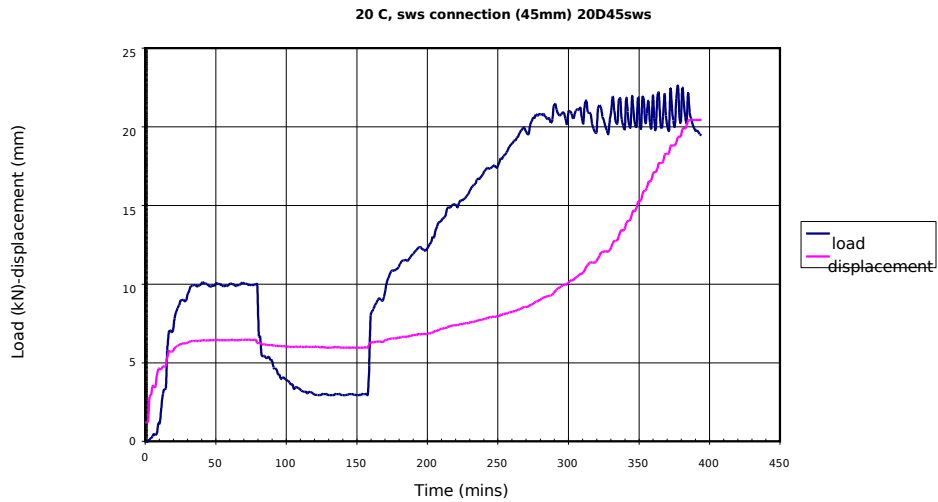
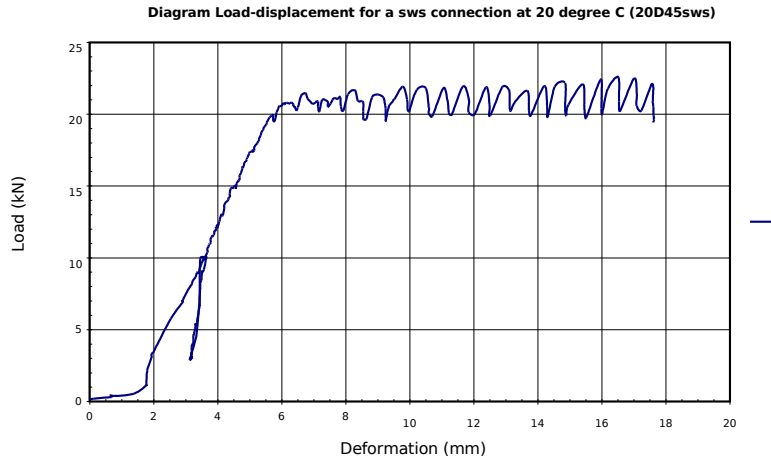


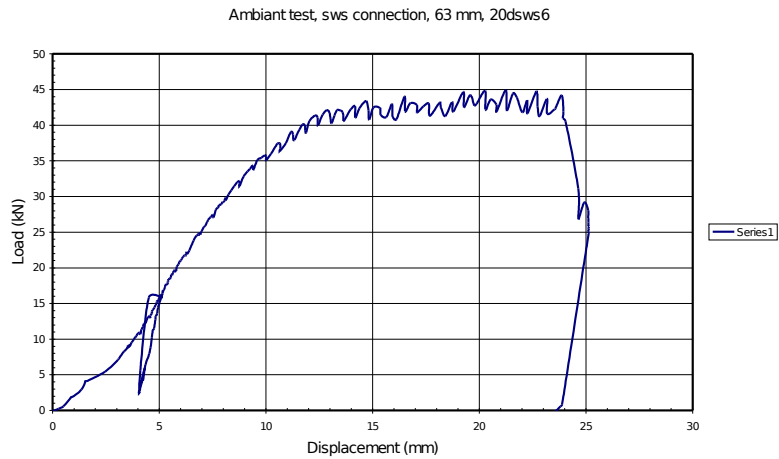
Appendix 2

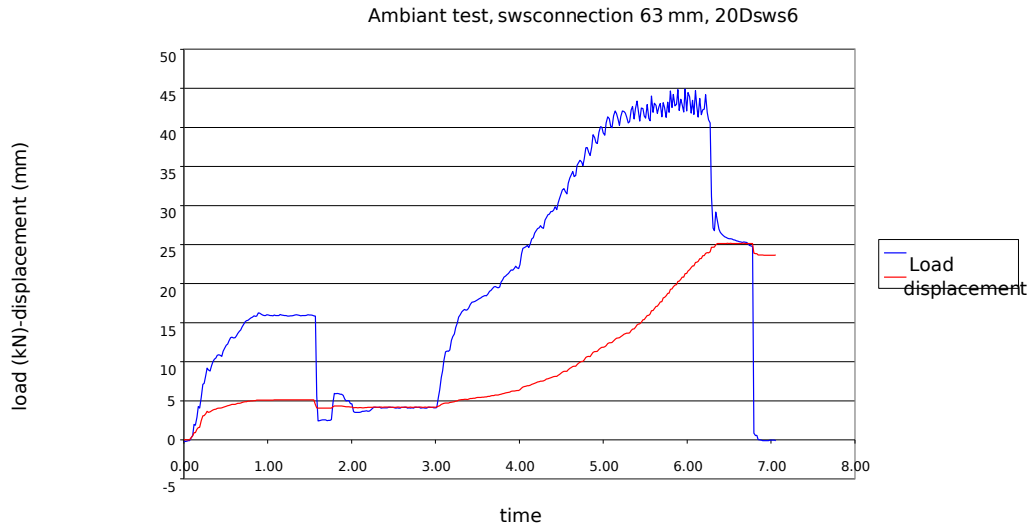
1 Ambient and heating tests

20D45SWS test: sws connection with a 45 mm timber member and two steel plates on each side (12mm).

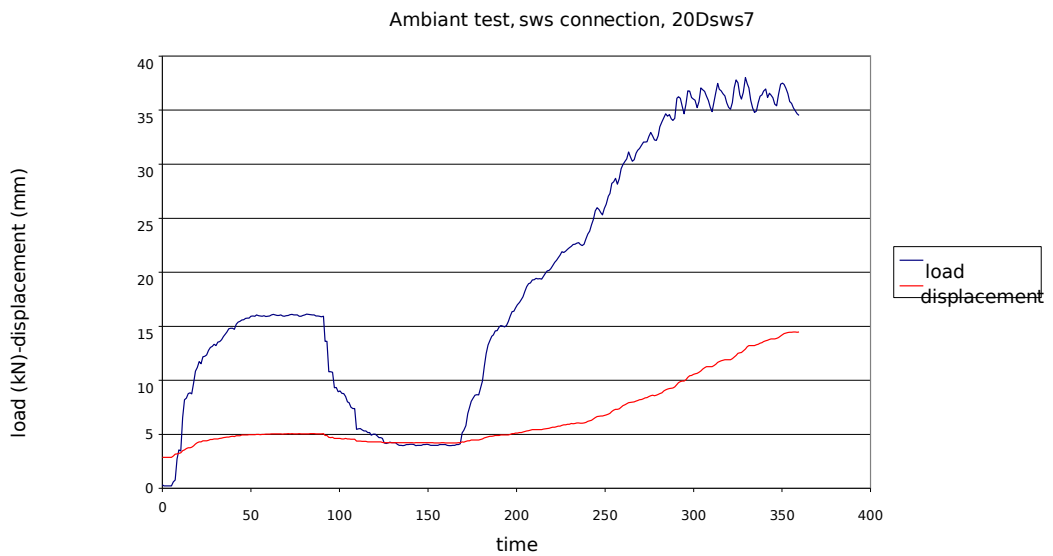
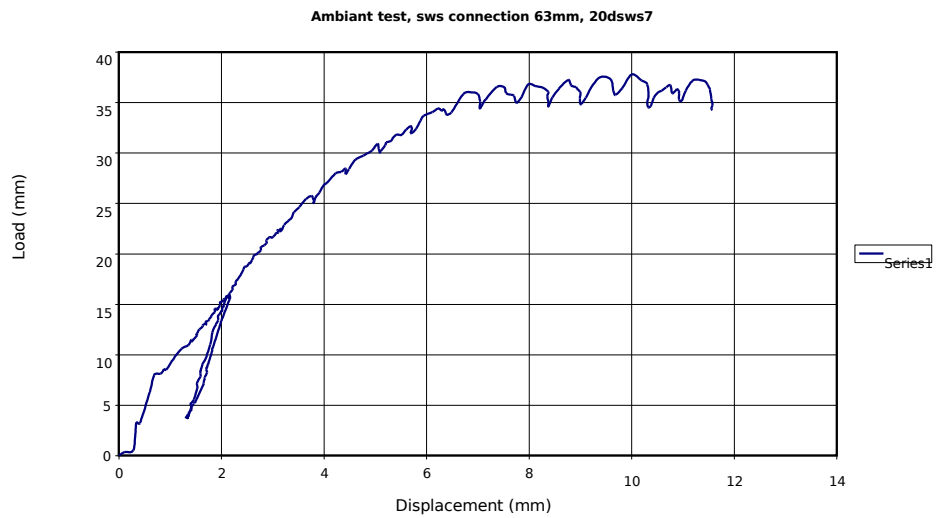


20DSWS6: sws connection, 63 mm timber member, one bolt, and two steel plates on each side (12mm)

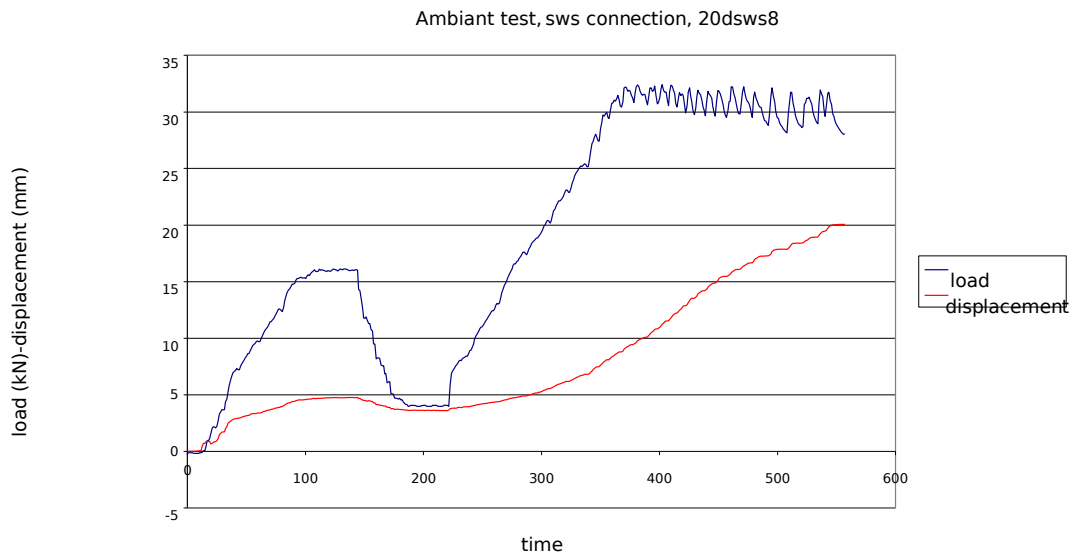
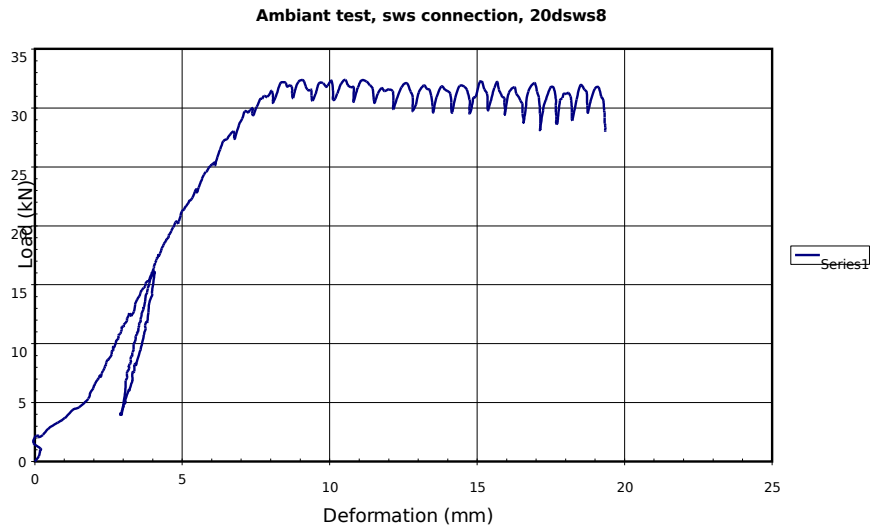




20DSWS7: sws connection, 63 mm thickness, 12mm steel plates on the sides.

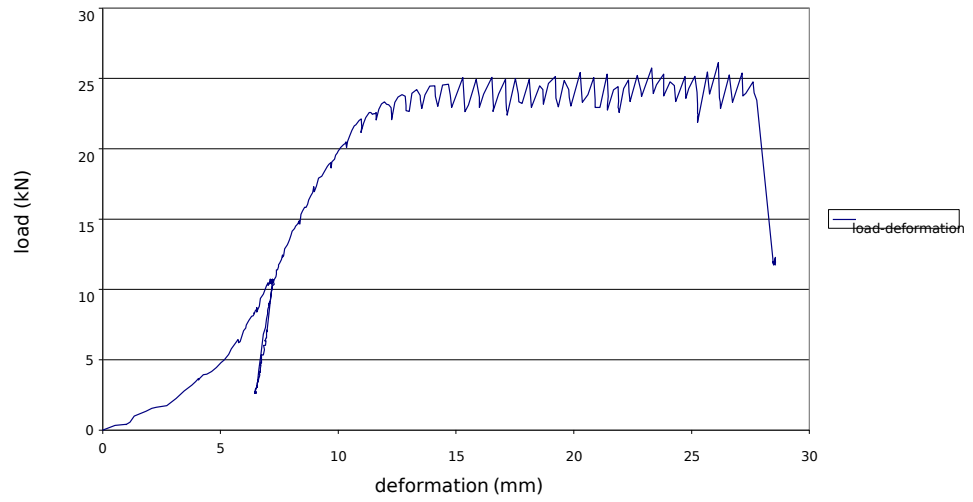


20DSWS8: sws connection, 63 mm thickness, 12 mm steel plates on the sides.

