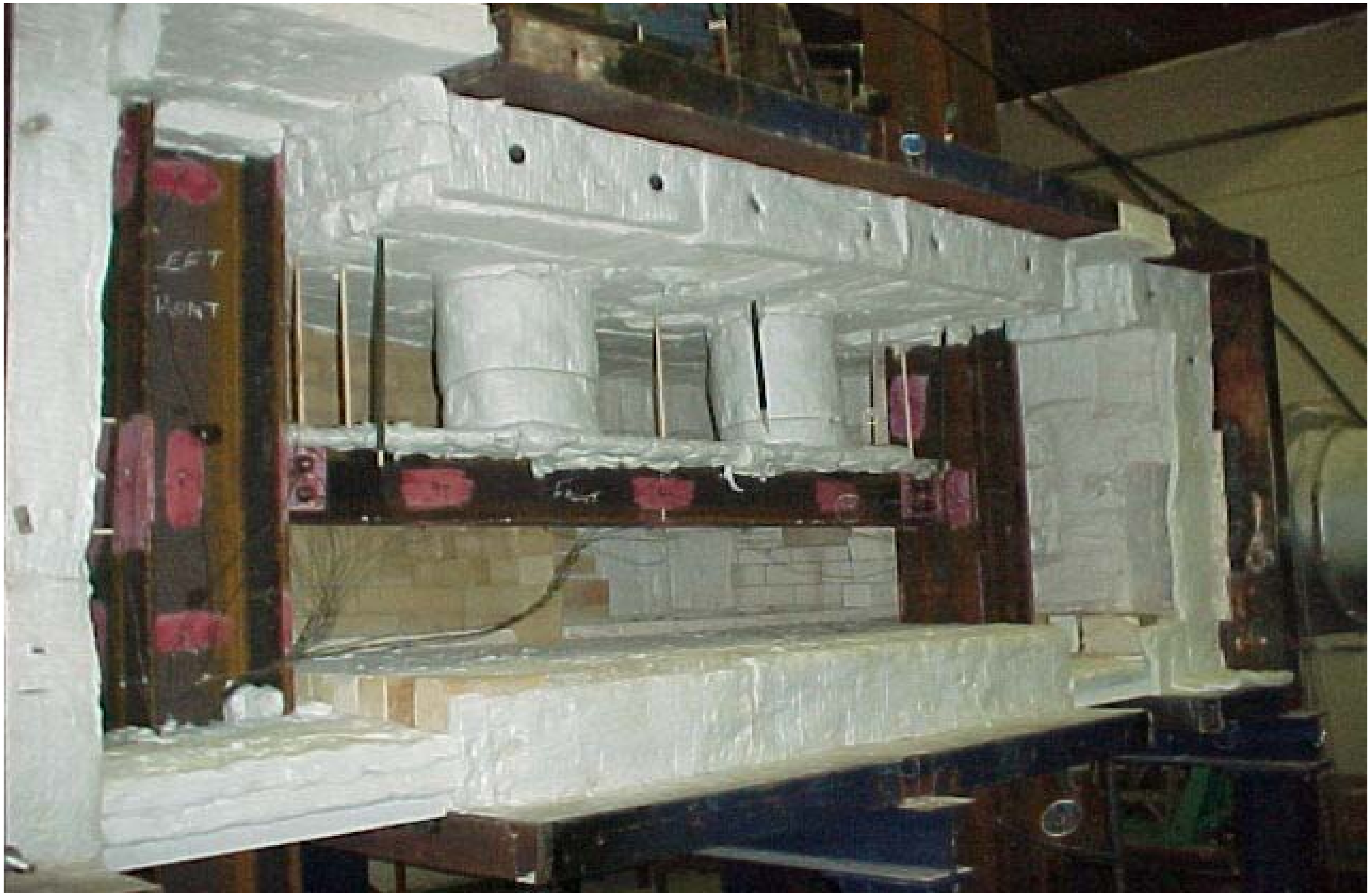
Flush Endplate Connection



COMPARISON WITH TEST

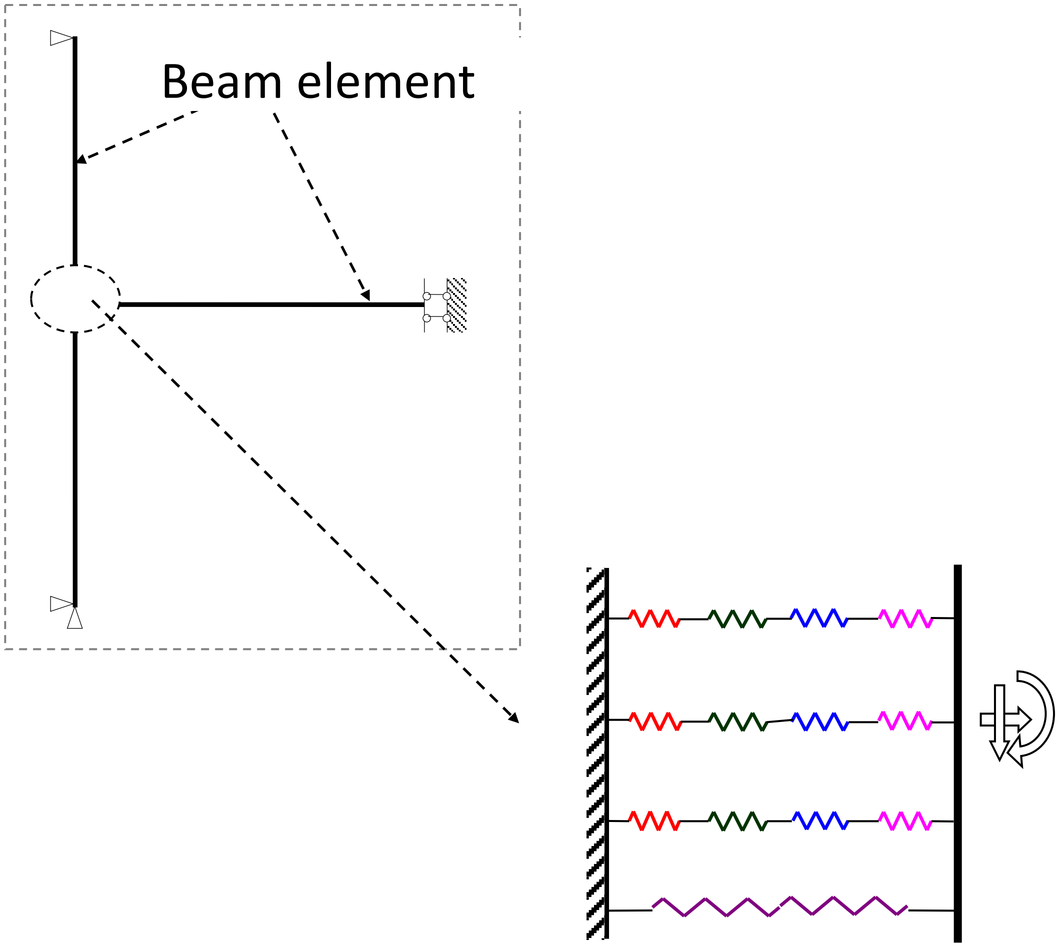


SUB-FRAME TEST BY JUN DING

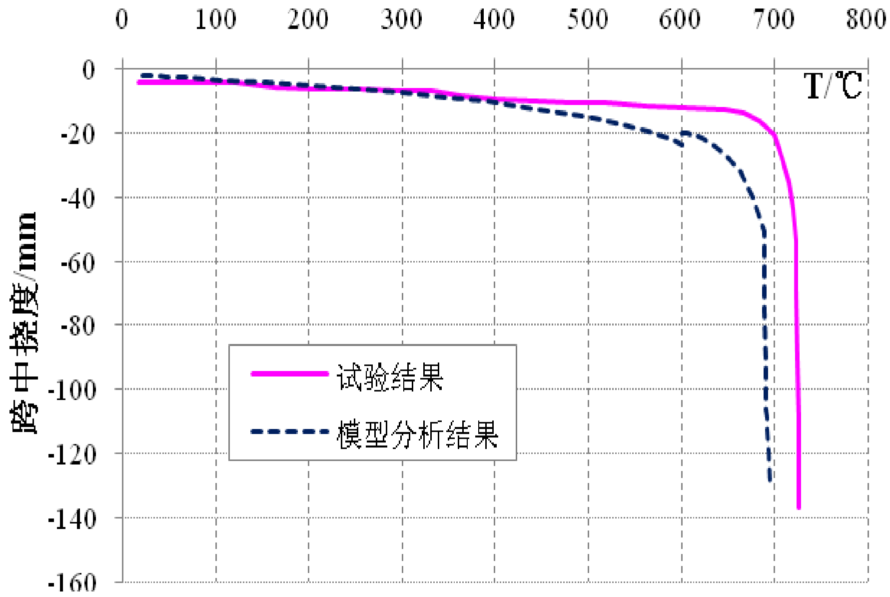


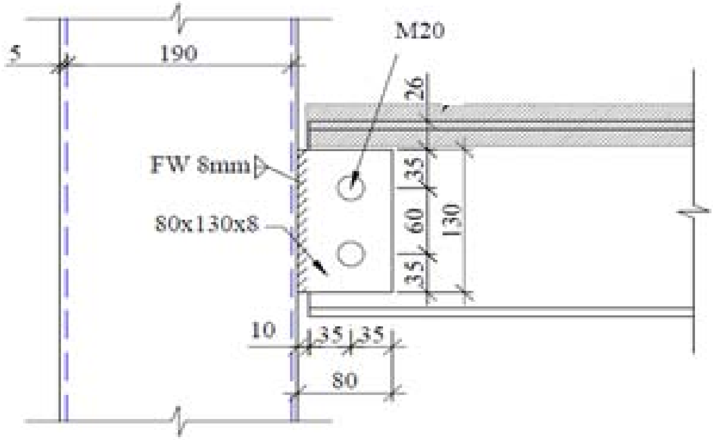
CONNECTION DETAILS

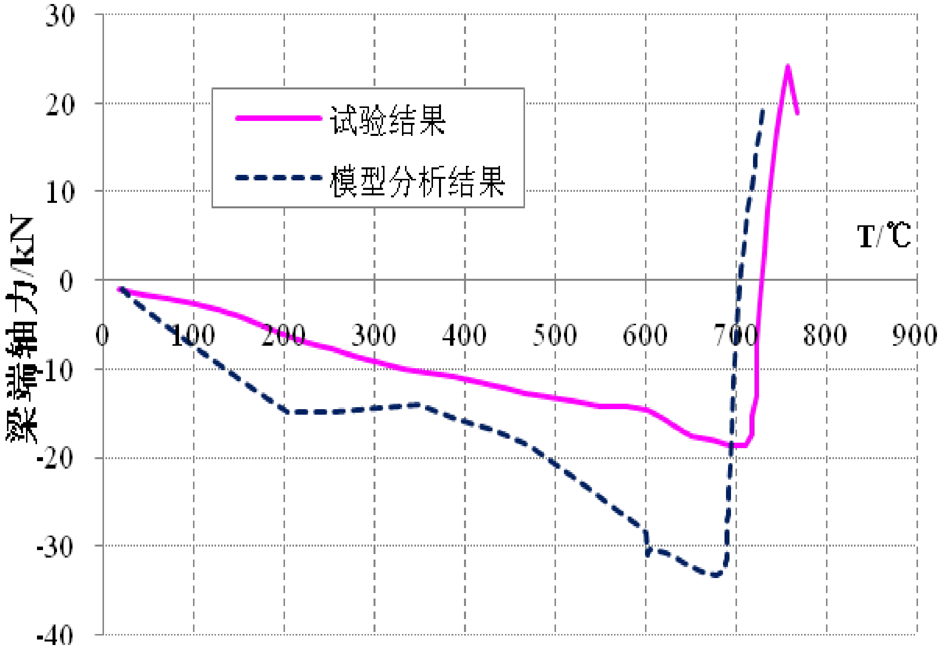
MODEL FOR THE FRAME



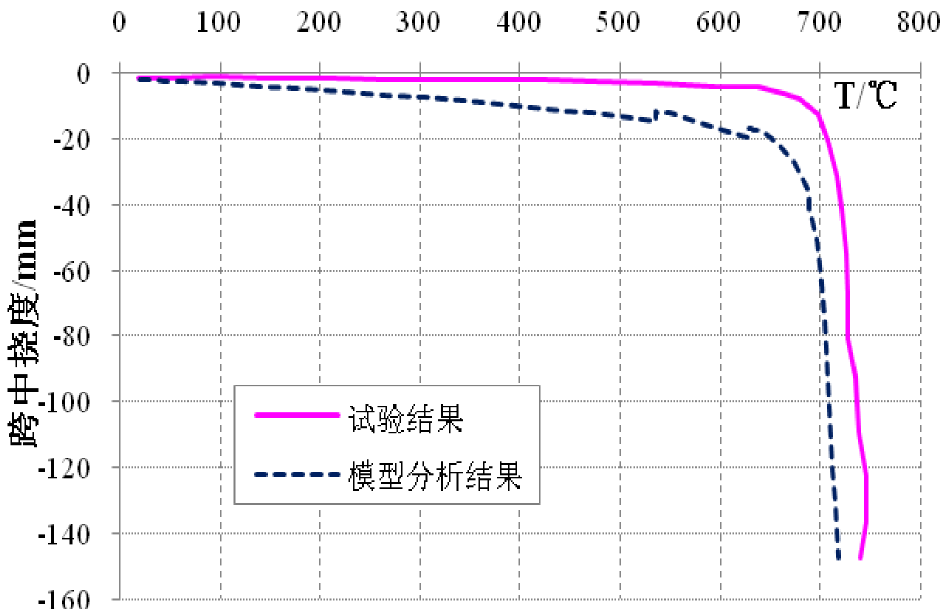
TEST 1, FIN PLATE CONNECTION

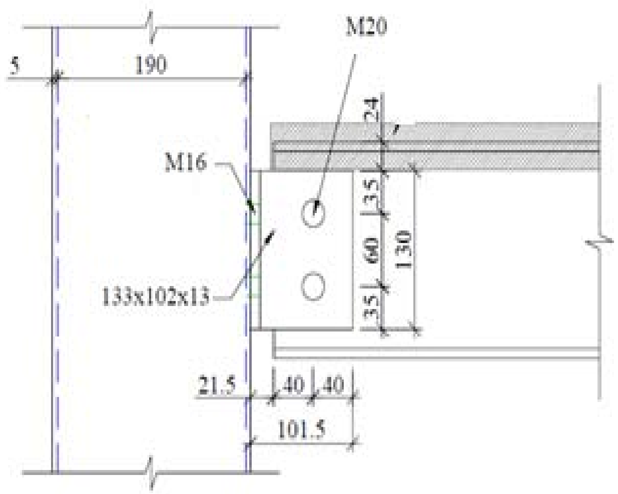


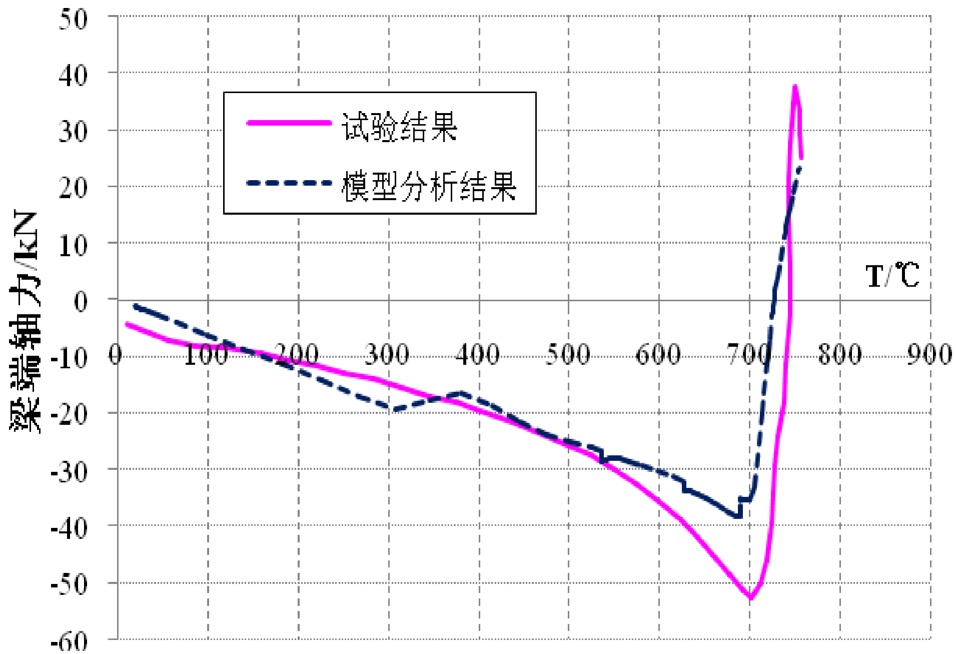




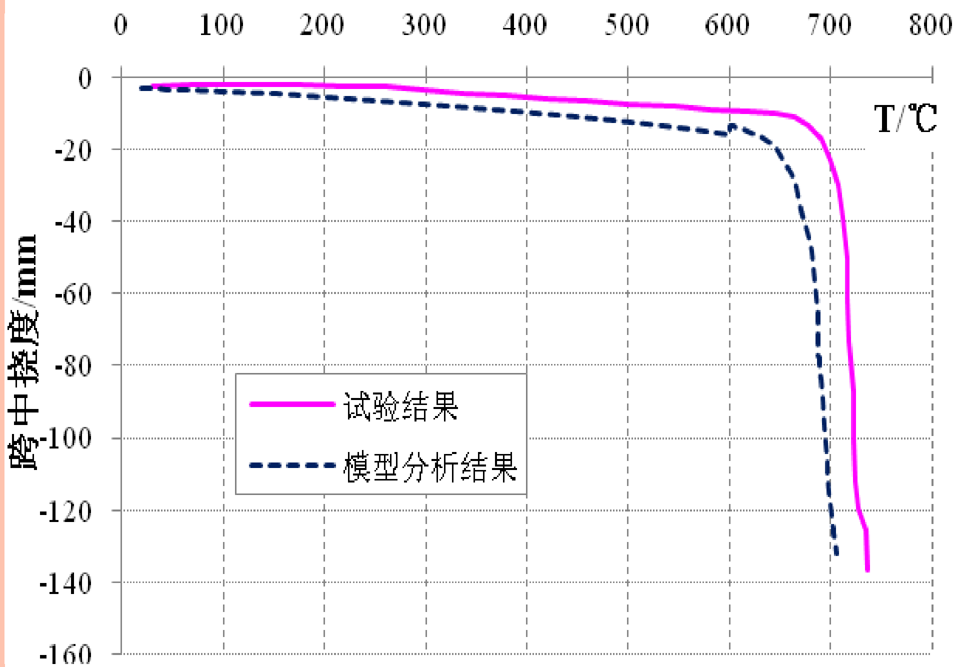
TEST 2, T-STUB CONNECTION

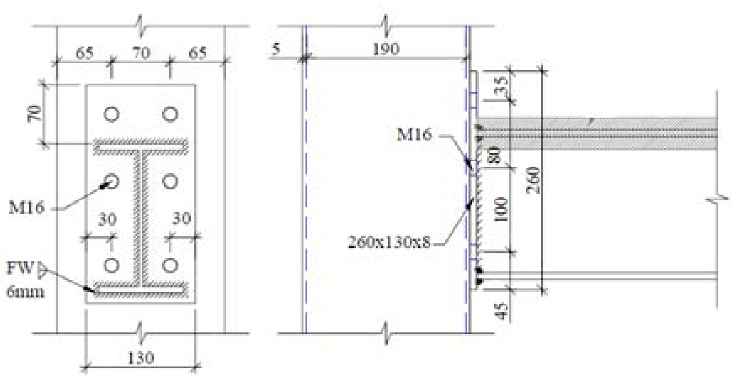


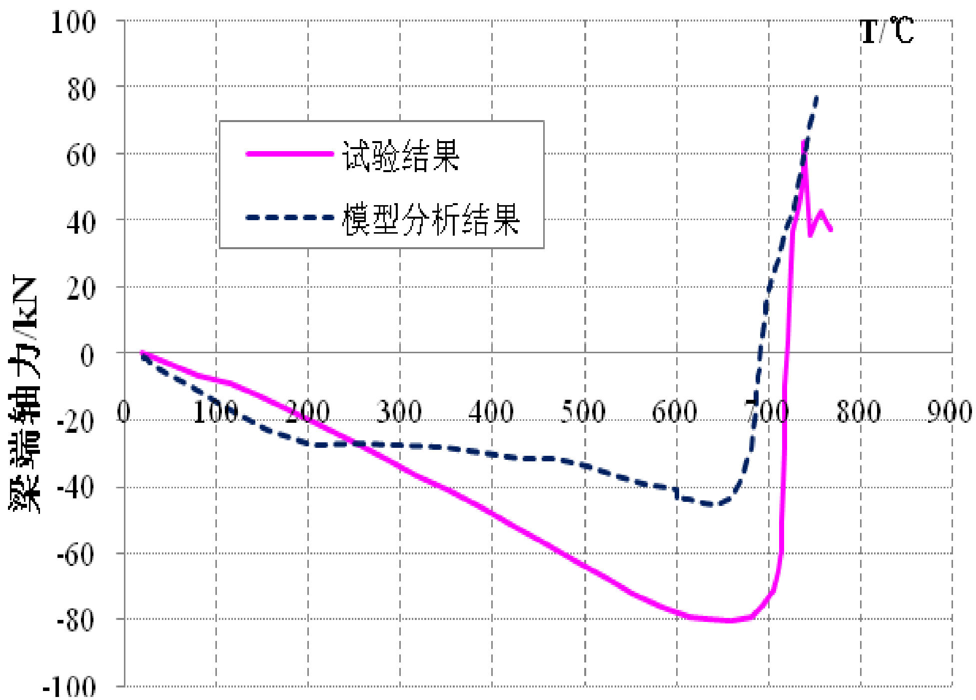




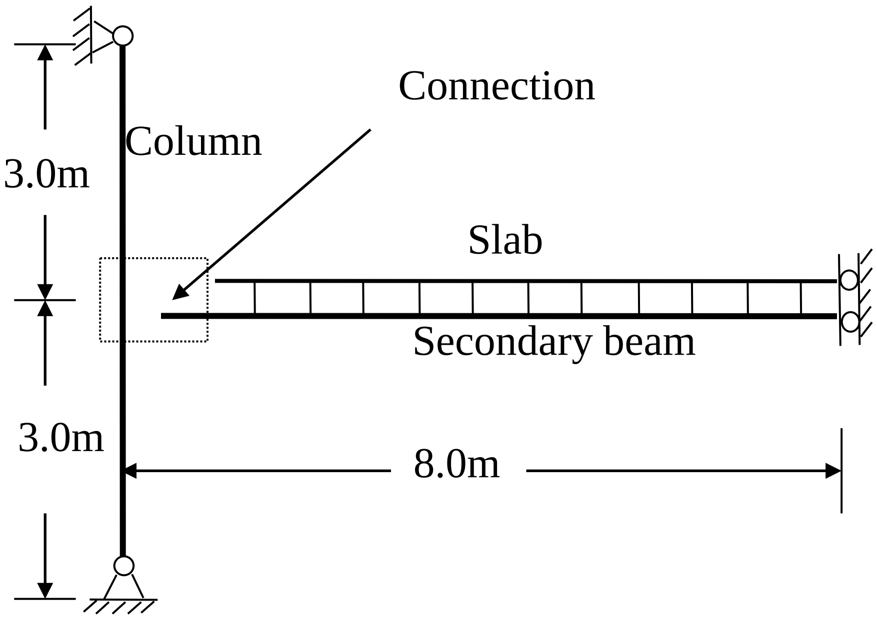
TEST 3, EXTENDED ENDPLATE CONNECTION



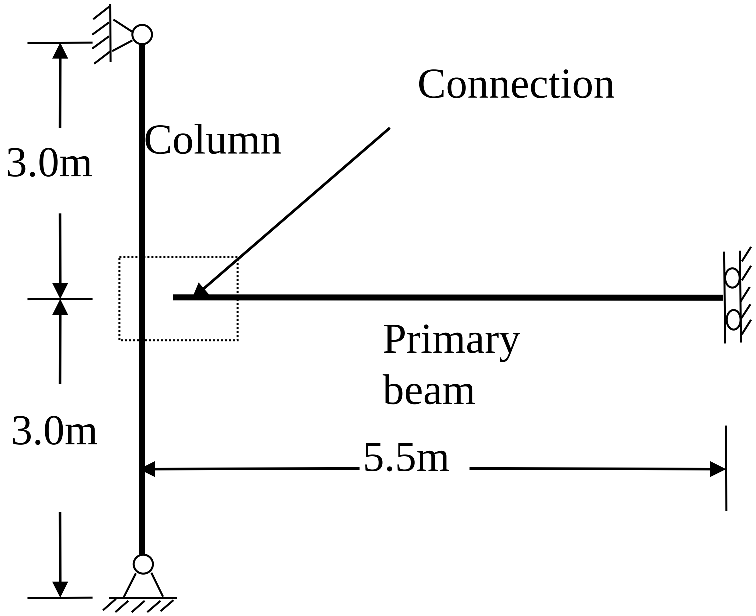




WTC7- SUBFRAME

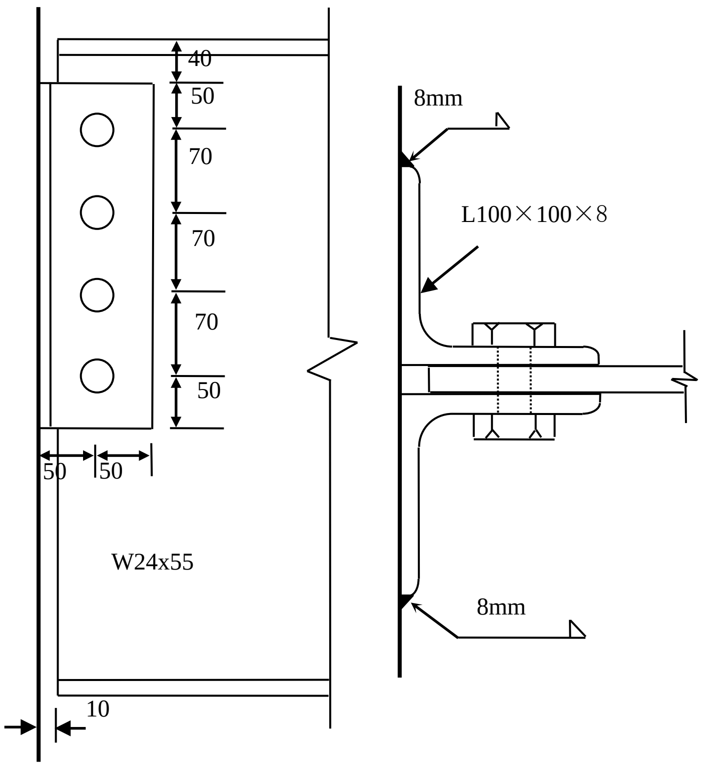


a. SB-C connection

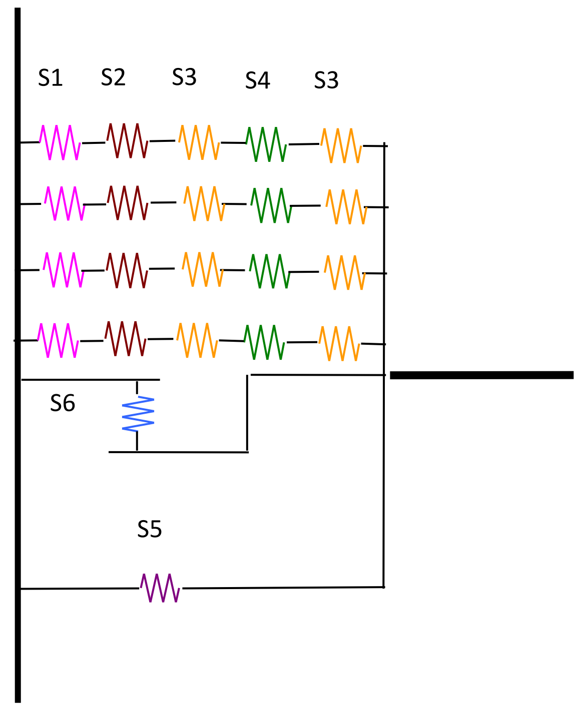


b. PB-C connection

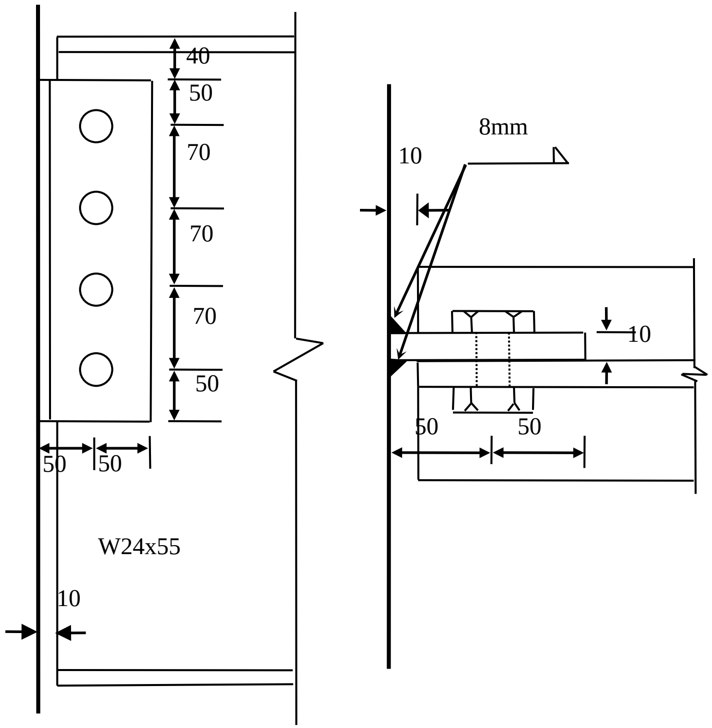
CONNECTION AND MODEL