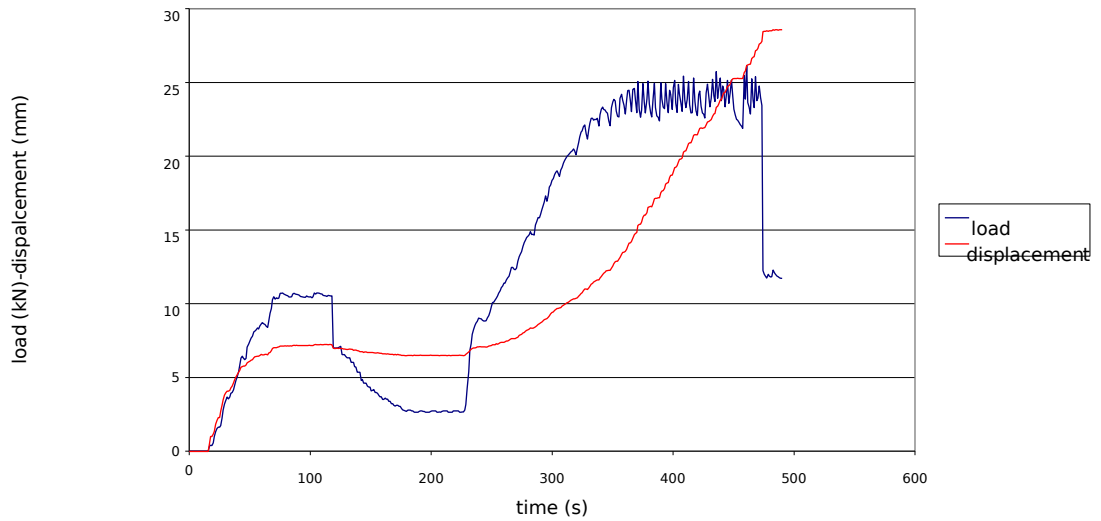


20SWS452: sws connection, one bolt, 45 mm timber, 12 mm steel plates on the sides.

load-deformation, ambient test, sws connection 45mm, 20sws452

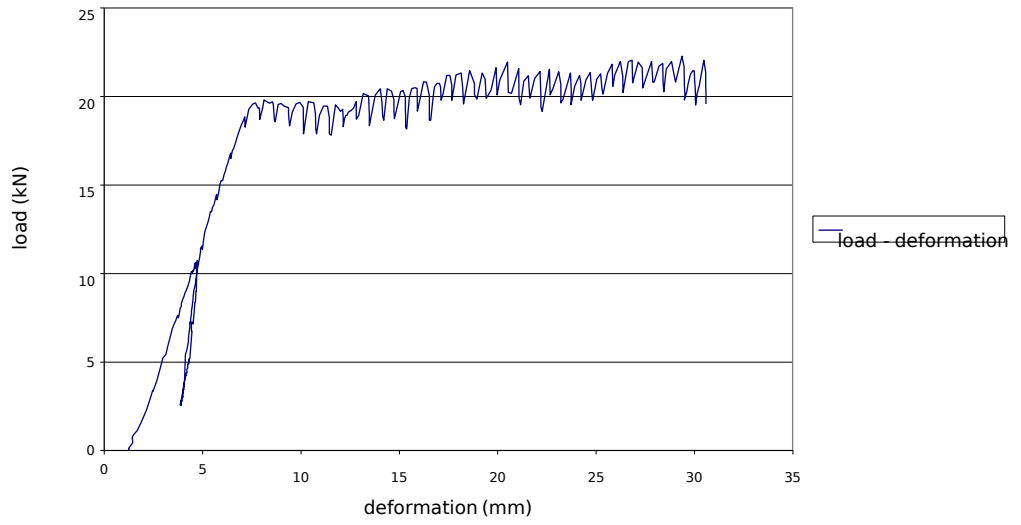


ambient test, sws connection 45mm, 20sws452

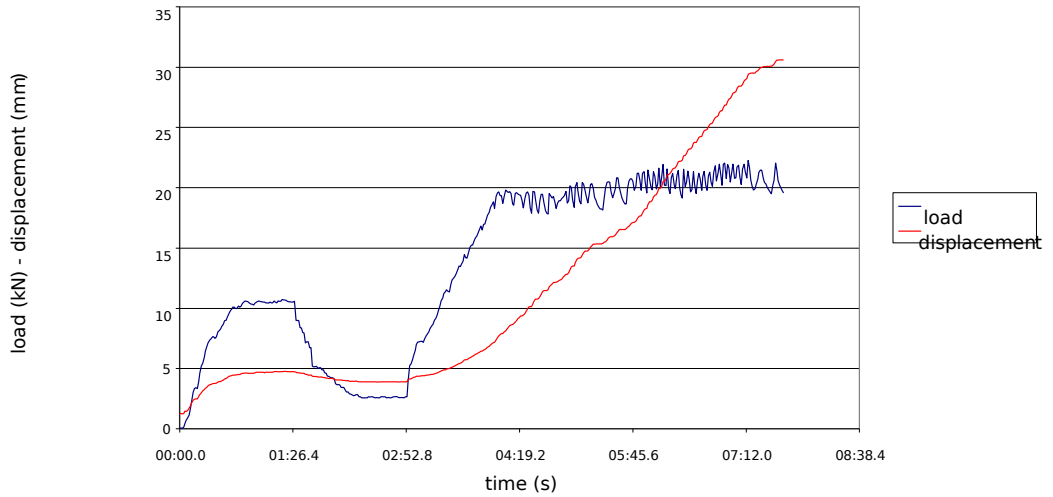


20SWS453: sws connection, one bolt, 45 mm timber, 12 mm steel plates.

load - deformation, ambient test, sws connection, 63mm, 20sws453

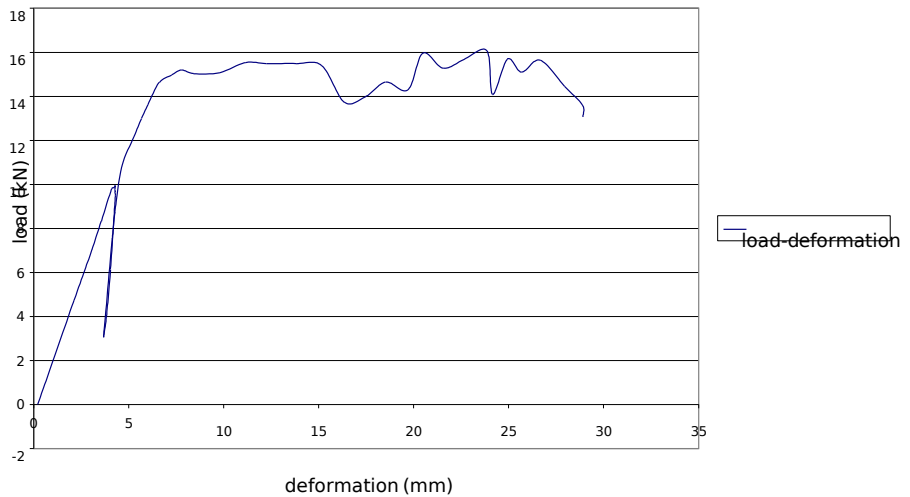


Ambiant test, sws connection 45mm, 20sws453

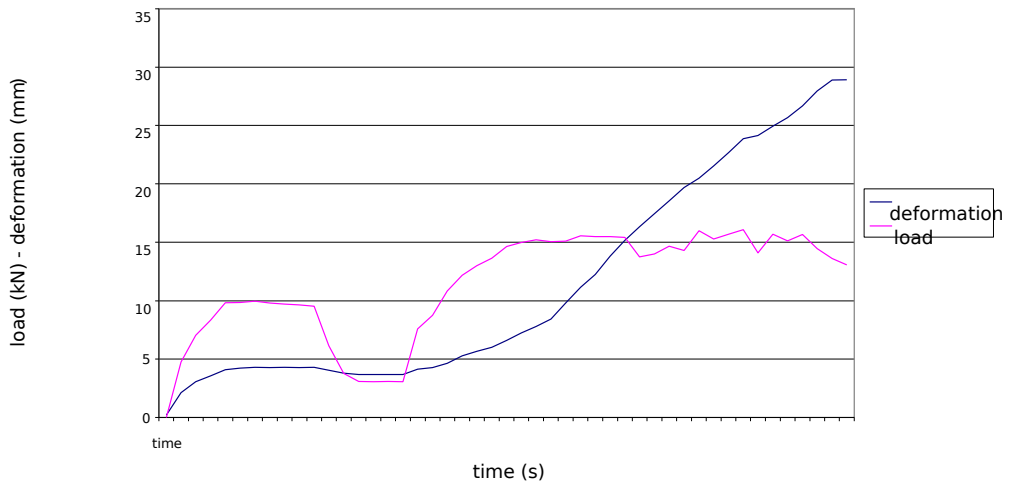


100sws45: 100 C heating test, sws connection, 45 mm timber, 6 mm steel plates.

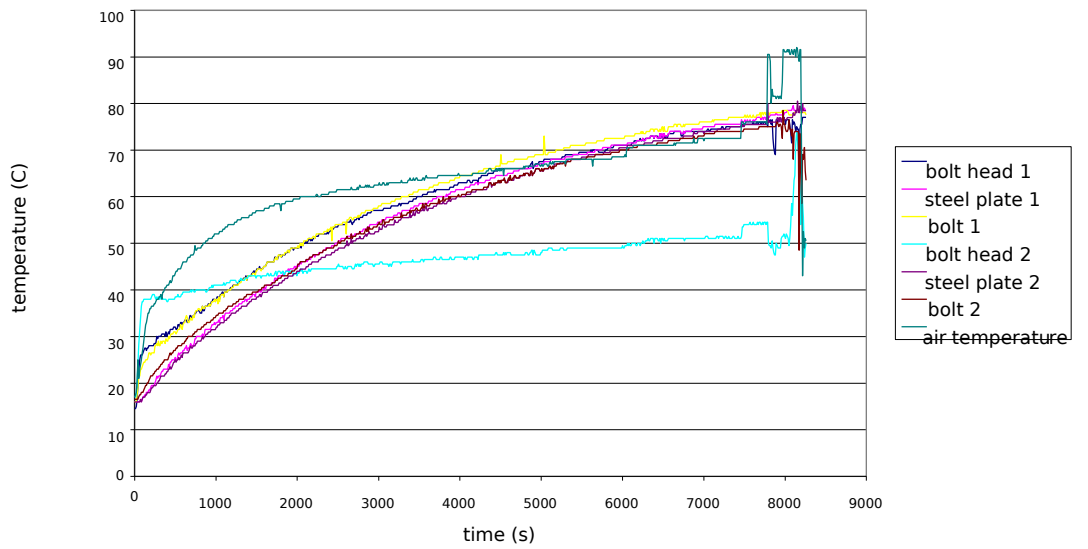
load-deformation, 100C heating test, sws connection 45m, 100sws45



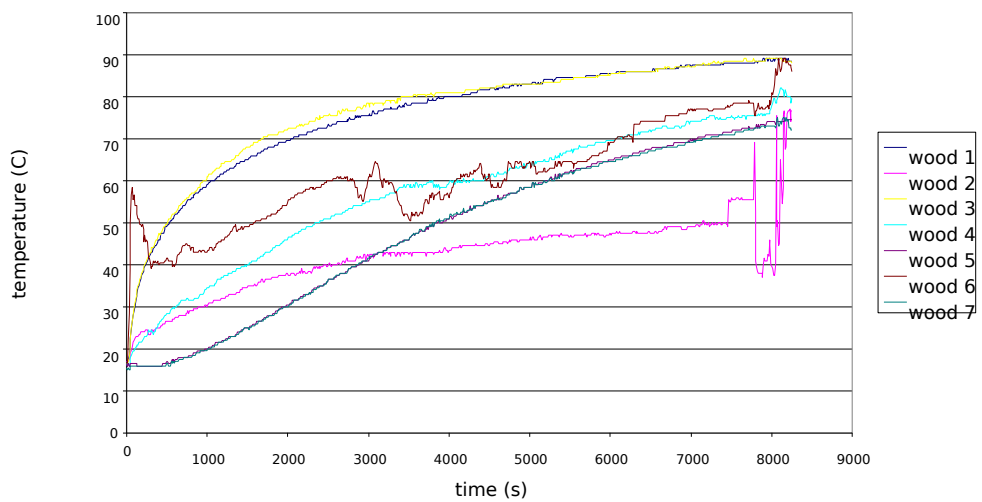
100 C heating test, sws connection 45mm, 100sws45



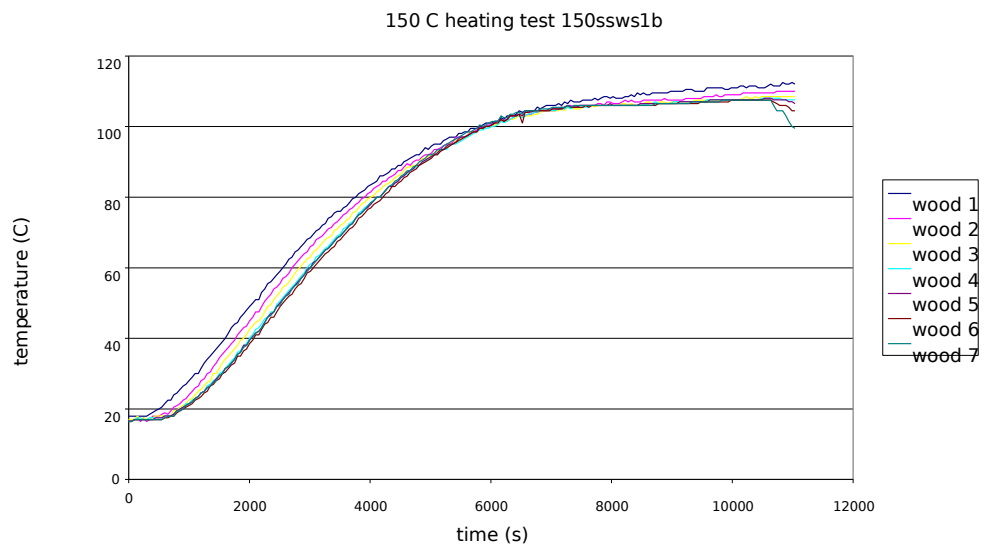
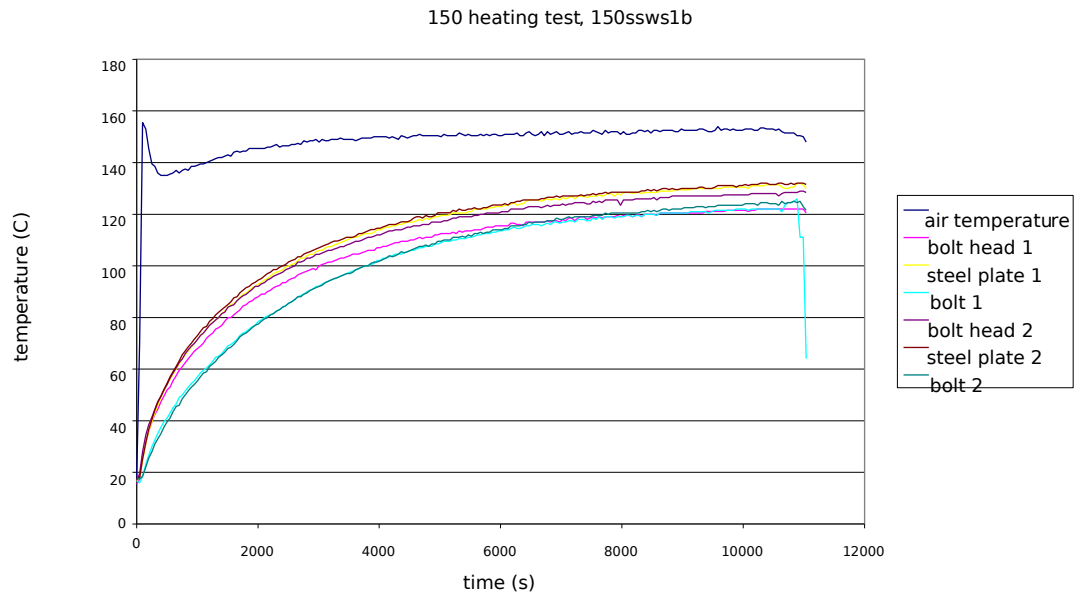
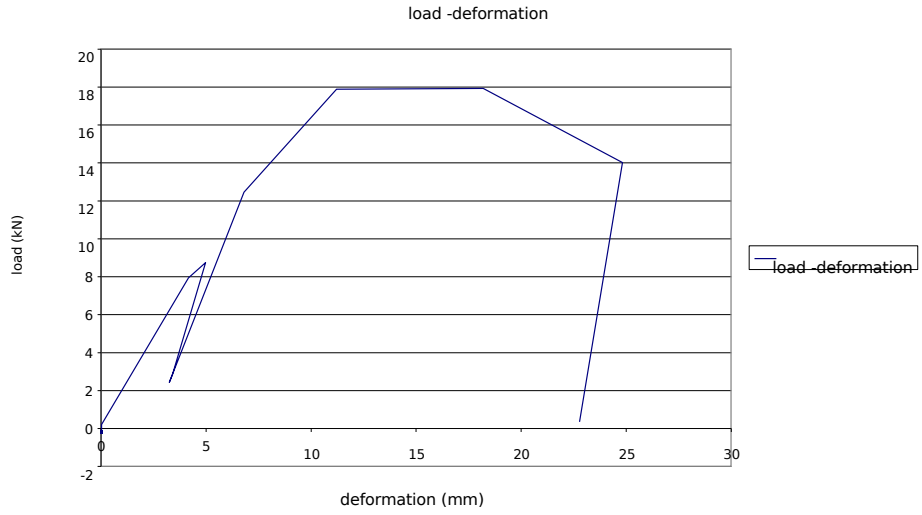
100 C heating test, 100sws45, temperatures