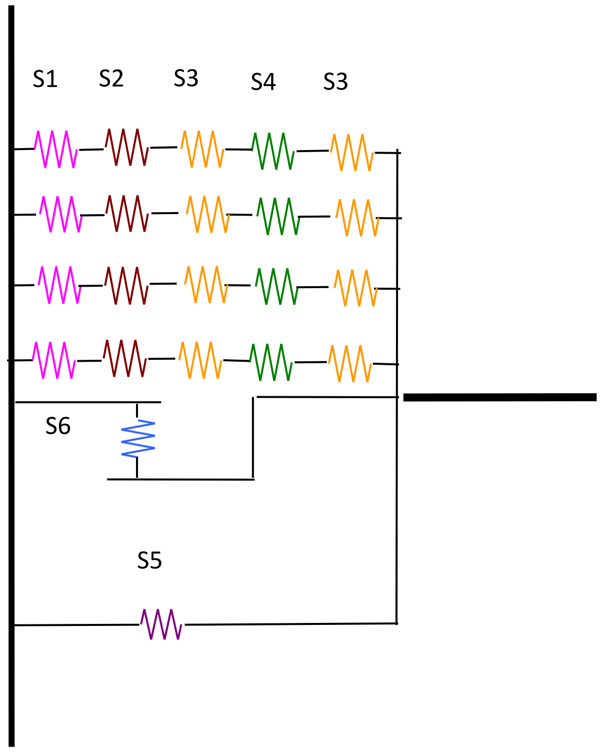
a. K4 Connection



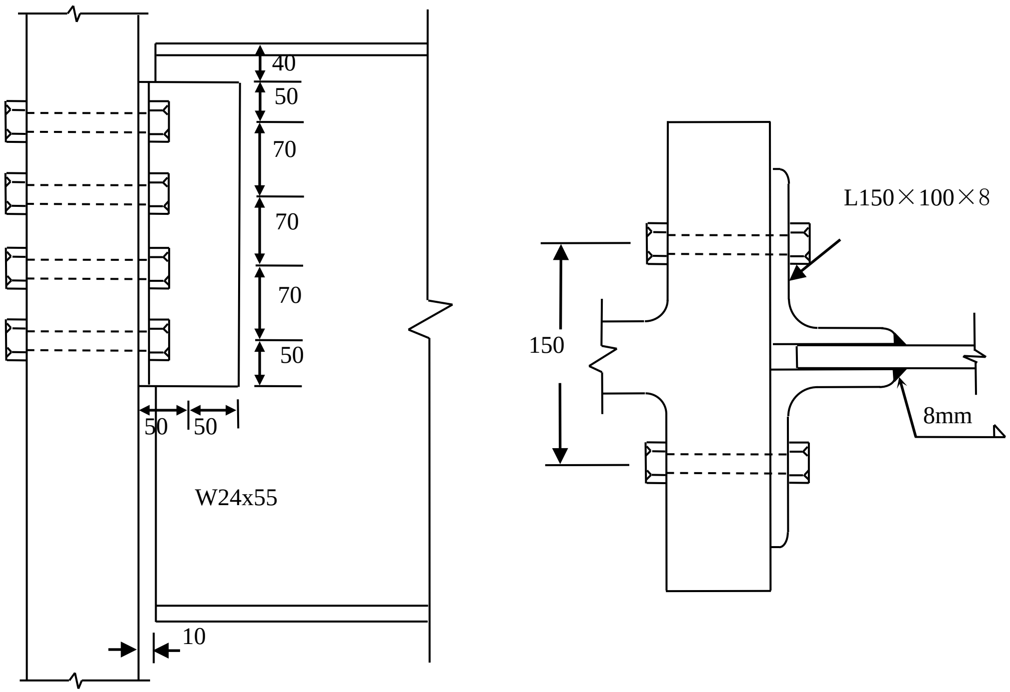
CONNECTION AND MODEL

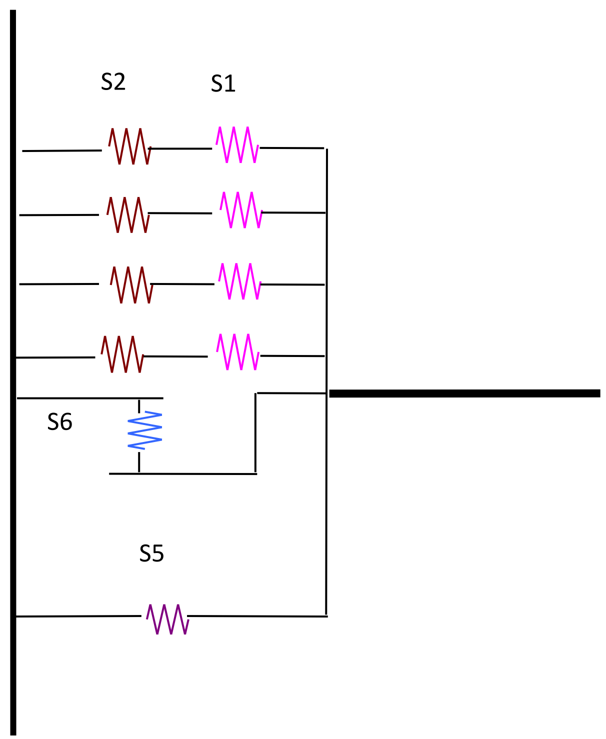


b. Fin Connection



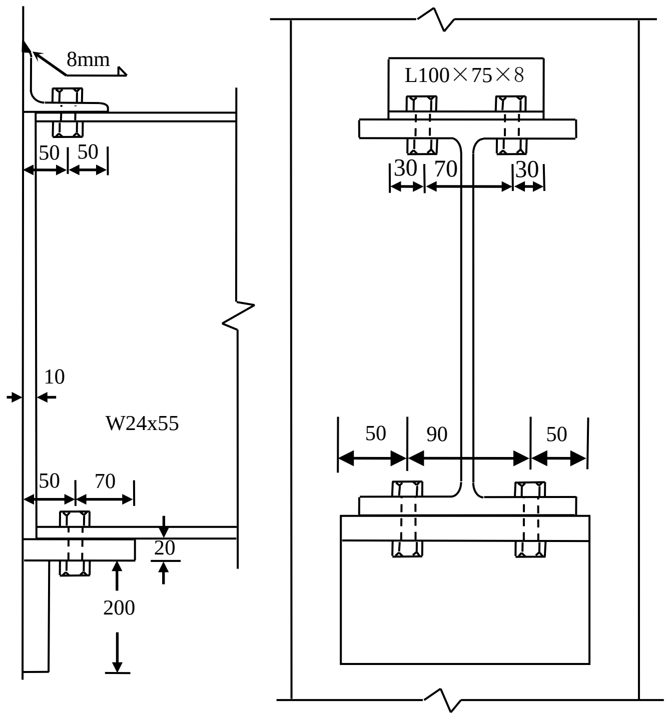
CONNECTION AND MODEL



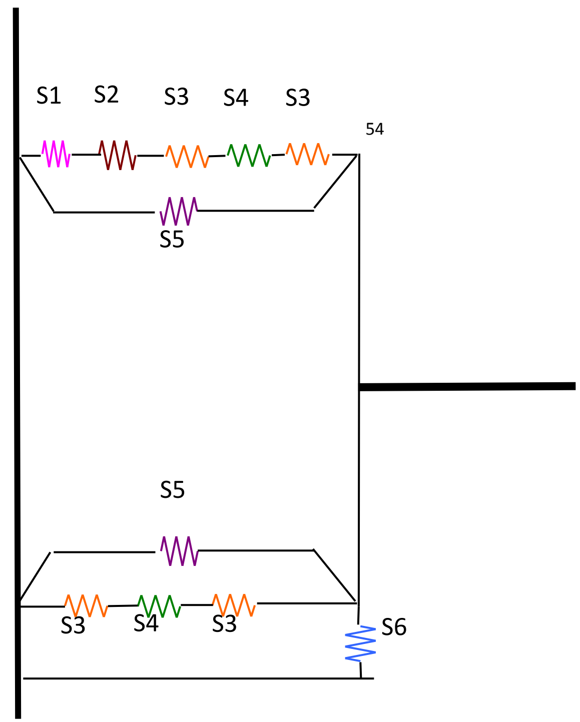


c. H4 Connection

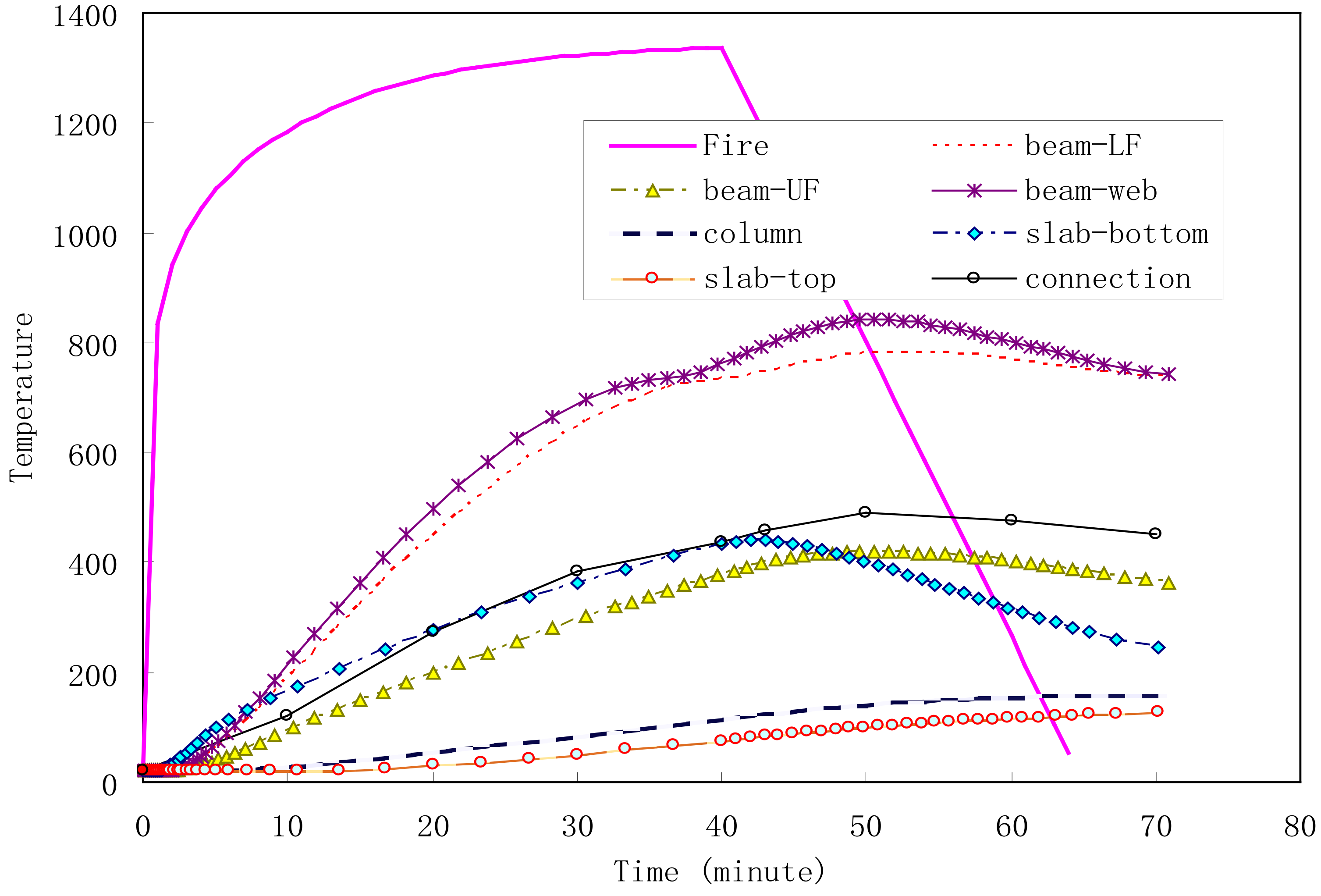
CONNECTION AND MODEL



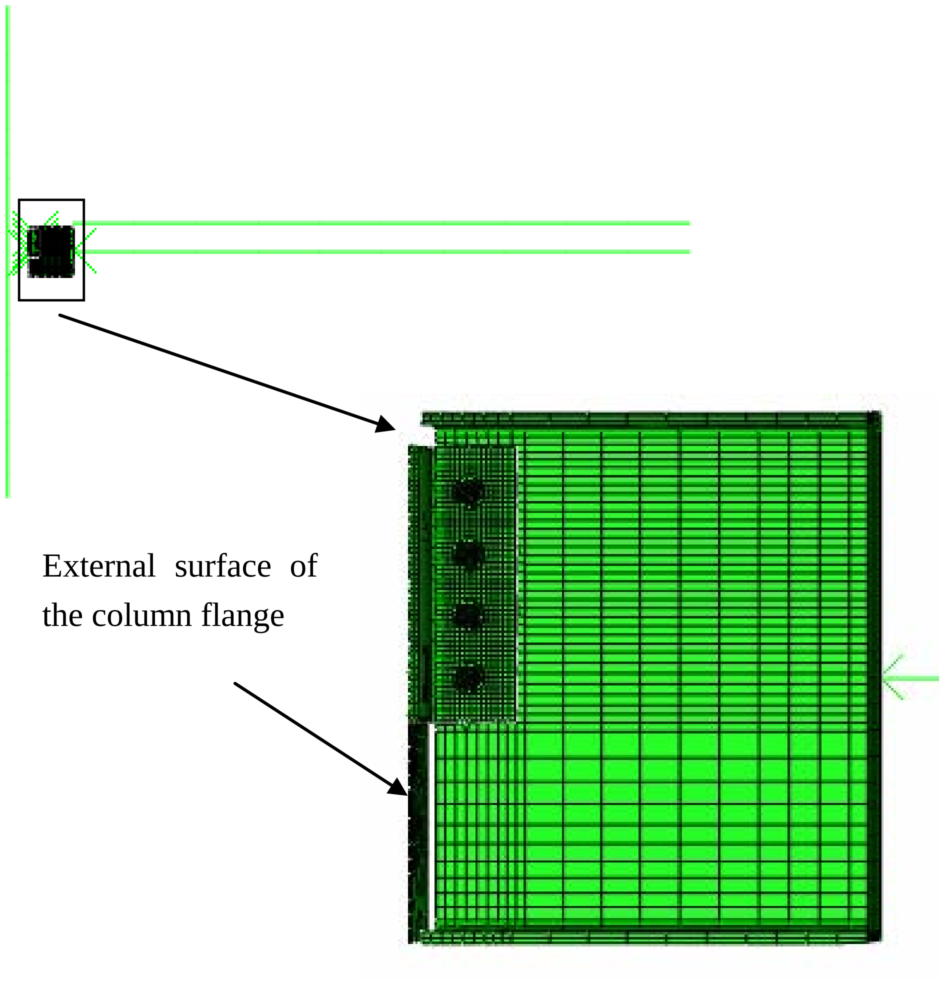
d. STC Connection



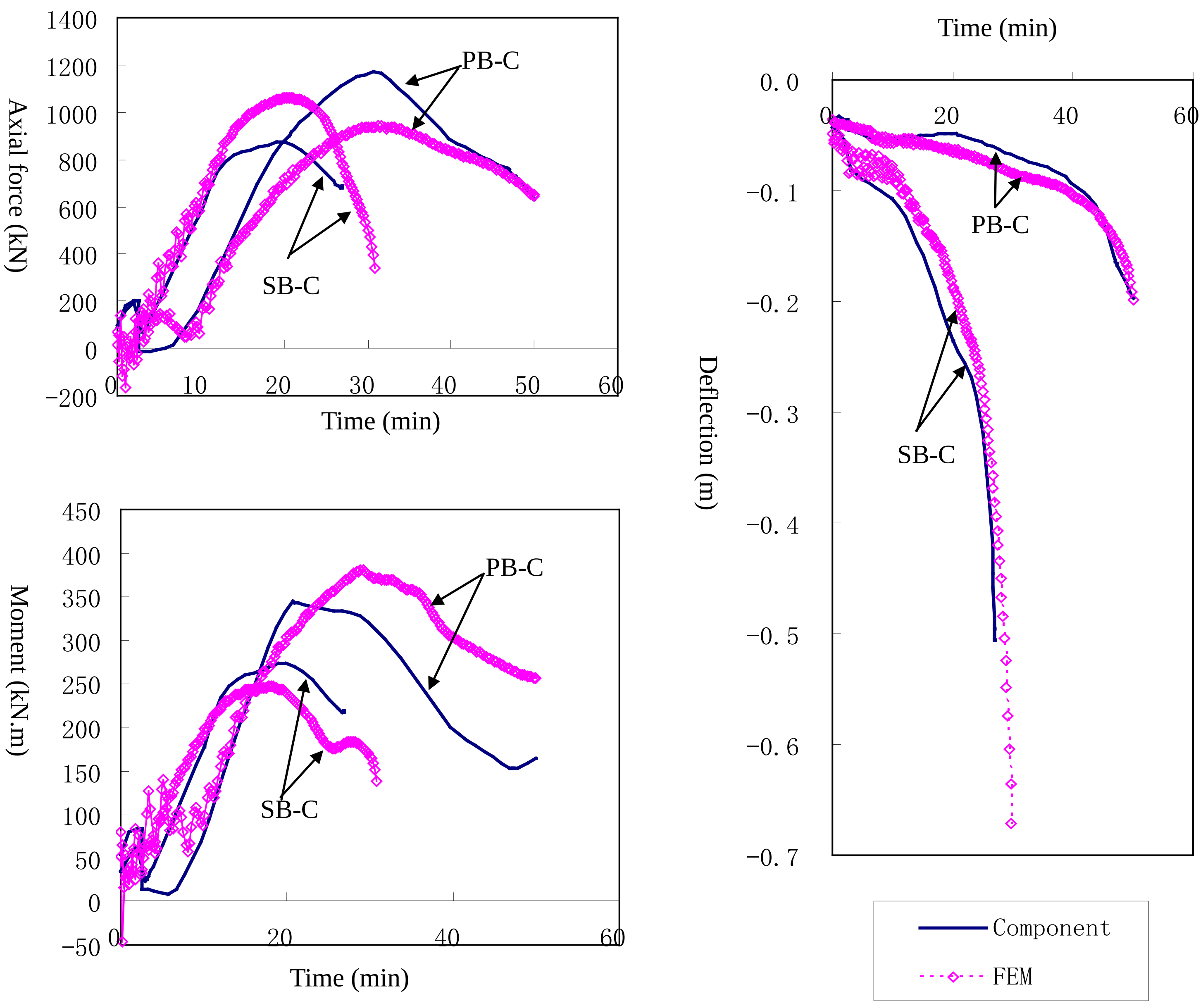