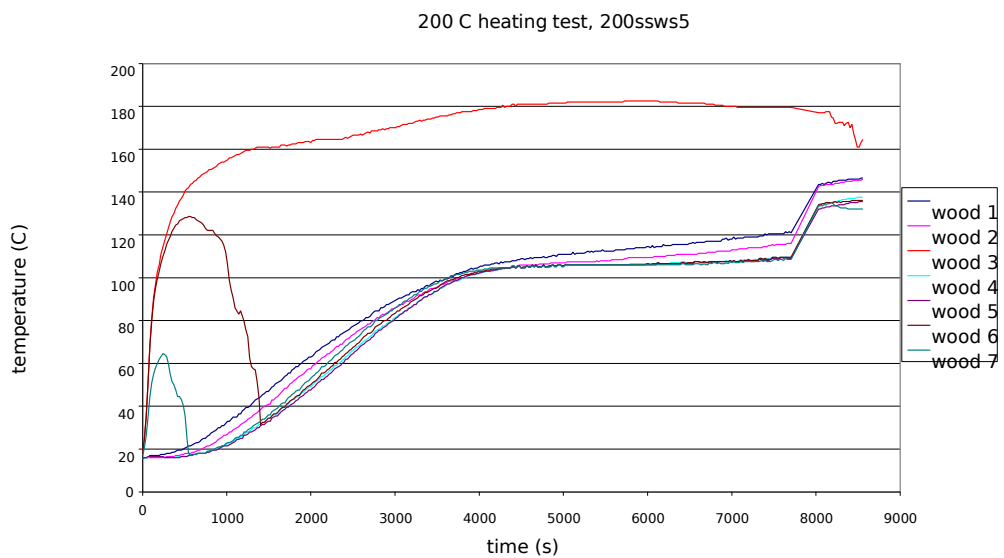
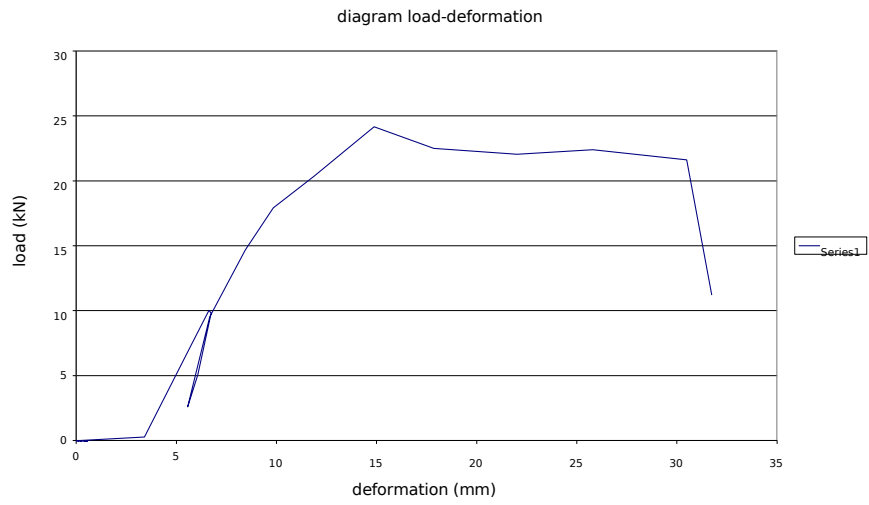
100 C heating test, 100sws45, temperatures



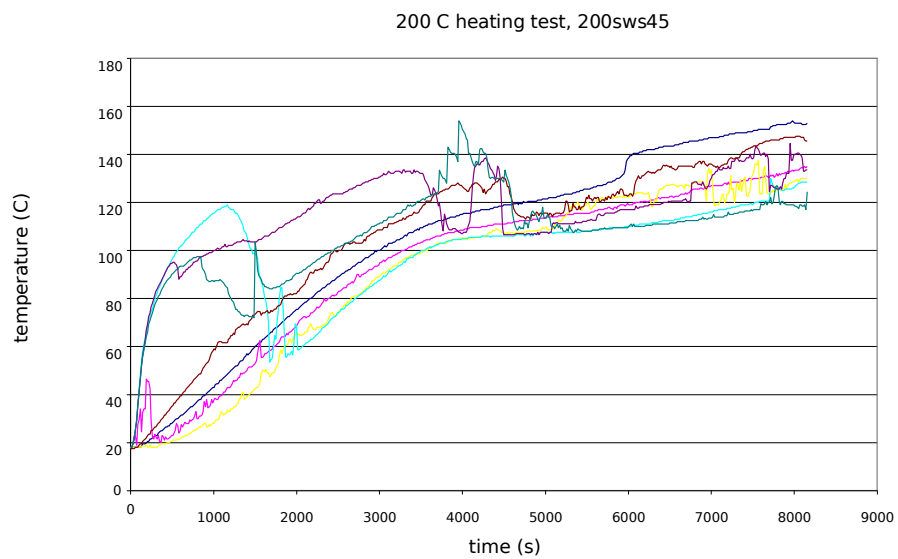
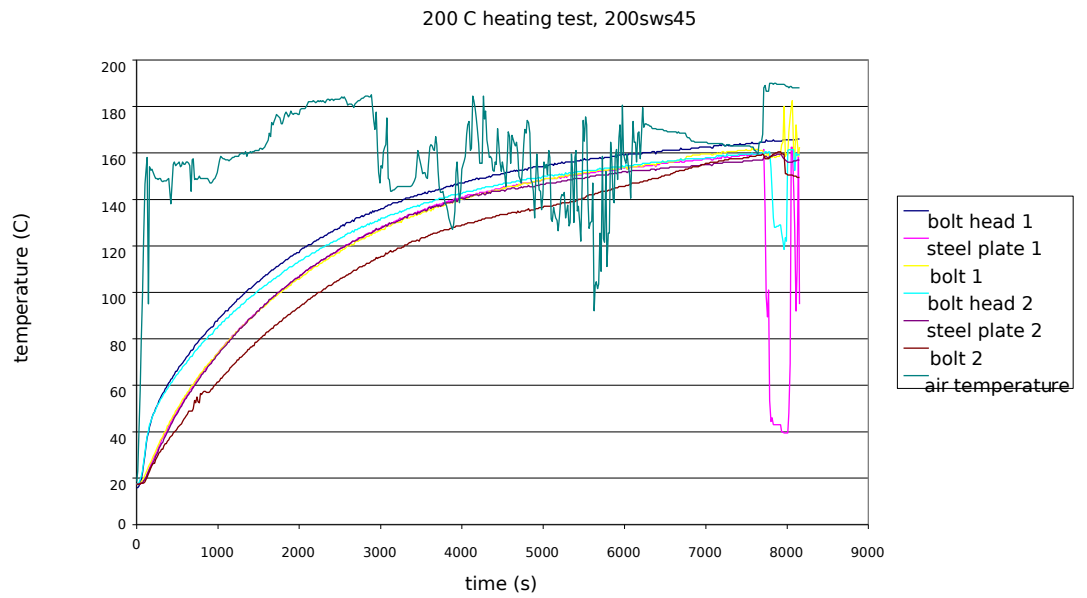
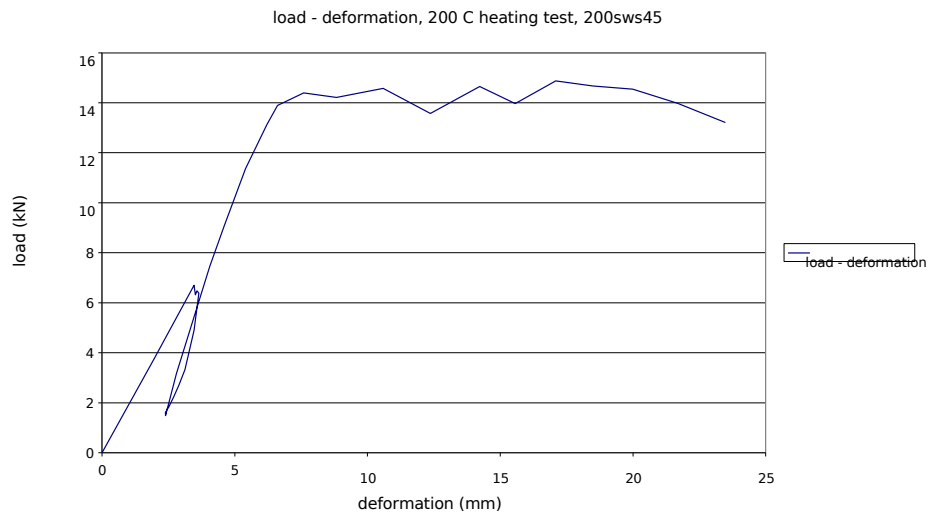
150sswsb: 150 C heating test, sws connection,



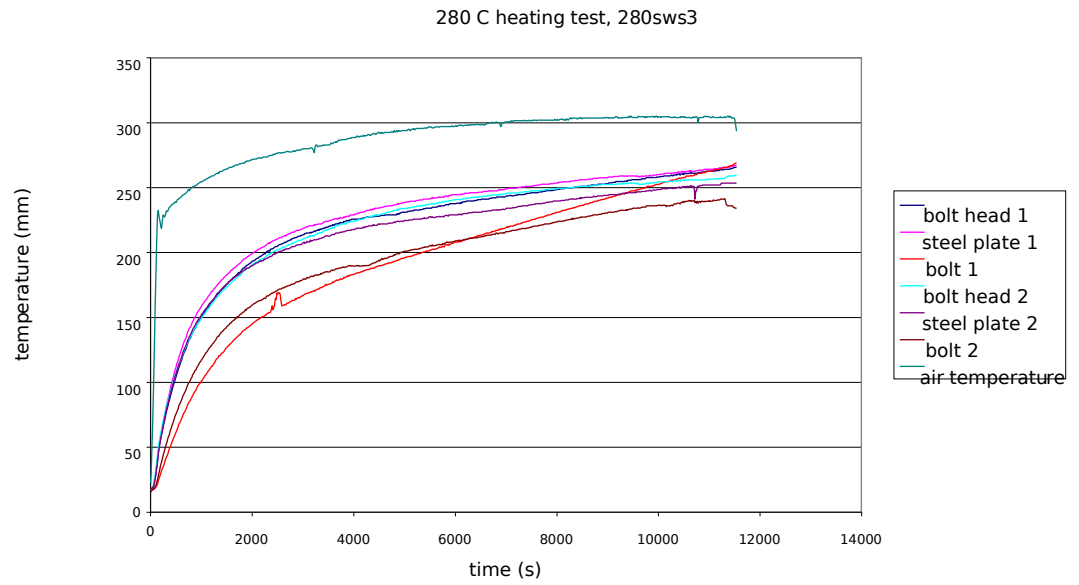
200ssws5: 200 C heating test, sws connection, 63 mm timber, 6 mm steel plates.



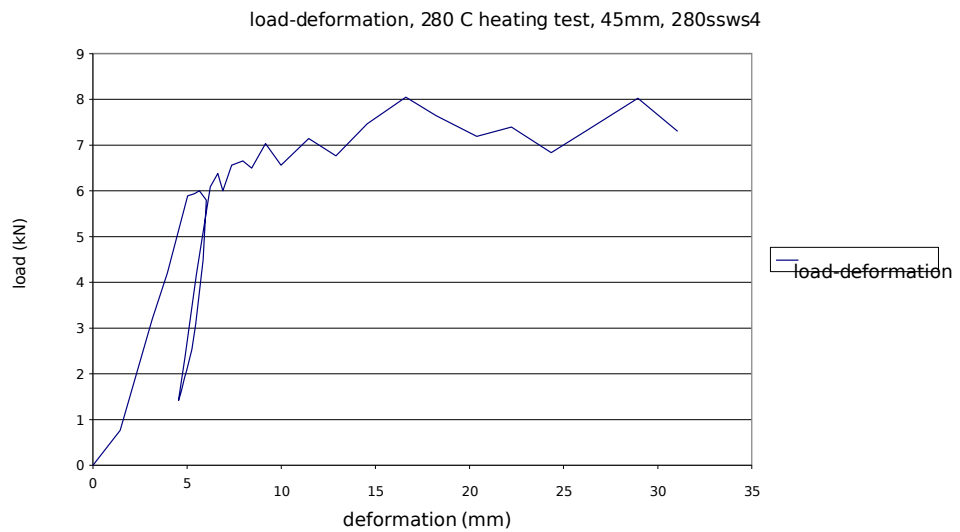
200ssws45: 200 C heating test, sws connection, 45 mm timber, 6 mm steel plate.