TEMPERATURE OF THE MEMBERS



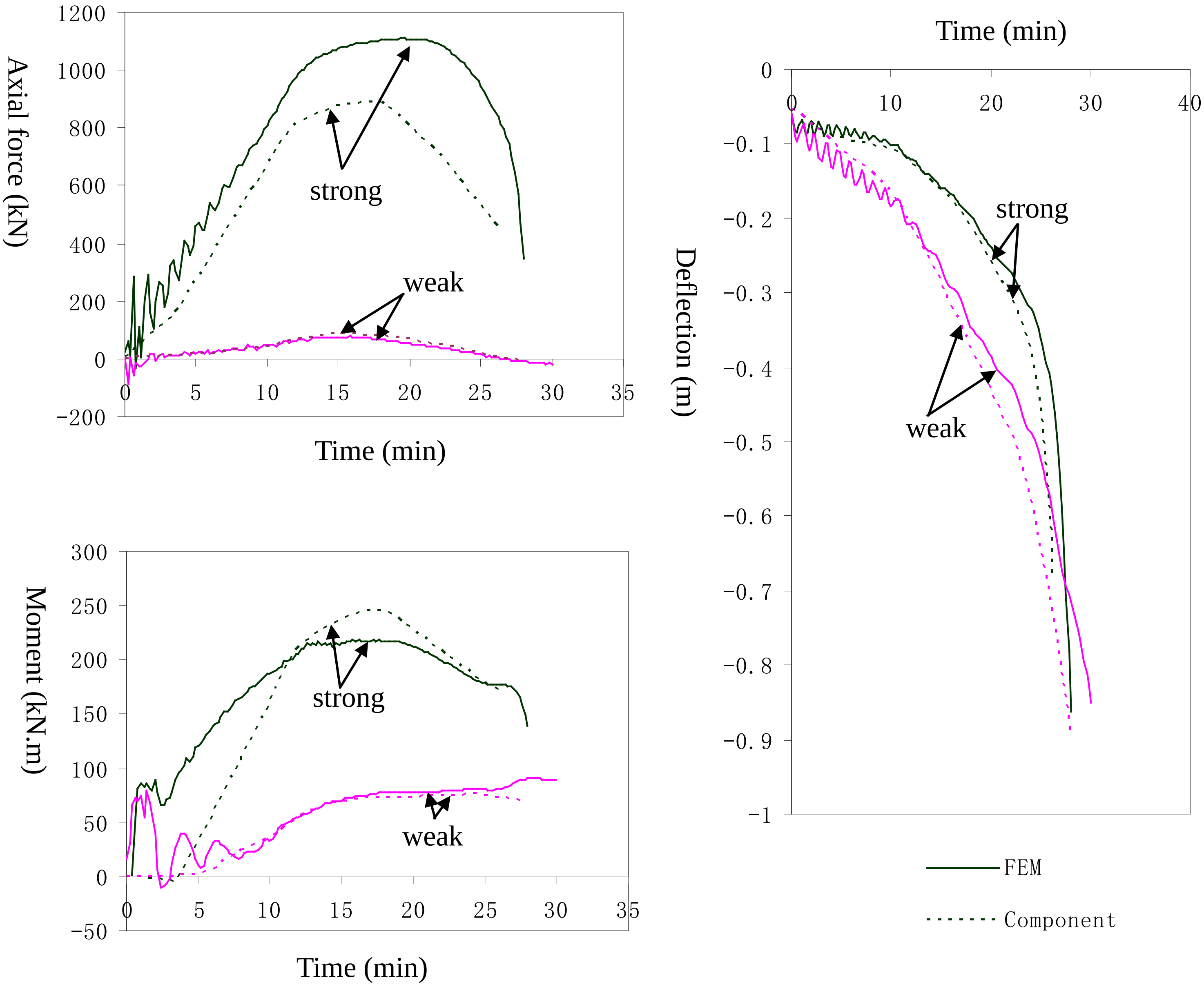
FINITE ELEMENT MODEL



STC Connection

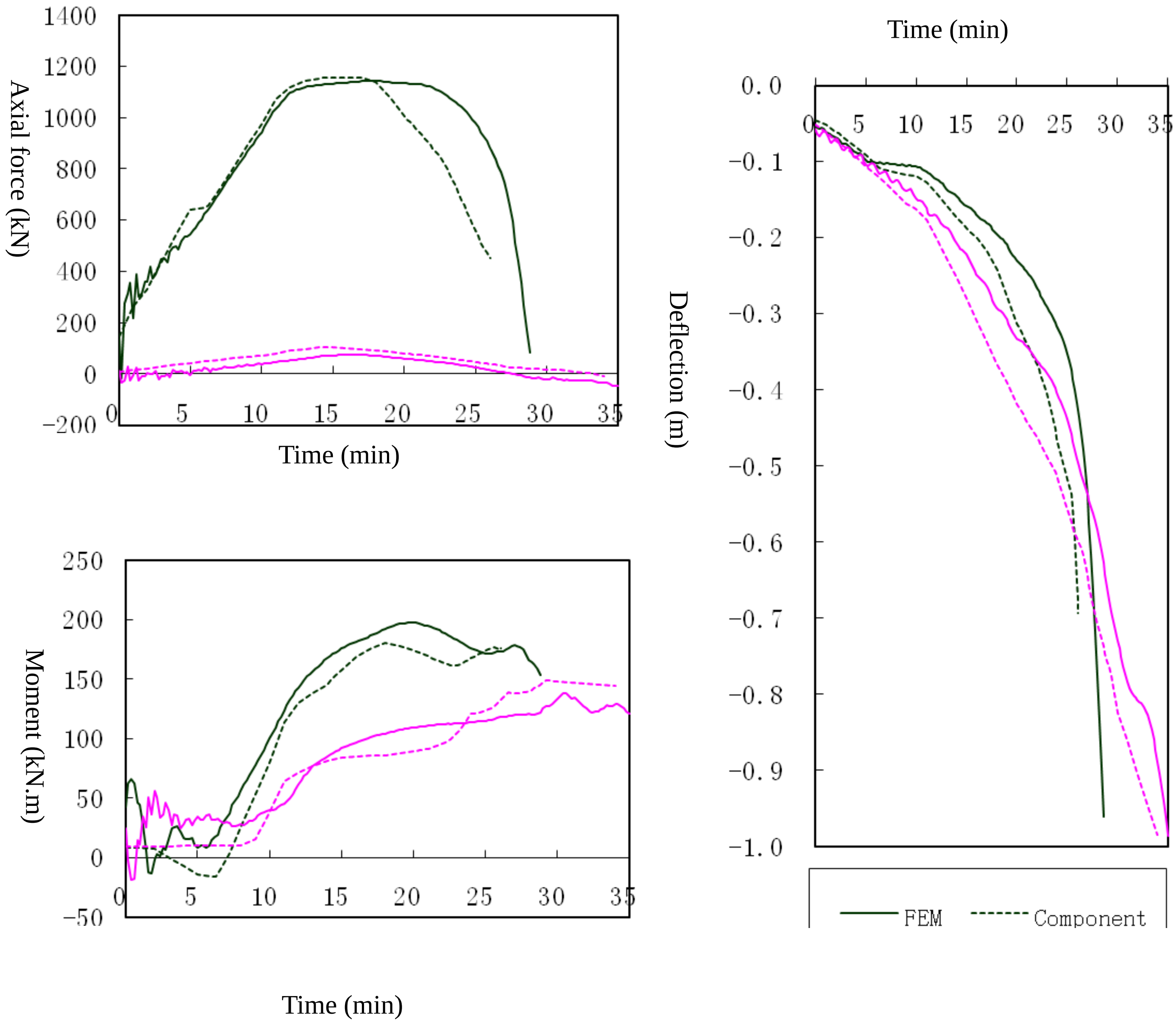


K4



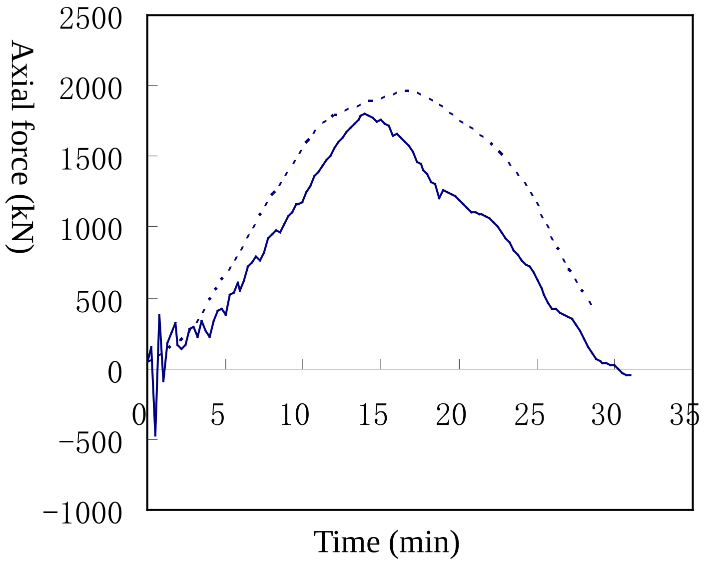
Axial force (kN)
1200
1000
800
600
400
200
0
-200
0
5
10
15
20
25
30
35
Time (min)
strong
weak
Moment (kN.m)
300
250
200
150
100
50
0
-50
0
5
10
15
20
25
30
35
Time (min)
strong
weak
Time (min)
Deflection (m)
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
0
10
20
30
40
strong
weak
FEM
Component

H4

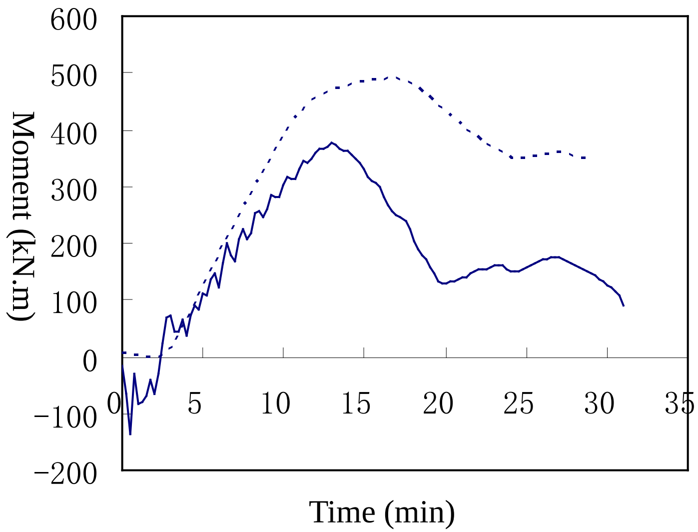


Axial force (kN)
1400
1200
1000
800
600
400
200
0
−200
0
5
10
15
20
25
30
35
Time (min)
Moment (kN.m)
250
200
150
100
50
0
−50
0
5
10
15
20
25
30
35
Time (min)
Time (min)
Deflection (m)
0. 0
−0. 1
−0. 2
−0. 3
−0. 4
−0. 5
−0. 6
−0. 7
−0. 8
−0. 9
−1. 0
0
5
10
15
20
25
30
35
FEM
Component

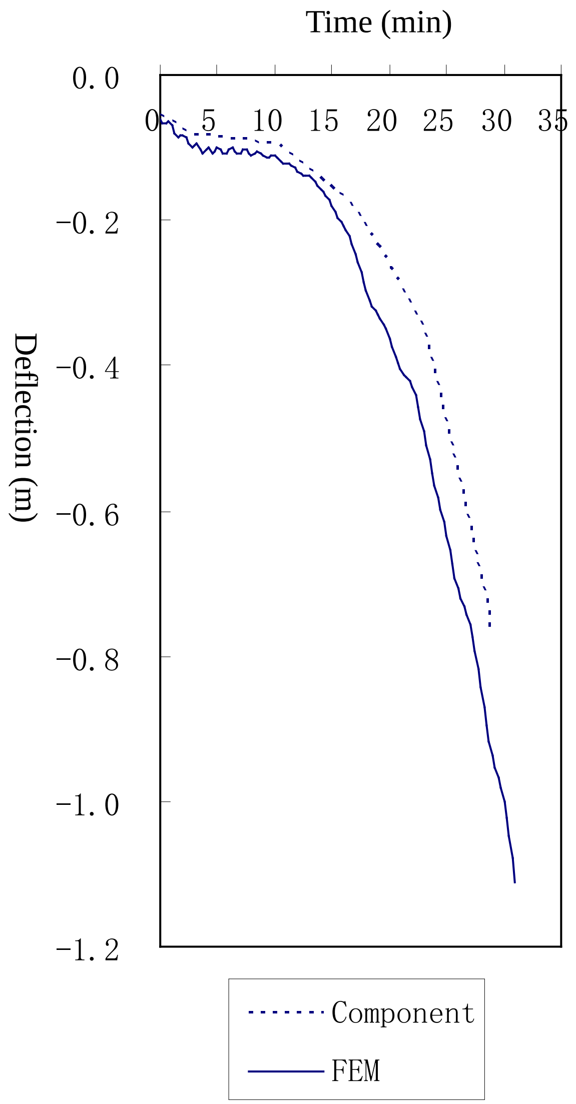
Fin



Axial force (kN)
2500
2000
1500
1000
500
0
-500
-1000
0
5
10
15
20
25
30
35
Time (min)