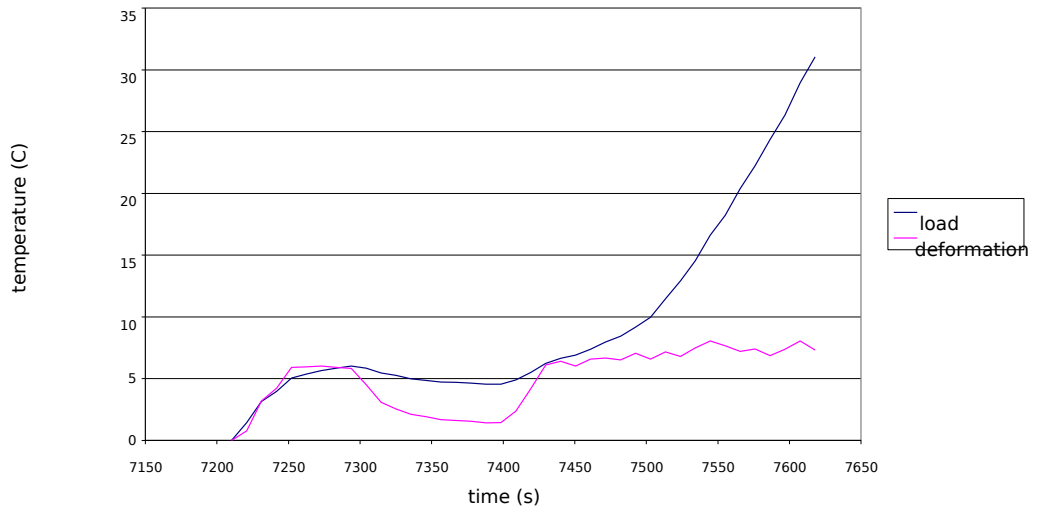
280ssws3: 280 C heating test, sws connection, 63 mm timber, 6 mm steel plates.



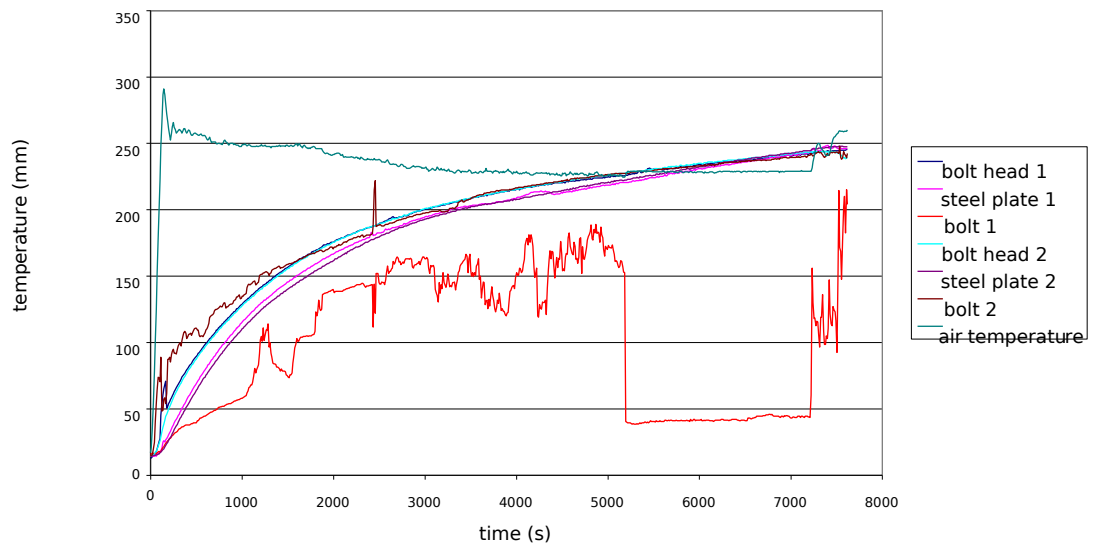
280ssws4



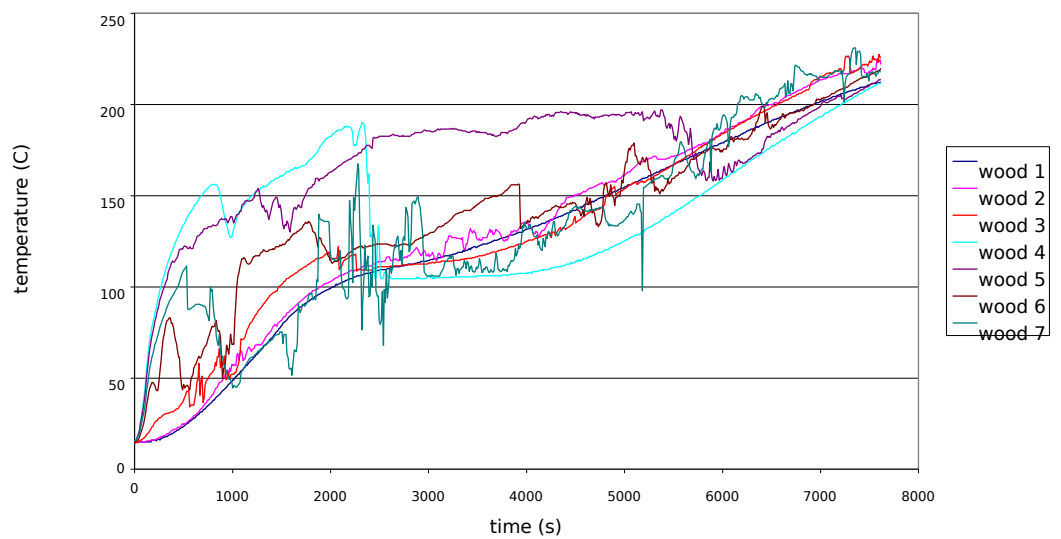
280 heating test, 45mm thickness, 280ssws4



280 C heating test, 45 mm thickness, 280ssws4

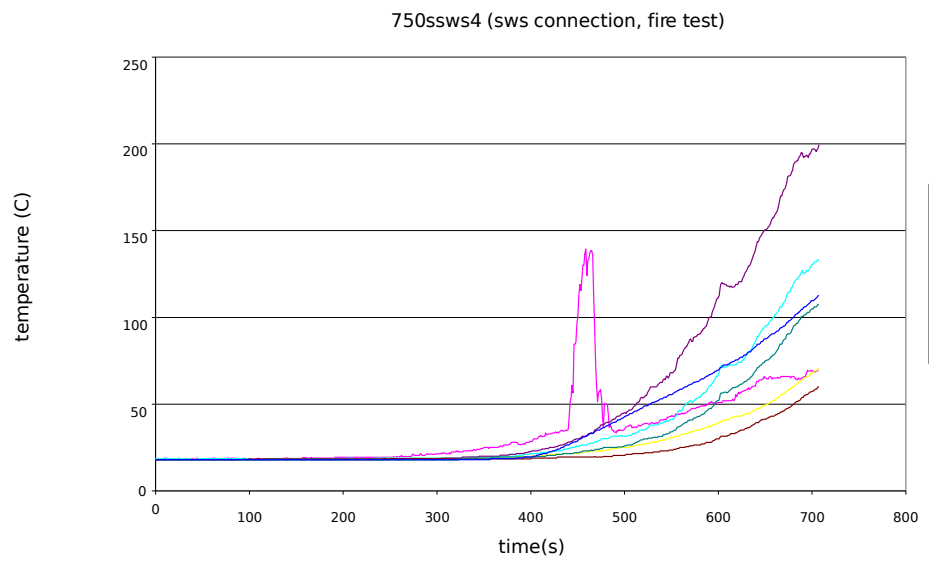
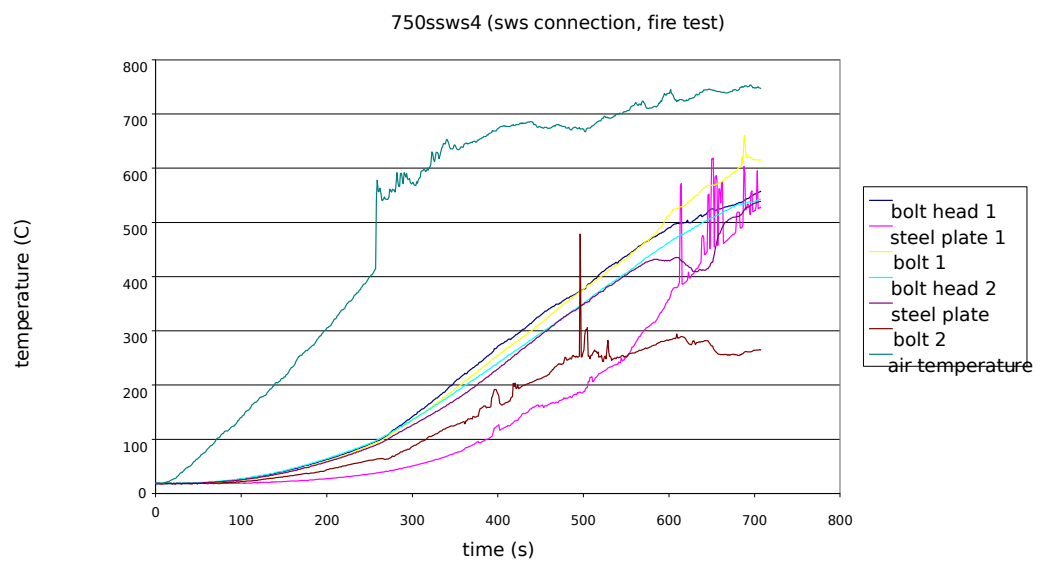
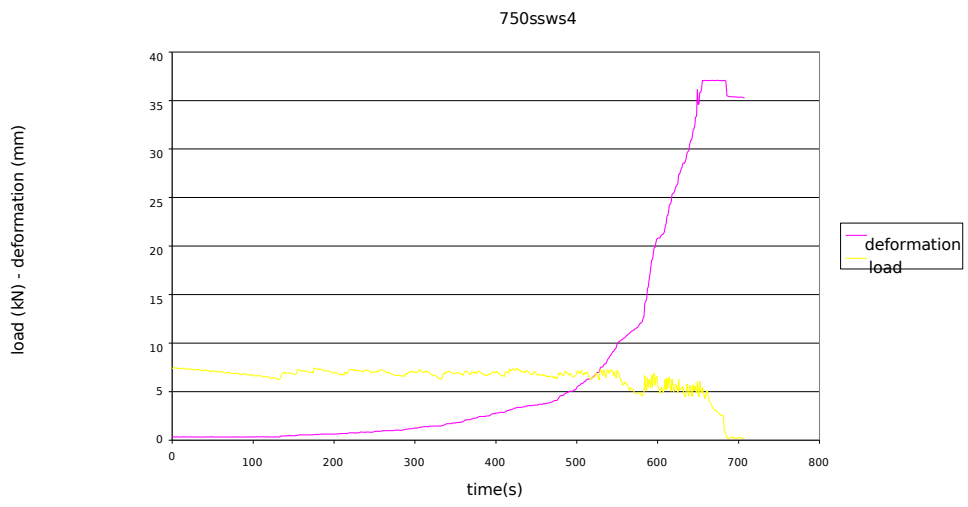


280 C heating test, 45 mm thickness, 280ssws4

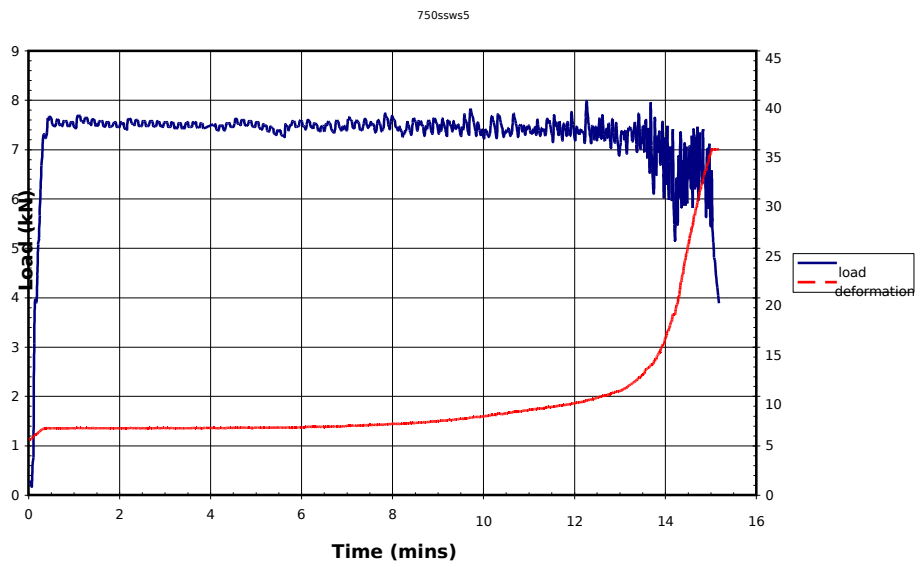


2 Fire test

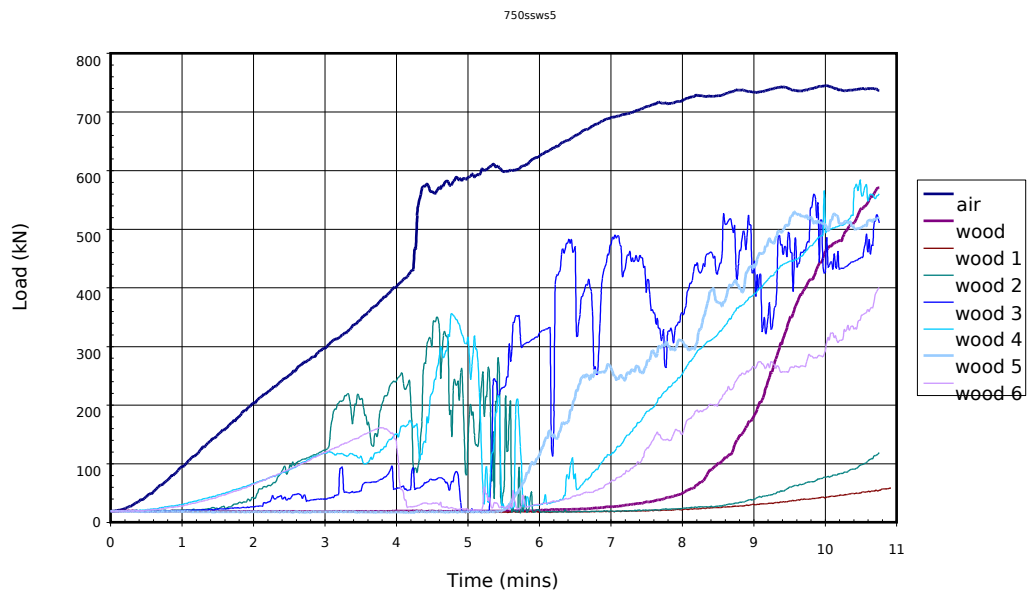
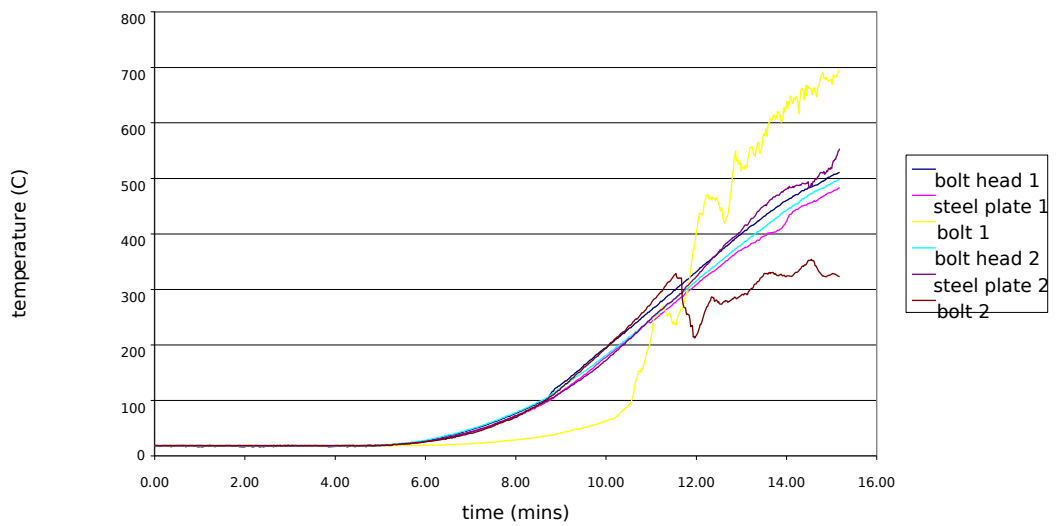
750ssws4: sws connection with one bolt



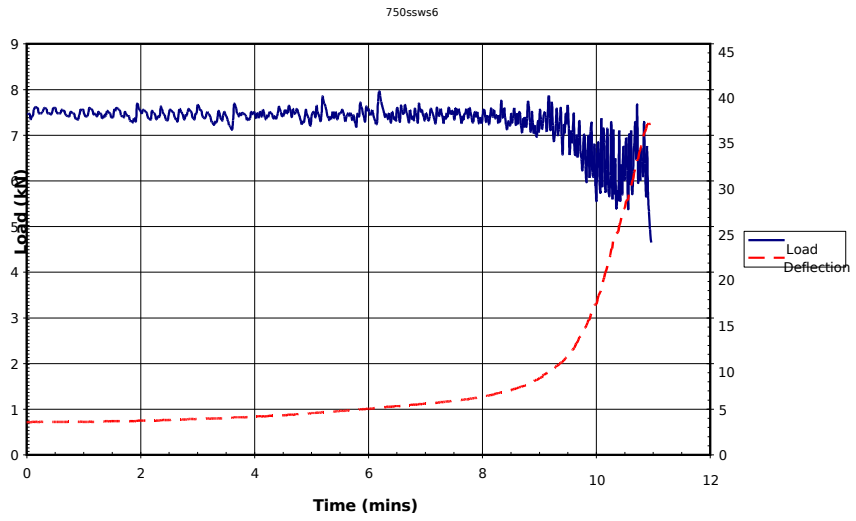
750ssws5: fire test, sws connection, one bolt.



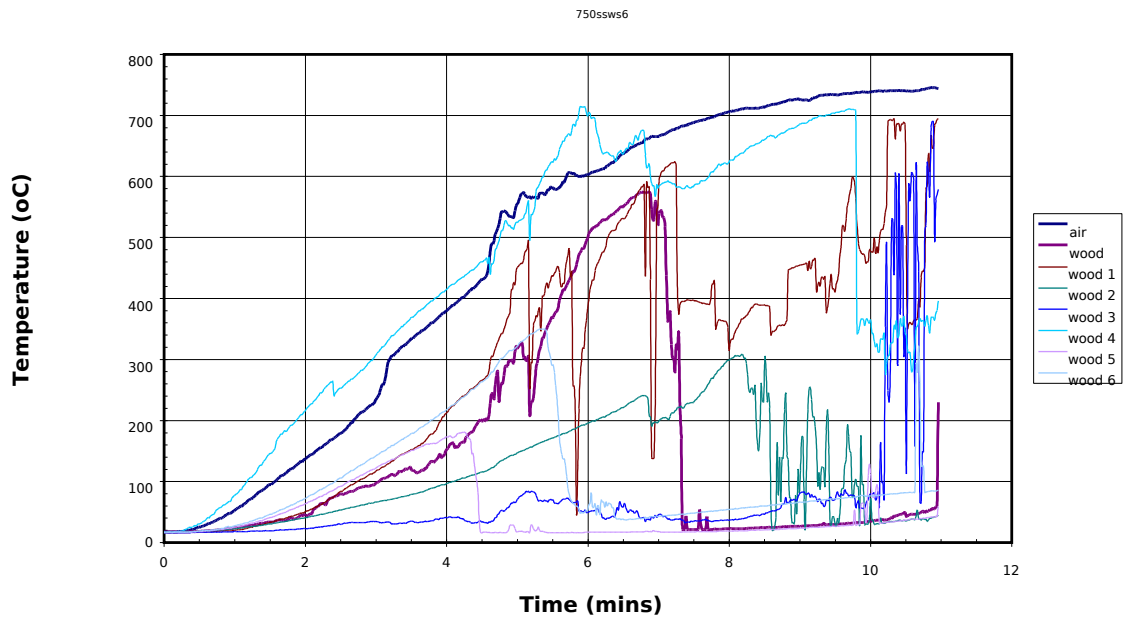
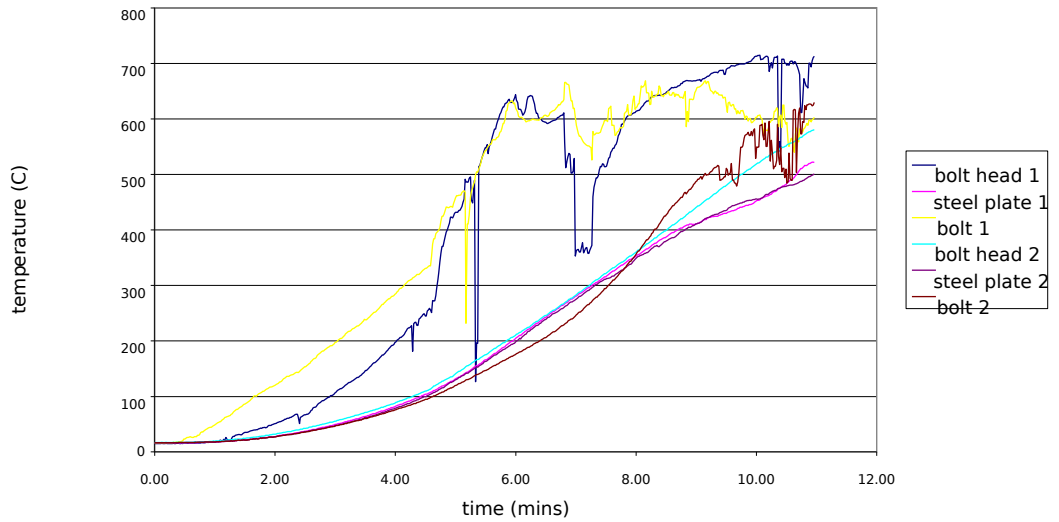
fire test, sws connection, 750ssws5



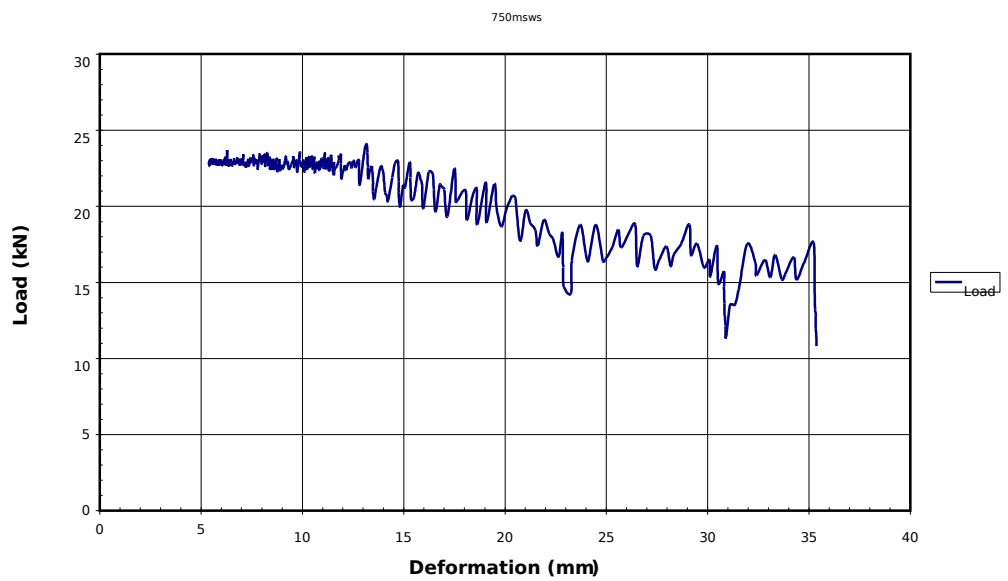
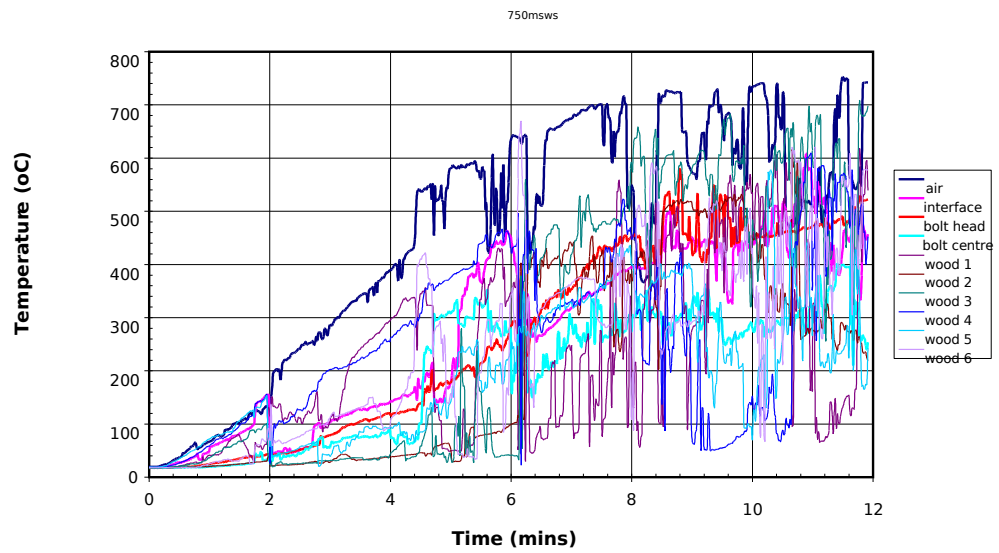
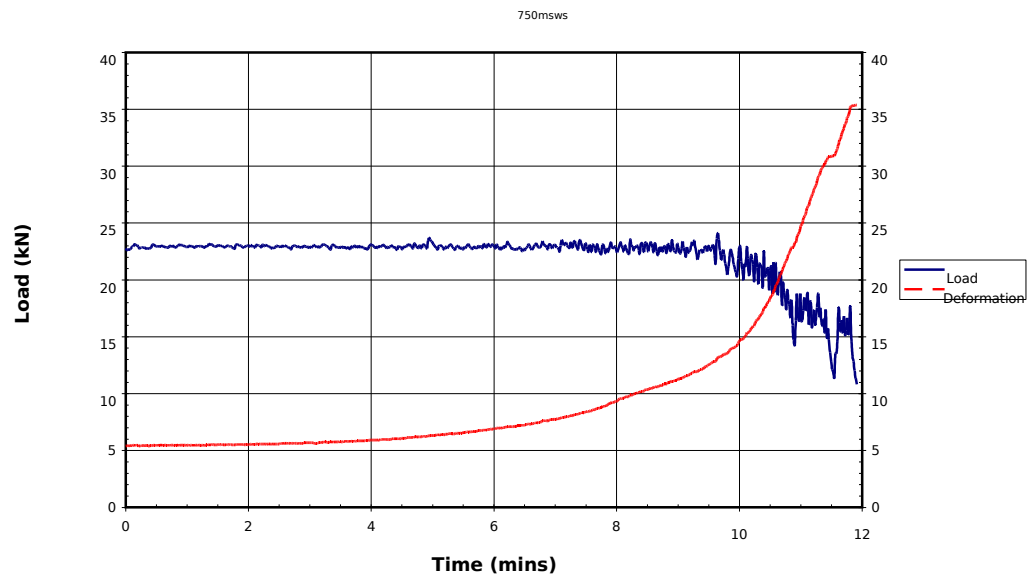
750ssws6: fire test, sws connection, one bolt.