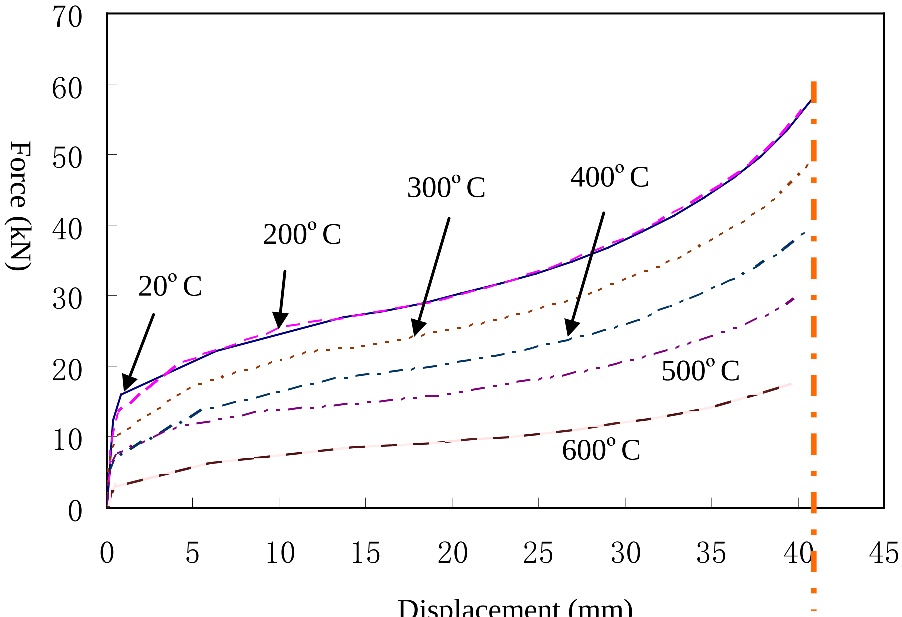


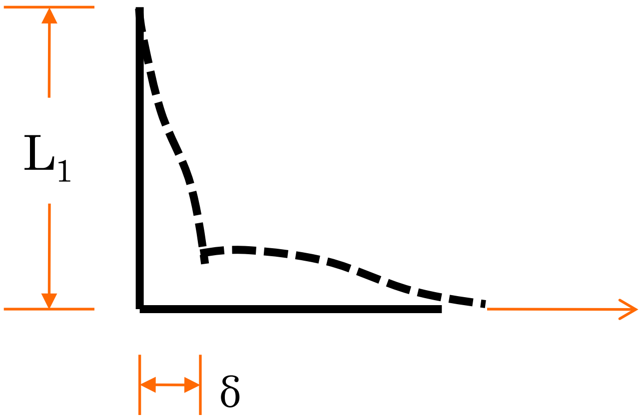
Moment (kN.m)
600
500
400
300
200
100
0
-100
-200
0
5
10
15
20
25
30
35
Time (min)



Time (min)
Deflection (m)
0. 0
-0. 2
-0. 4
-0. 6
-0. 8
-1. 0
-1. 2
0
5
10
15
20
25
30
35
Component
FEM

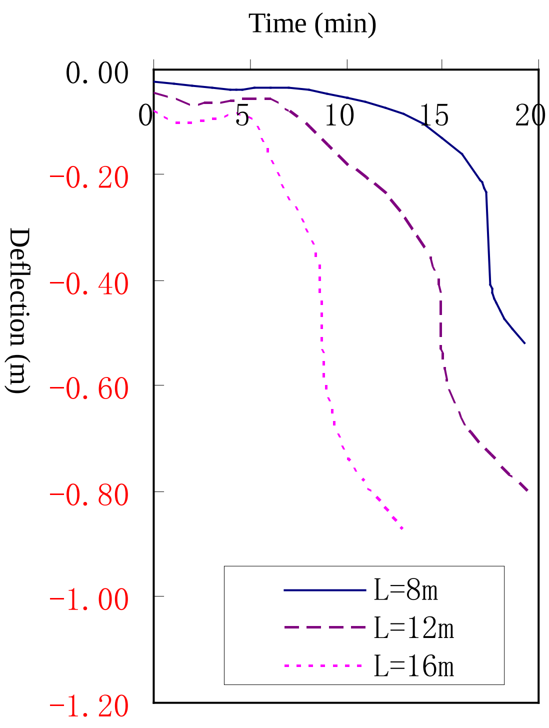
PARAMETRIC STUDY WITH COMPONENT-BASED MODEL

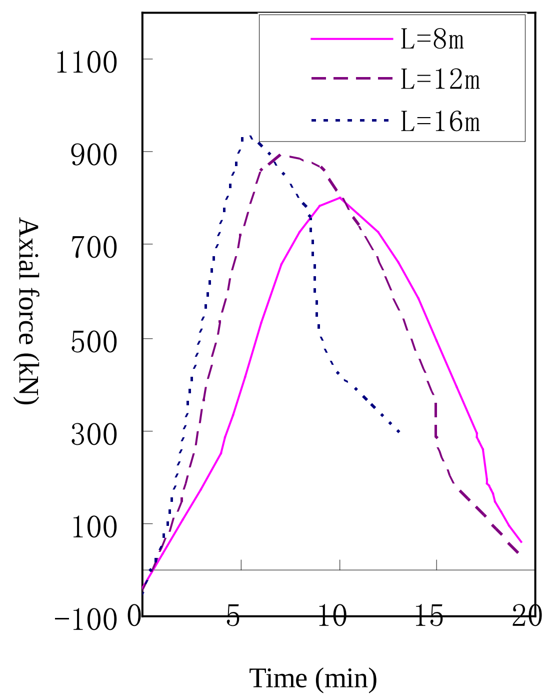


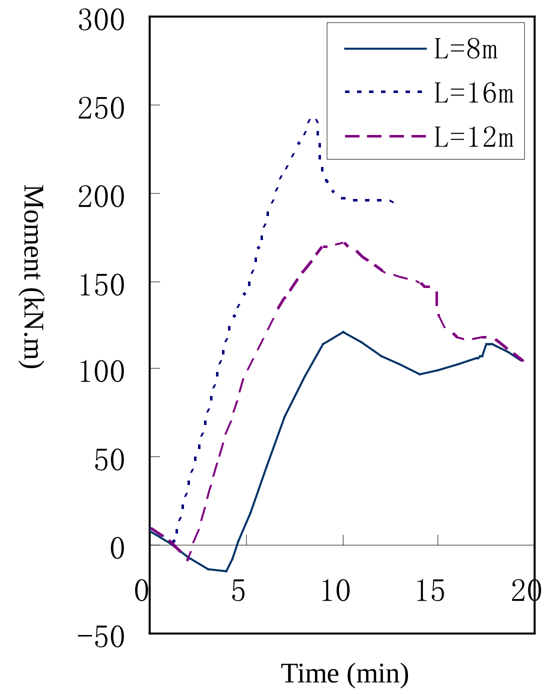


$\delta = 0.6L_1$

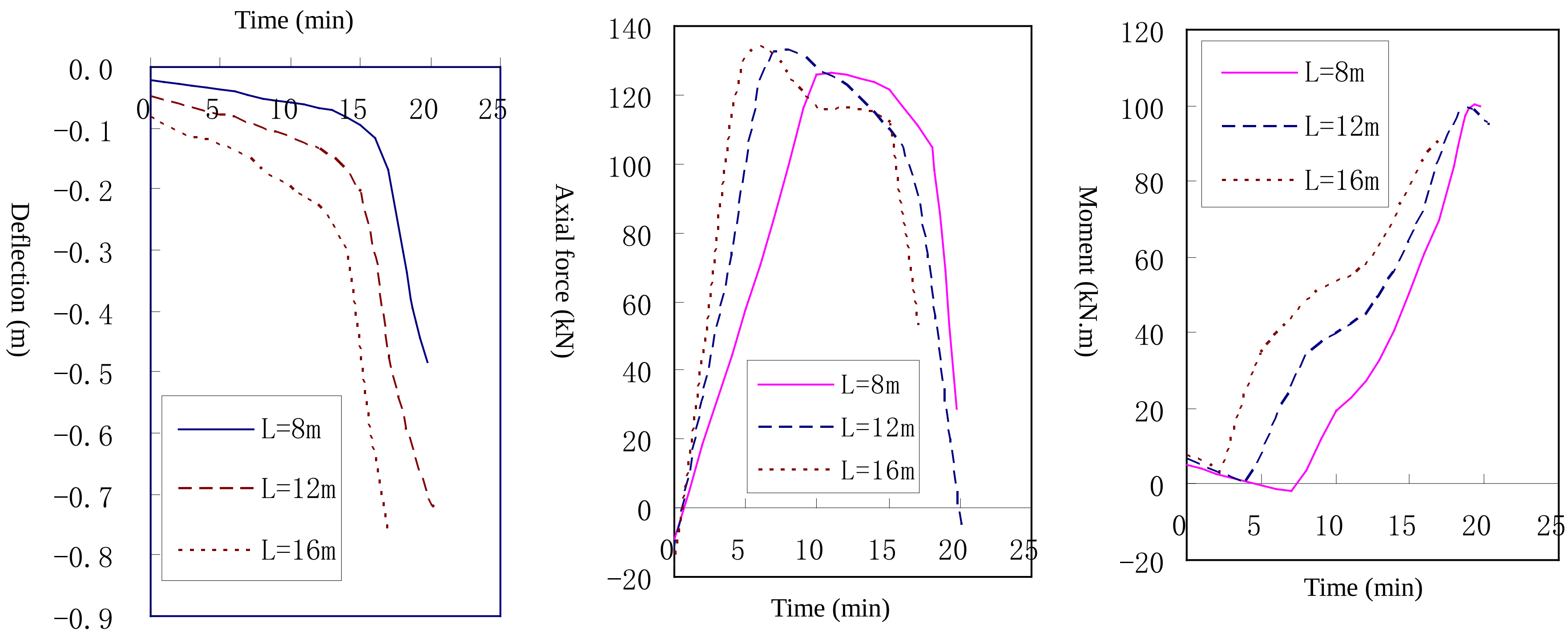
H4 WITH STRONG RESTRAINT C1



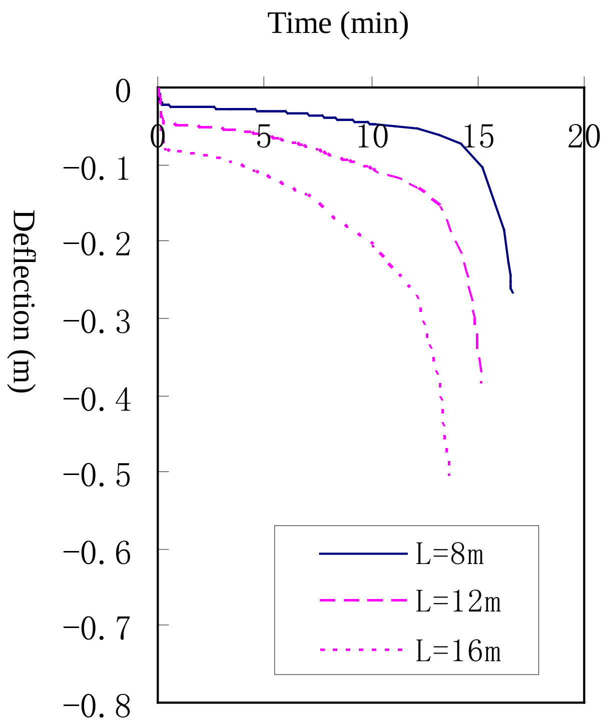


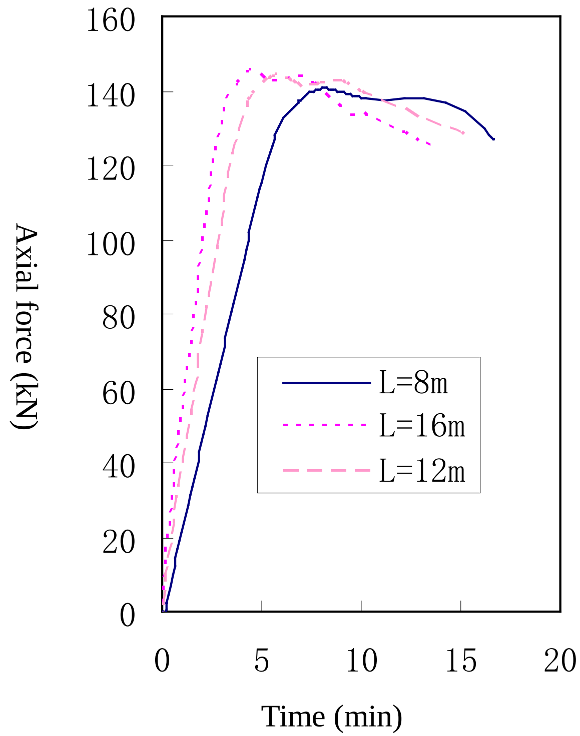


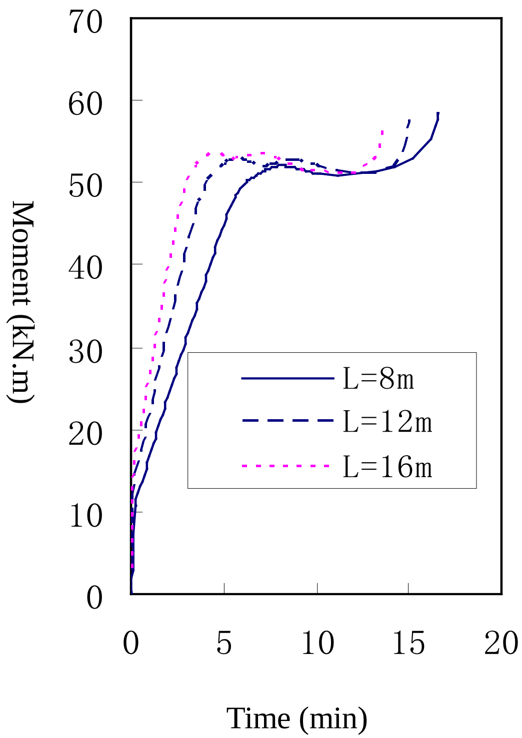
H4 WITH WEAK RESTRAINT C3



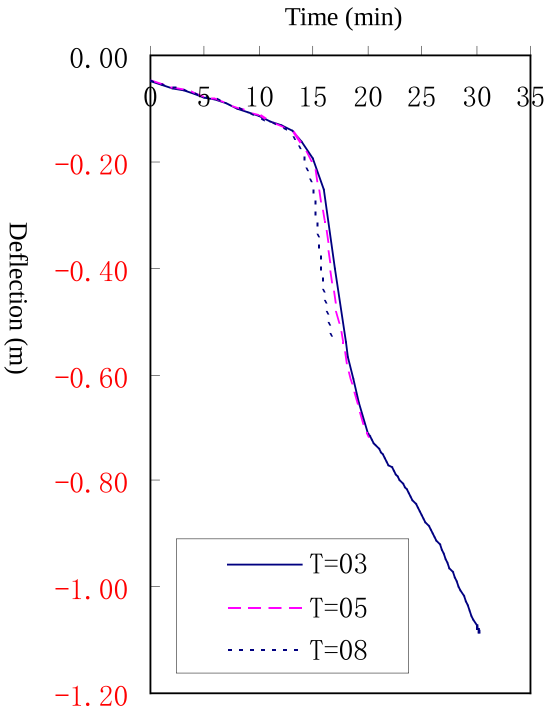
STC WITH WEAK RESTRAINT C3

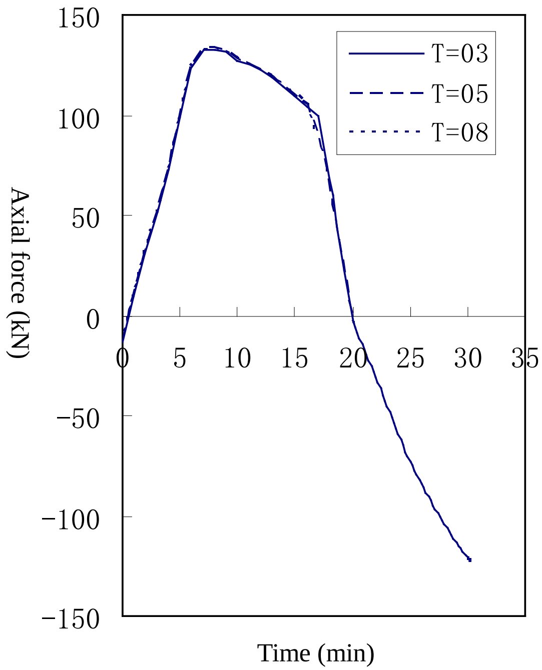


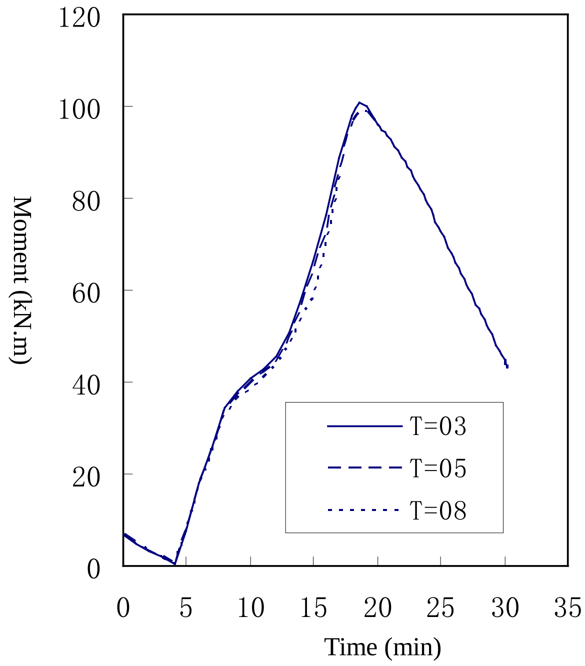




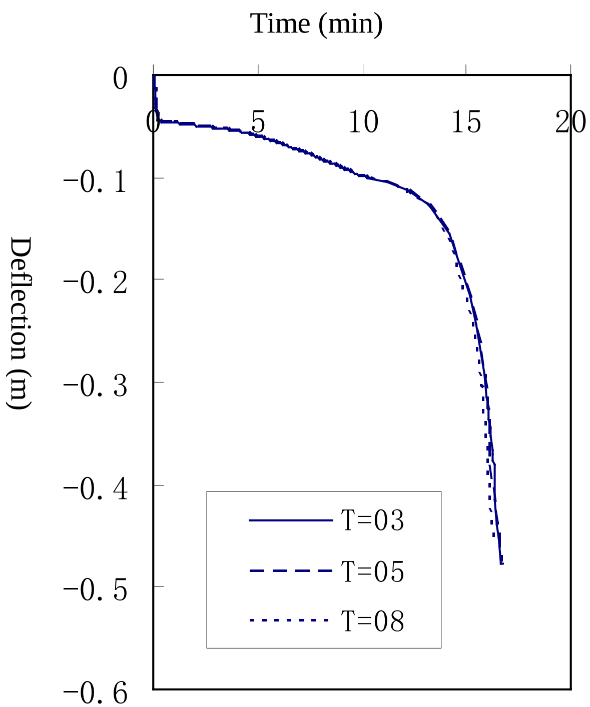
H4 -CONNECTION TEMPERATURE

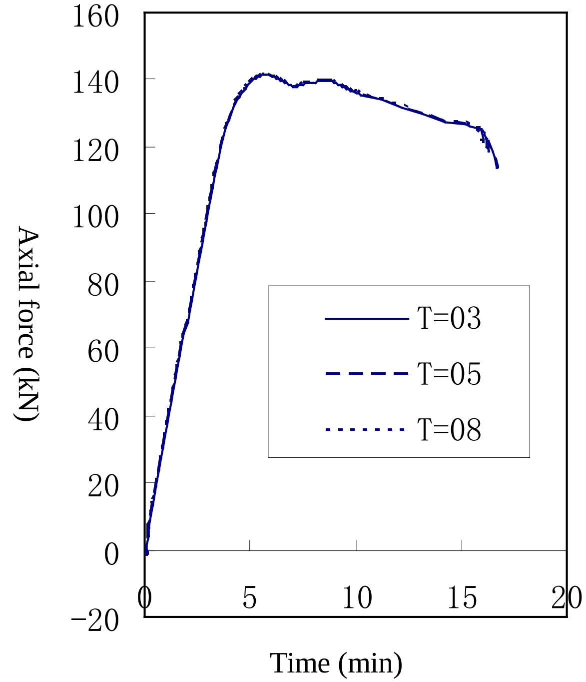


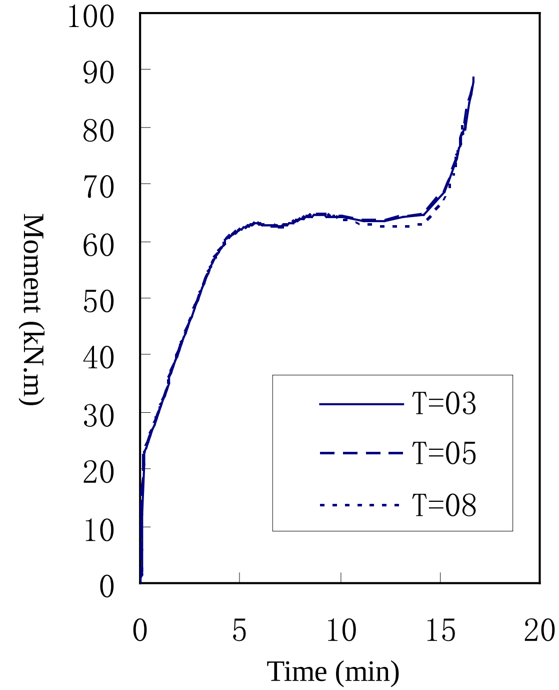




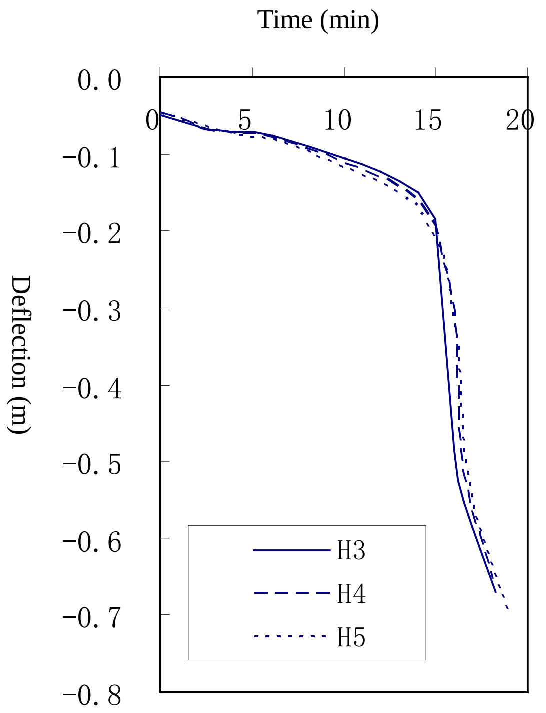
STC- CONNECTION TEMPERATURE



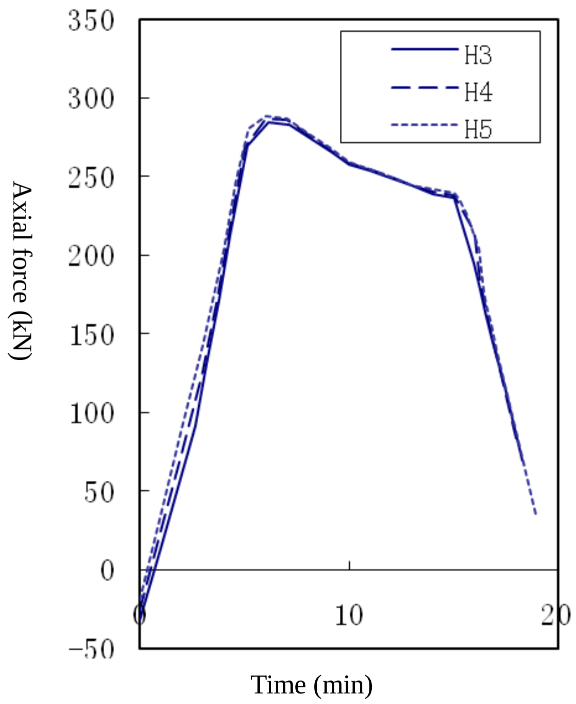




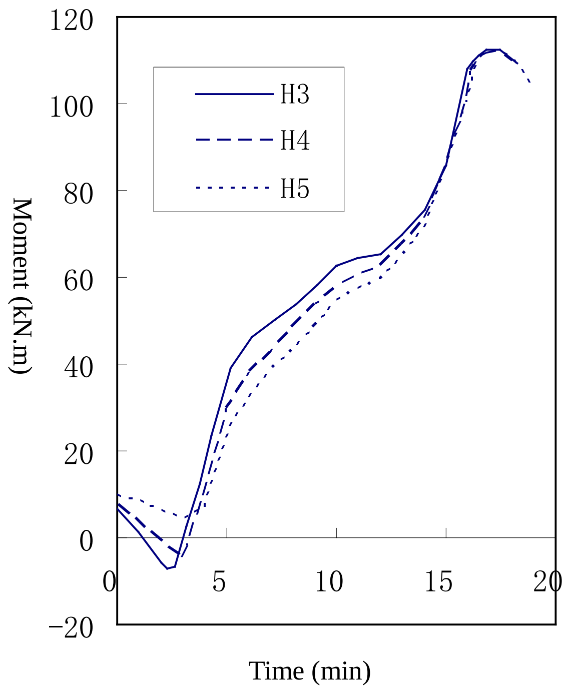
H3-H4-H5



Time (min)
0. 0
−0. 1
−0. 2
−0. 3
−0. 4
−0. 5
−0. 6
−0. 7
−0. 8
0
5
10
15
20
Deflection (m)
H3
H4
H5