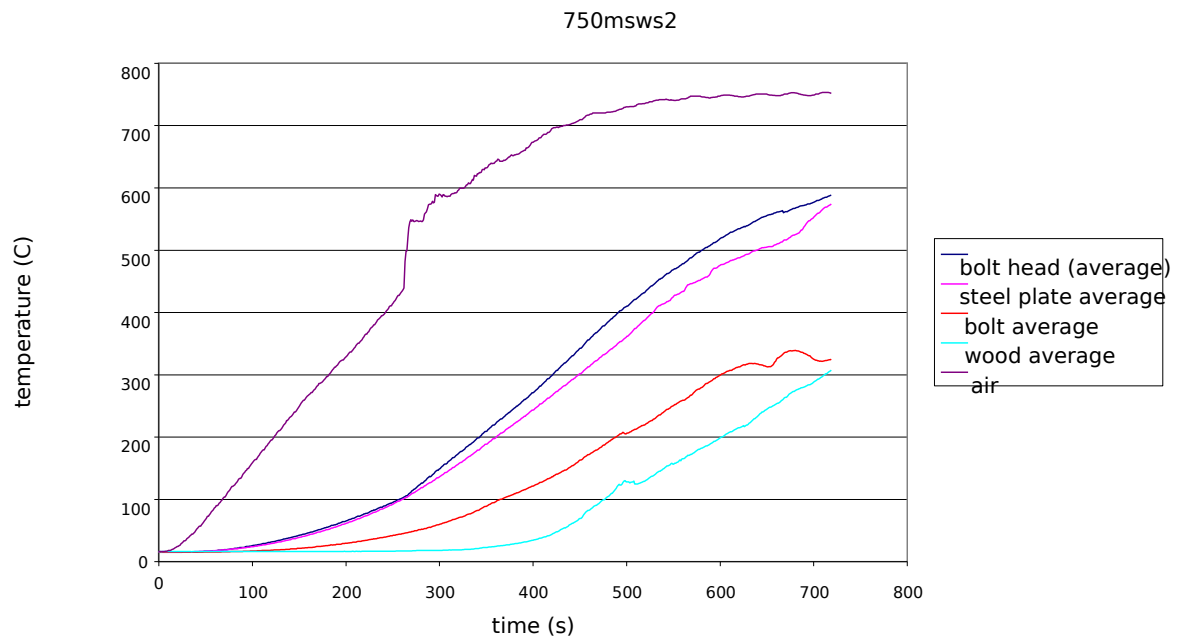
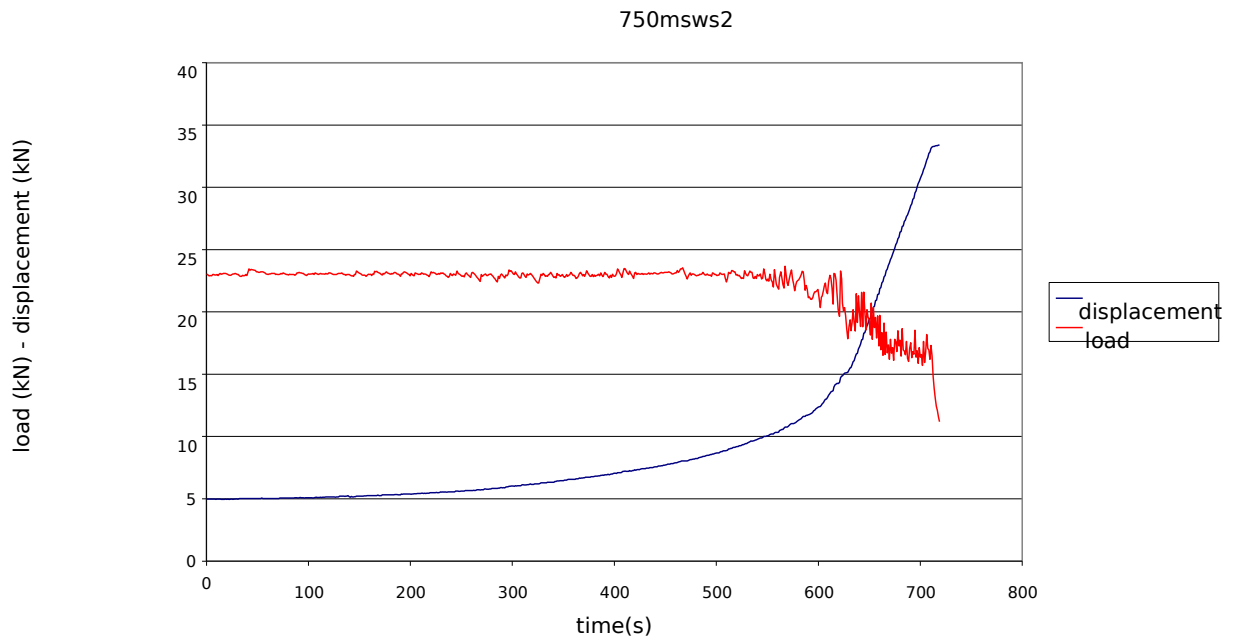
fire test, sws connection, 750ssws6



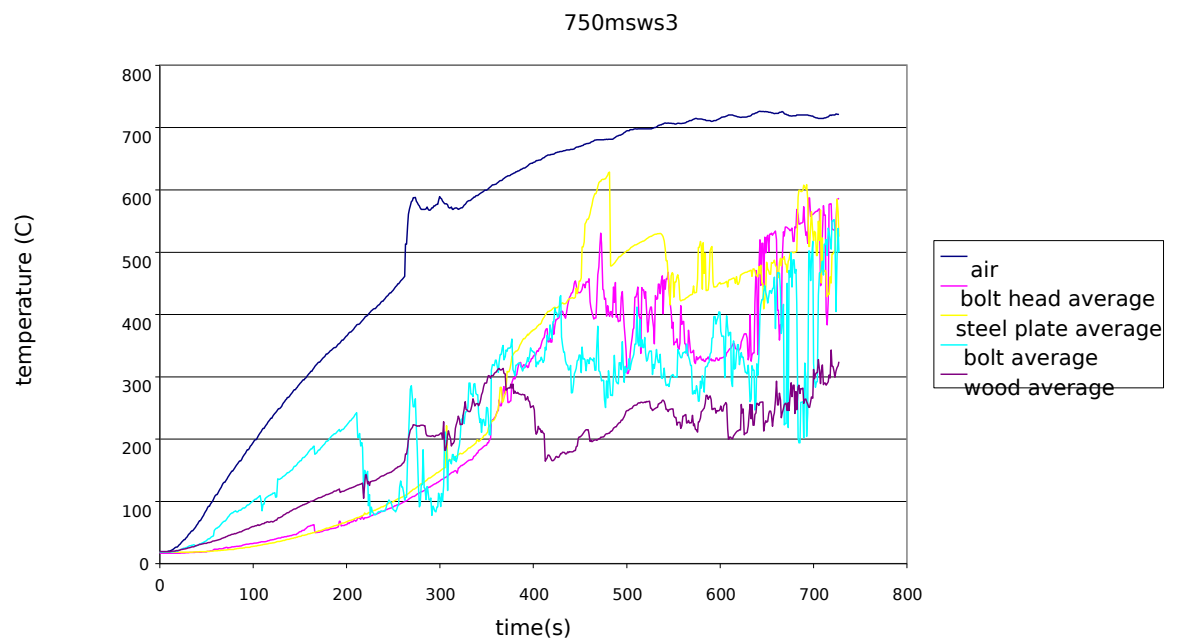
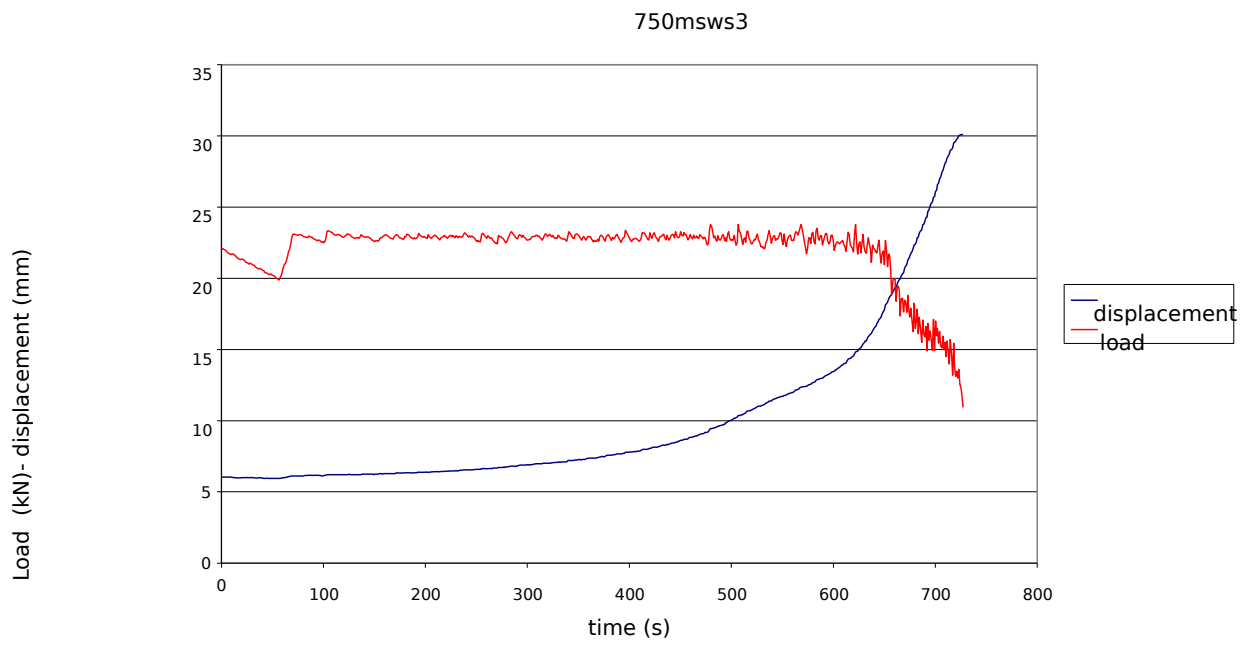
750msws1: fire test, sws connection, 4 bolts.



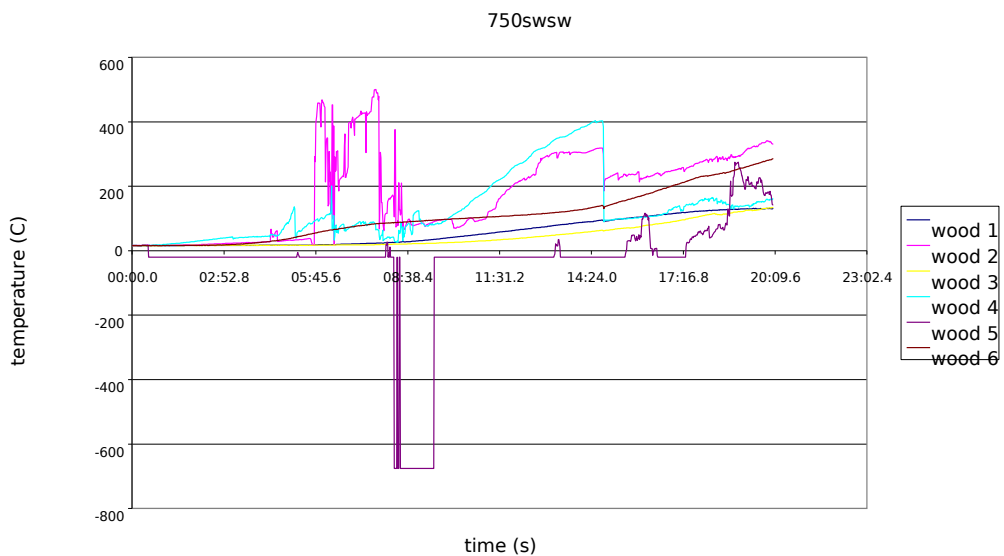
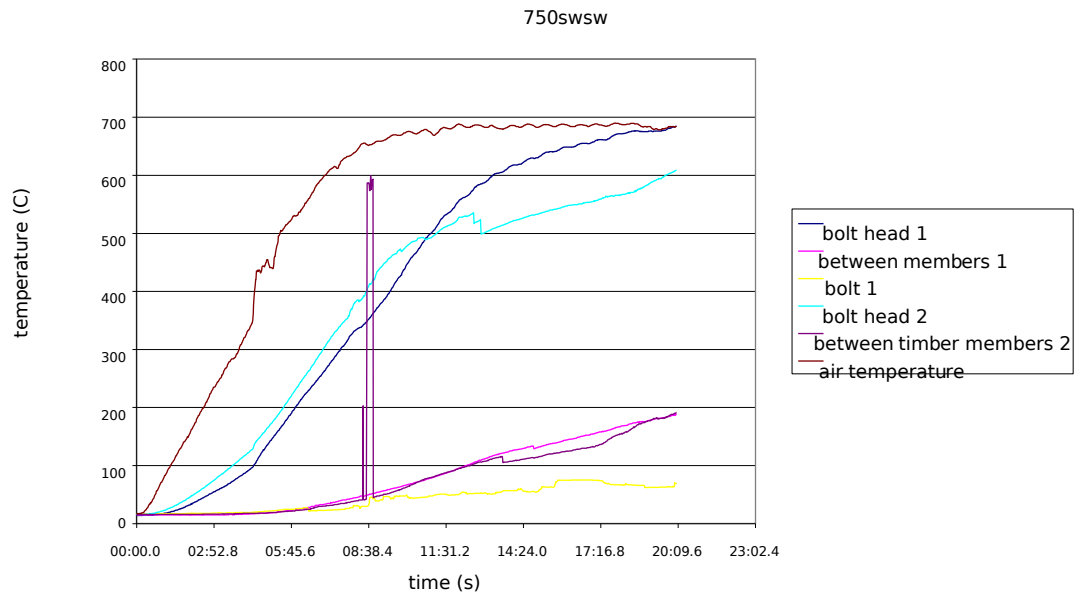
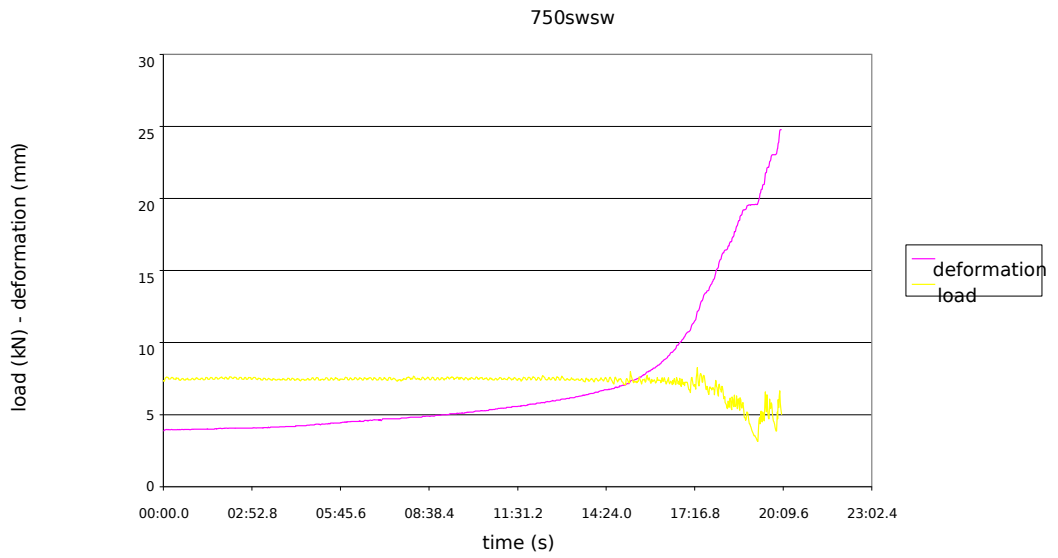
750msws2: fire test, sws connection, 4 bolts.



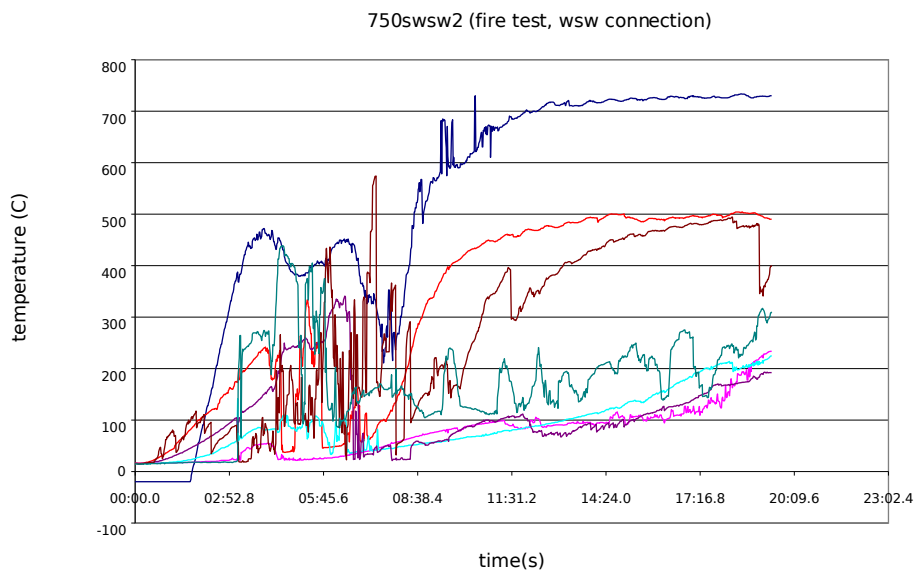
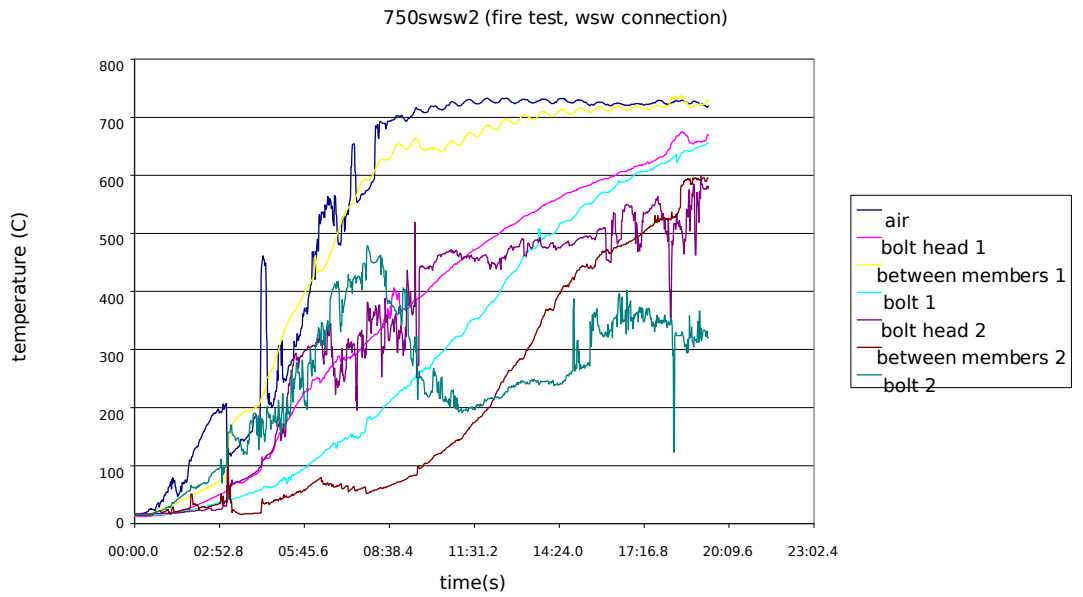
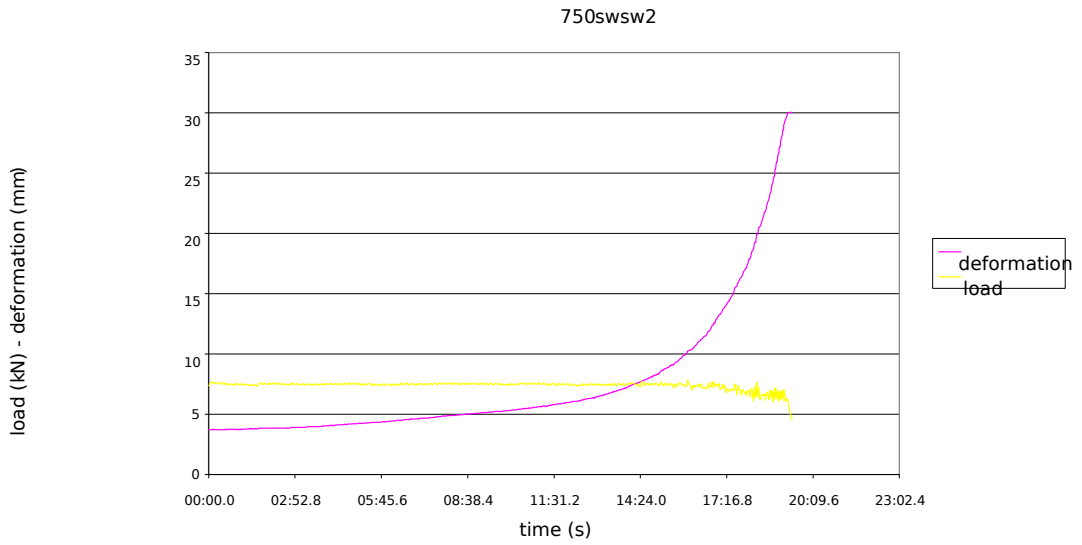
750msws3: sws connection, 4 bolts



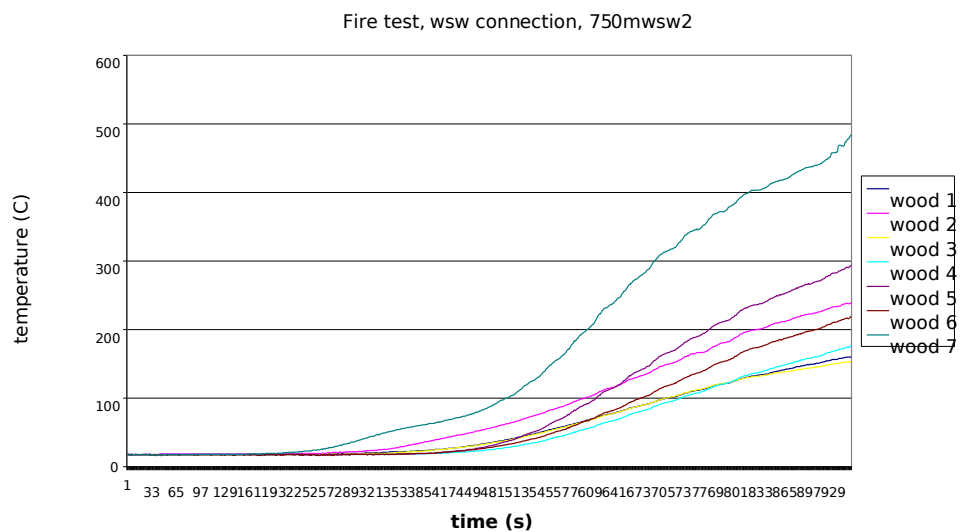
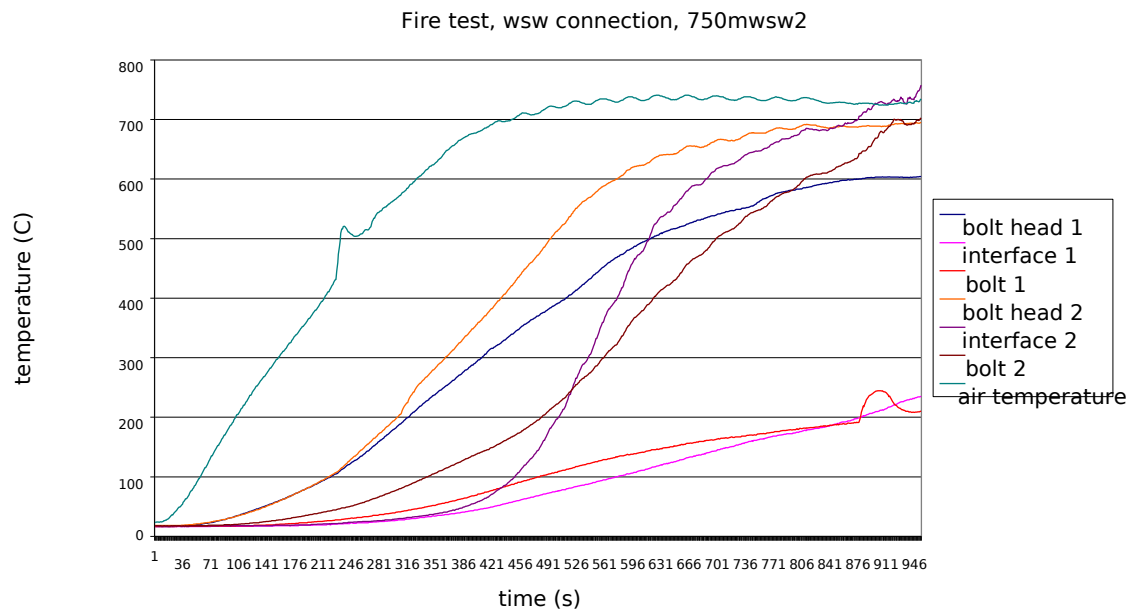
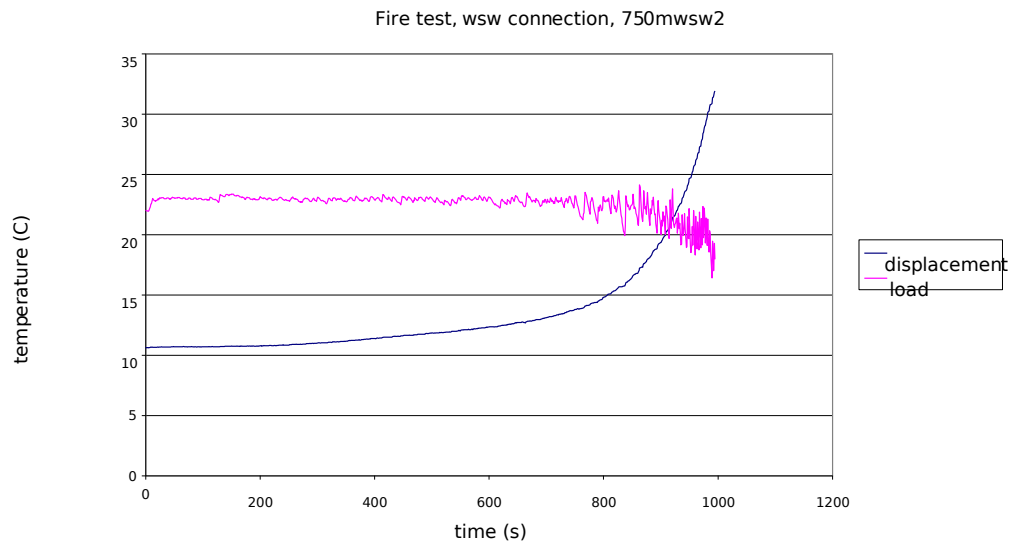
750swsw: wsw connection, one bolt



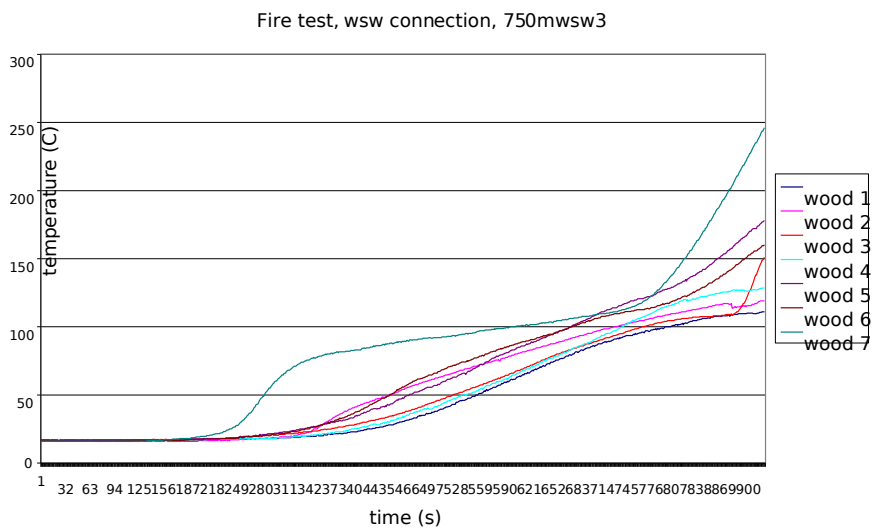
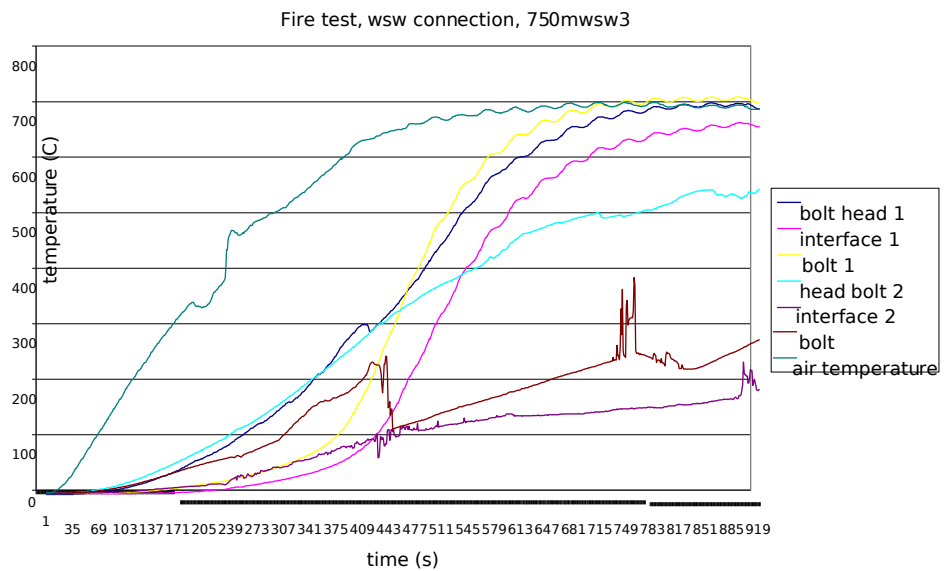
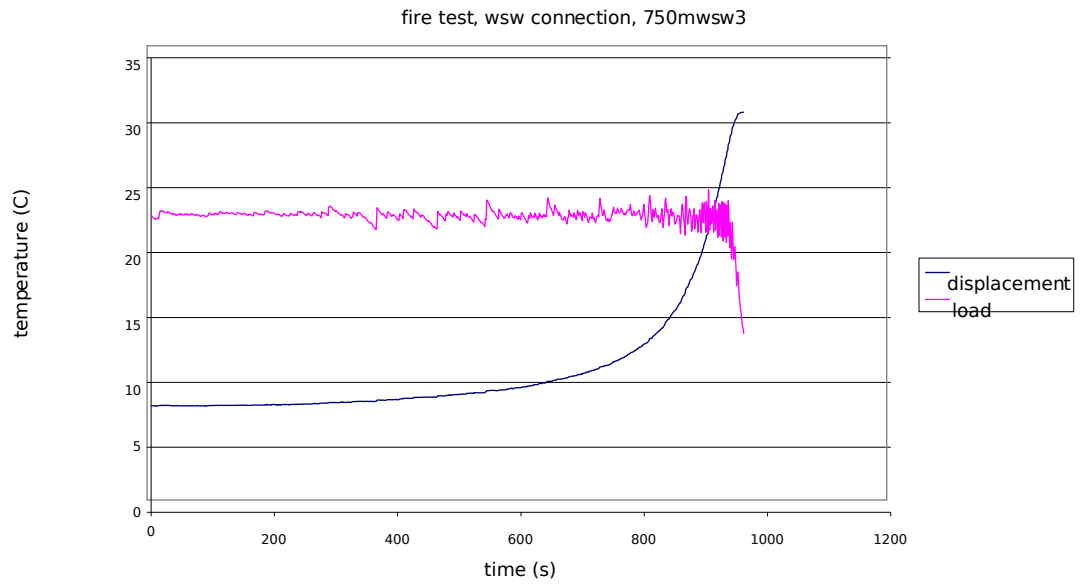
750swsw2: wsw connection, one bolt.