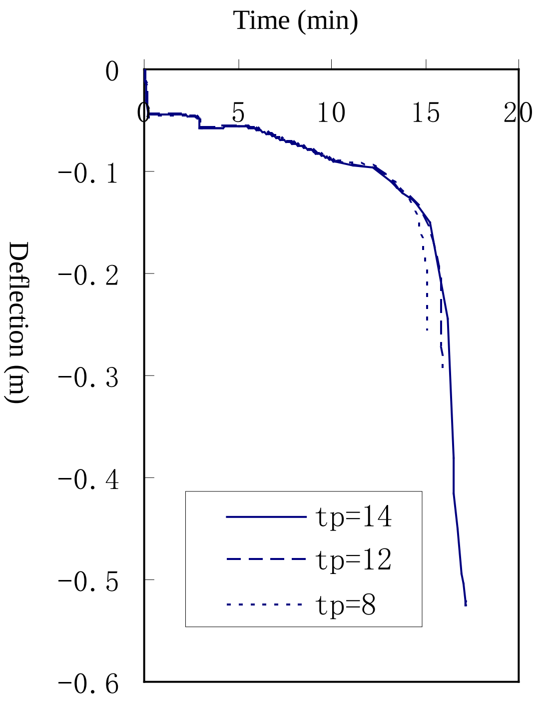


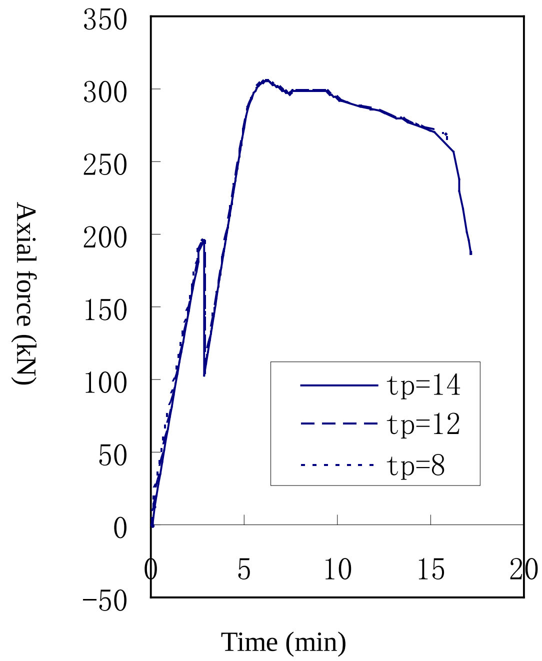
350
300
250
200
150
100
50
0
−50
0
10
20
Axial force (kN)
Time (min)
H3
H4
H5

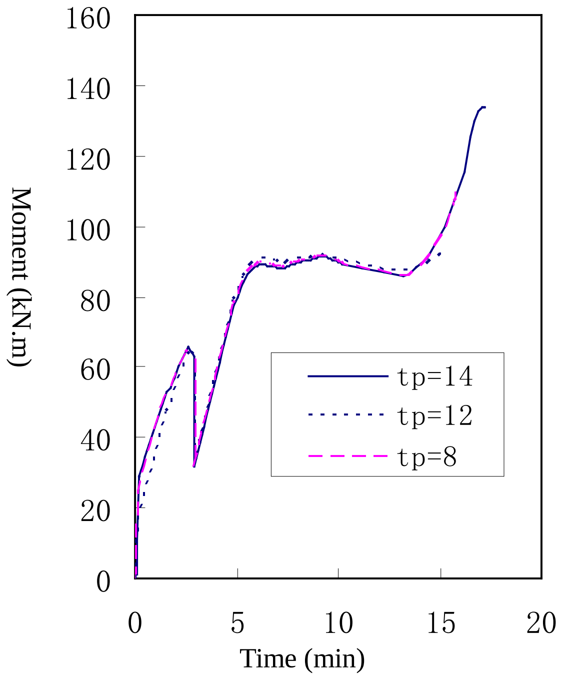


120
100
80
60
40
20
0
−20
0
5
10
15
20
Moment (kN.m)
Time (min)
H3
H4
H5

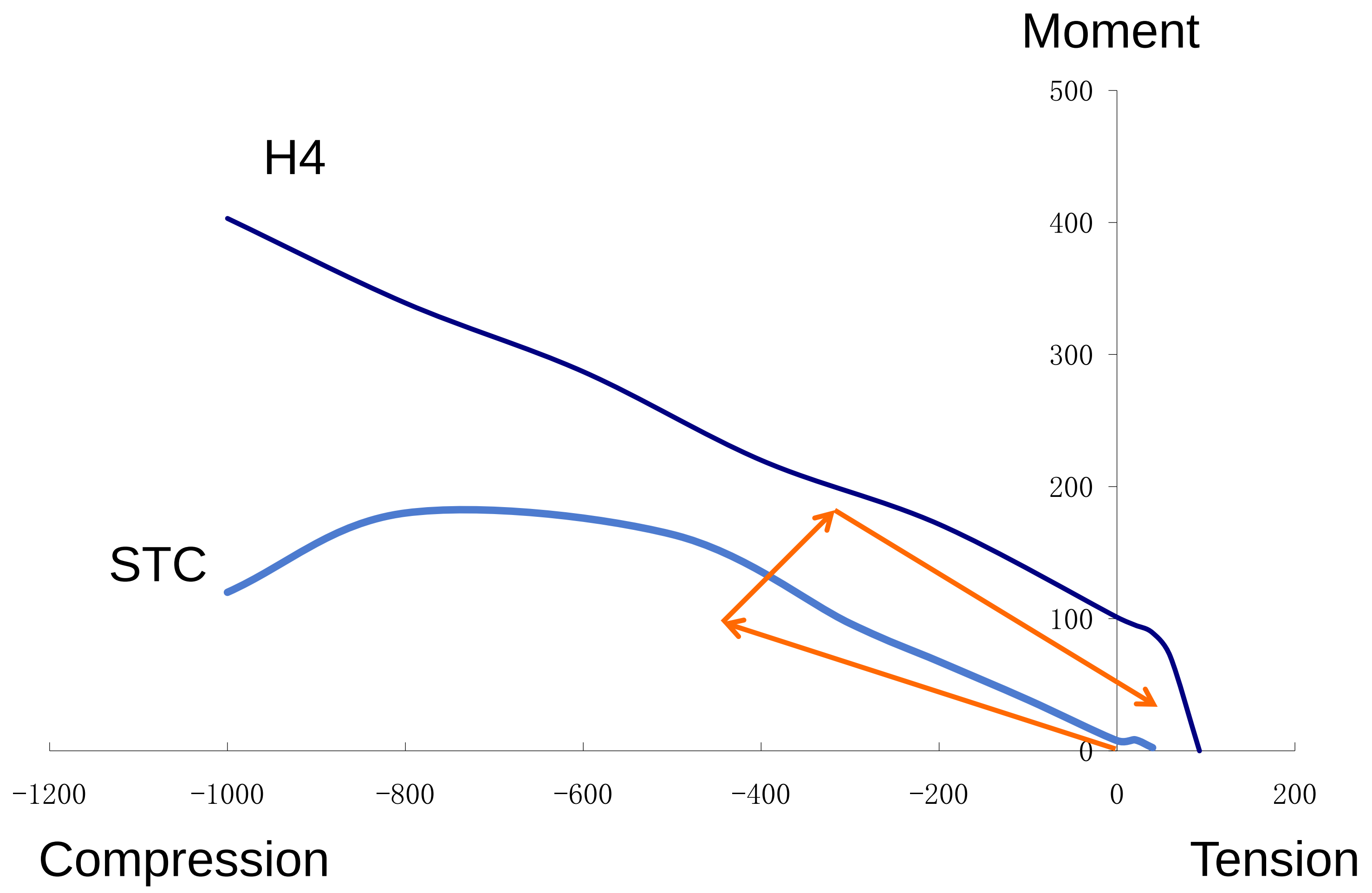
Tf=8, 12, AND 14


Time (min)
0
5
10
15
20
0
-0. 1
-0. 2
-0. 3
-0. 4
-0. 5
-0. 6
Deflection (m)
tp=14
tp=12
tp=8

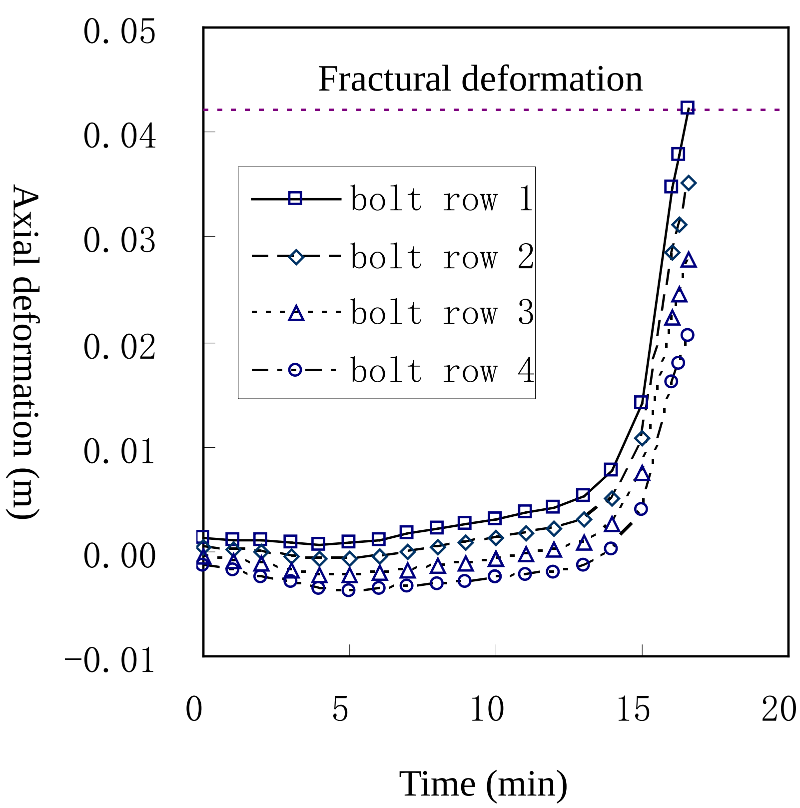

350
300
250
200
150
100
50
0
-50
Axial force (kN)
0
5
10
15
20
Time (min)
tp=14
tp=12
tp=8

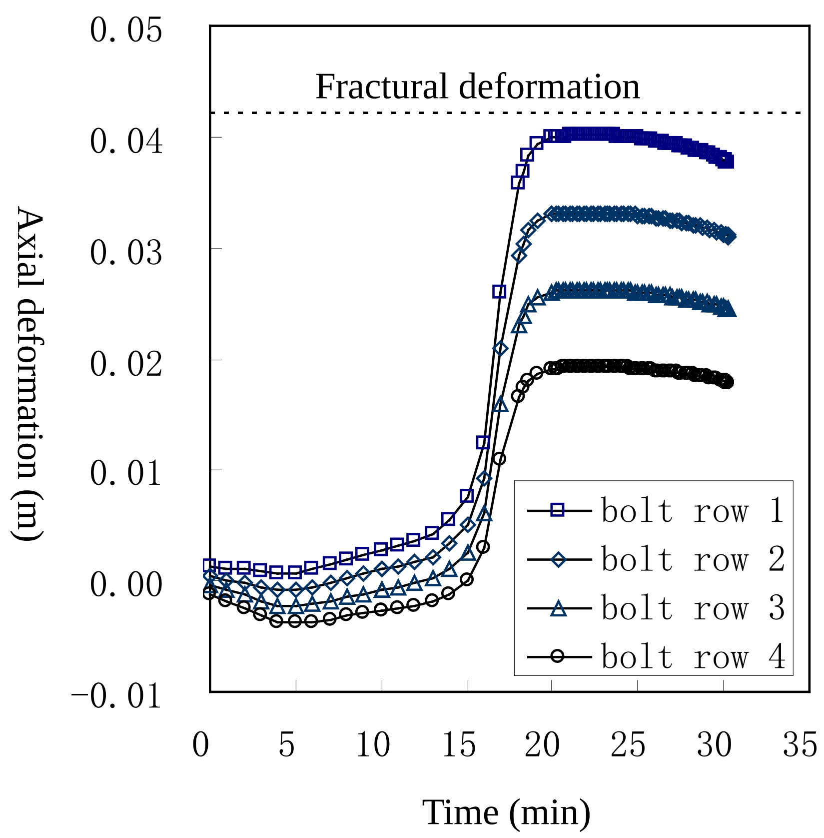

160
140
120
100
80
60
40
20
0
Moment (kN.m)
0
5
10
15
20
Time (min)
tp=14
tp=12
tp=8

DEVELOPMENT OF THE CONNECTION FORCES



DEVELOPMENT OF THE COMPONENT FORCES





CONCLUSION

- Development of the axial force is related to the restraint stiffness, beam span, but is less sensitive to the connection characteristics, such as connection size, geometry and temperature, etc.
- The compressive axial force has the effect of enhancing the connection moment resistance, but also generating the second-order moment. Therefore, the effect of axial force is generally increase the fire resistance but can be harmful for beams with long span.
- Better connections should have good ductility. Connections with high stiffness, but low moment resistance should be avoided.
- Change of the connection geometry or connection temperature does not necessarily increase the connection fire resistance.