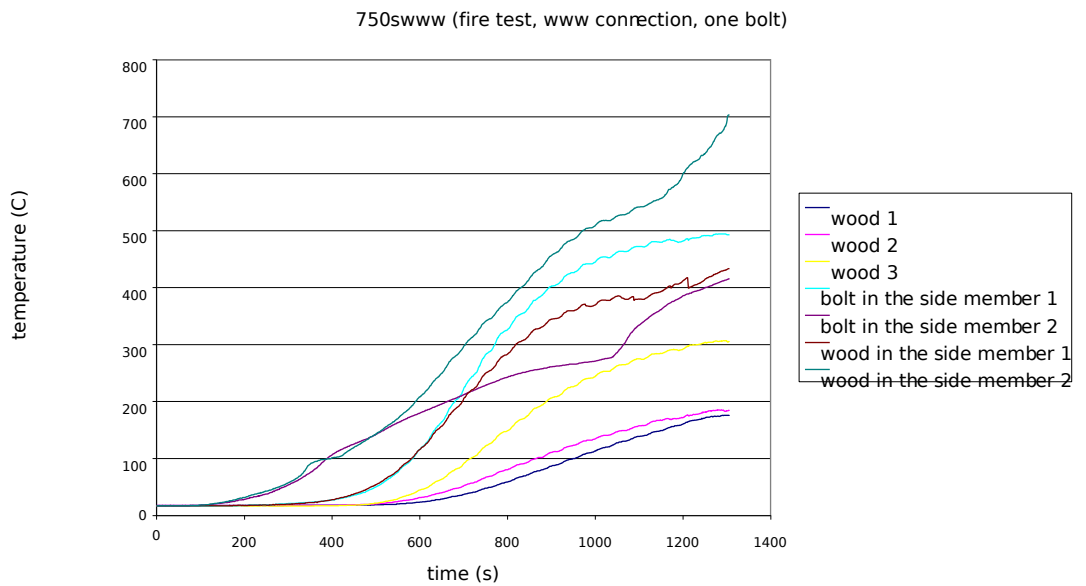
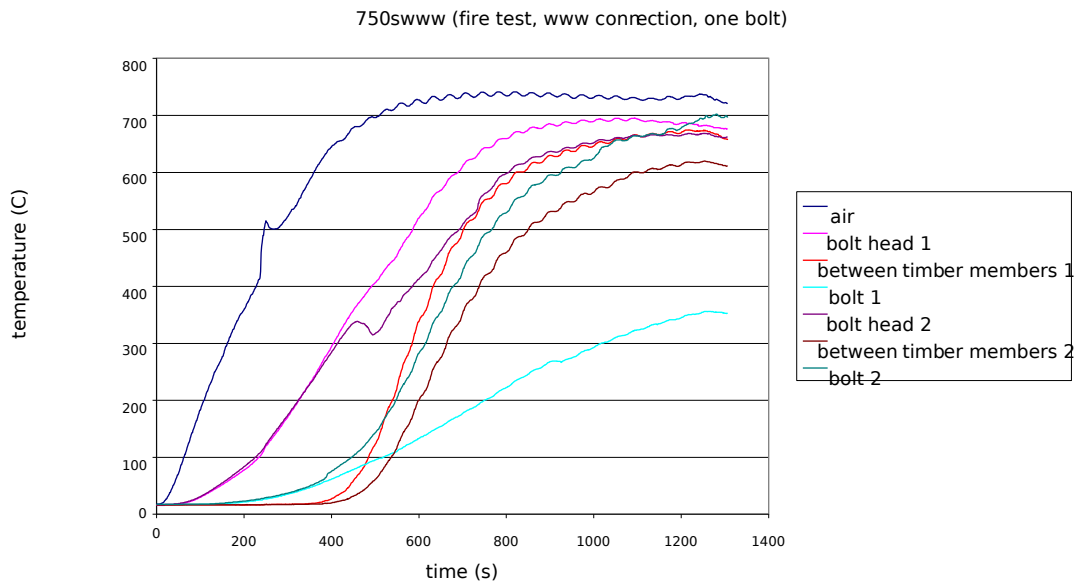
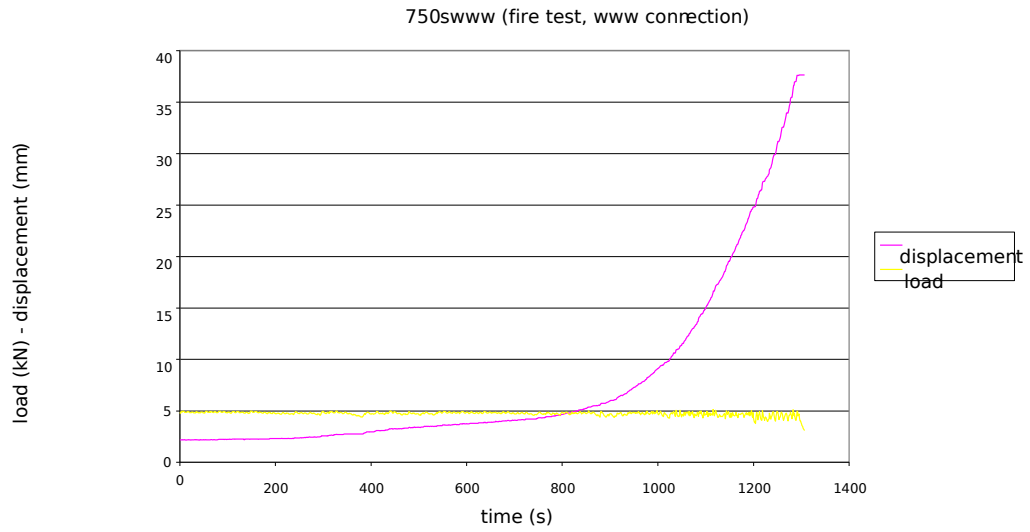
750mws2: invalidated results (problems with the furnace)
 750mws2: wsw connection with 4 bolts.



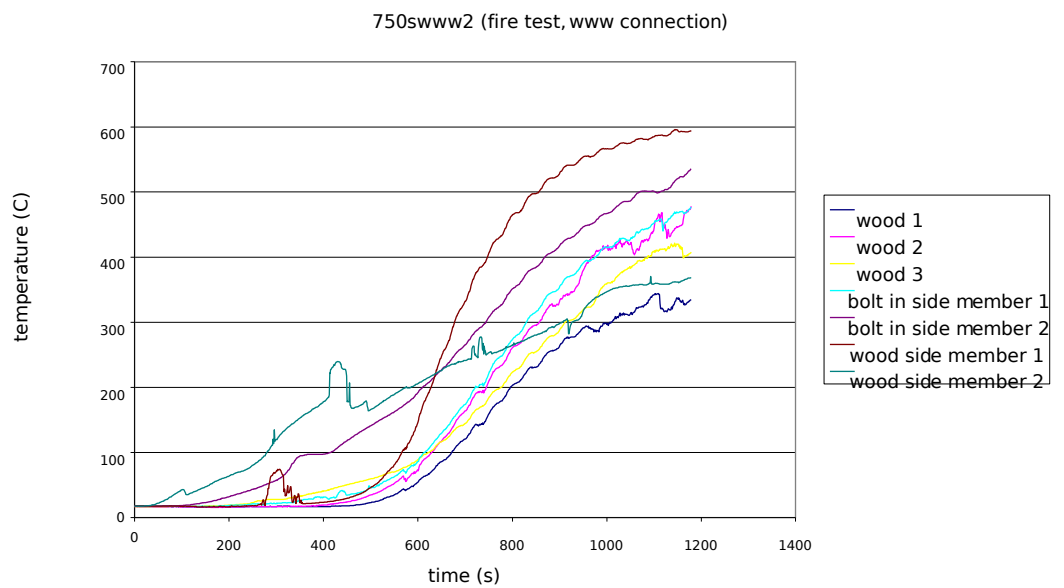
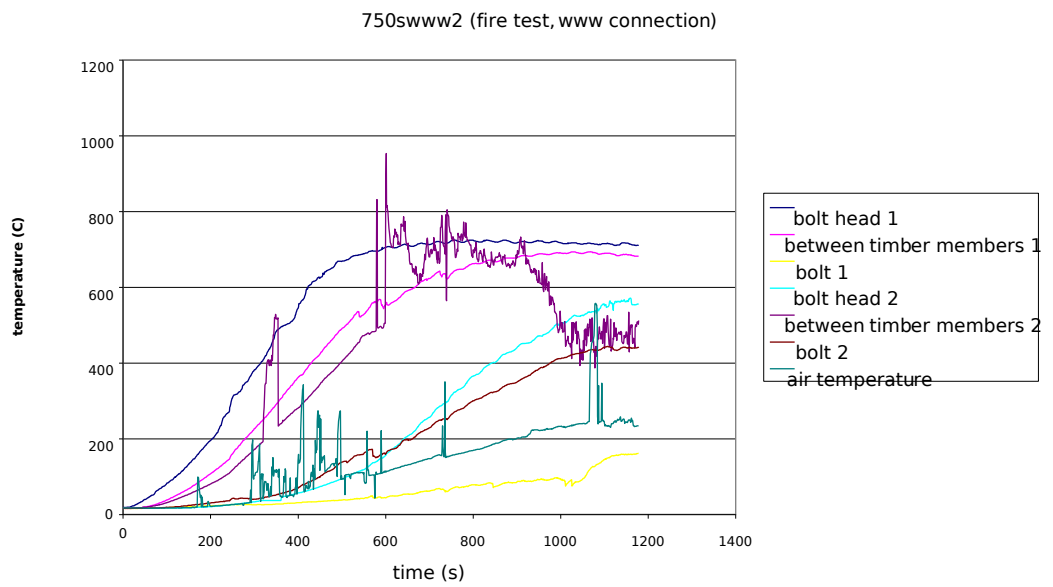
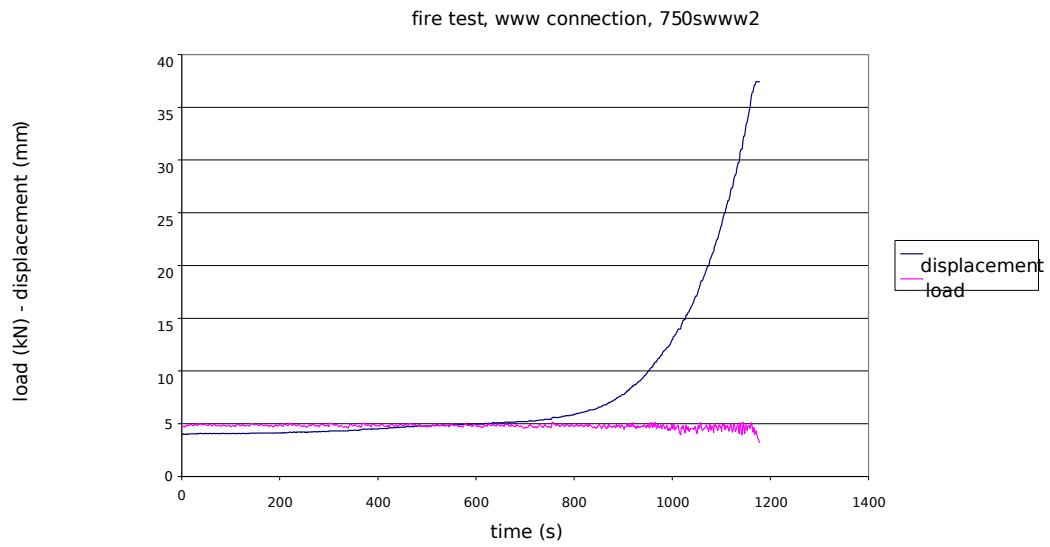
750mws3: wsw connection with 4 bolts.



750swww: www connection with one bolt.

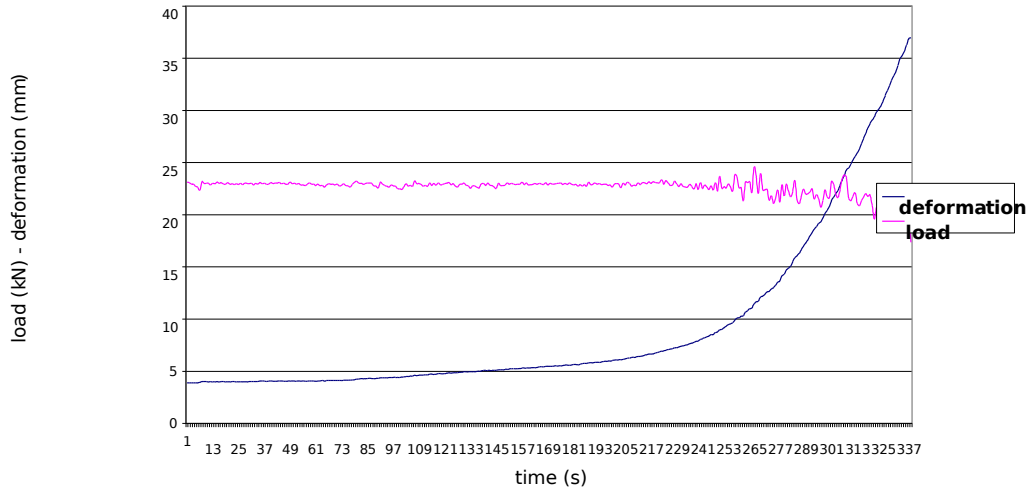


750swww2: www connection with one bolt.

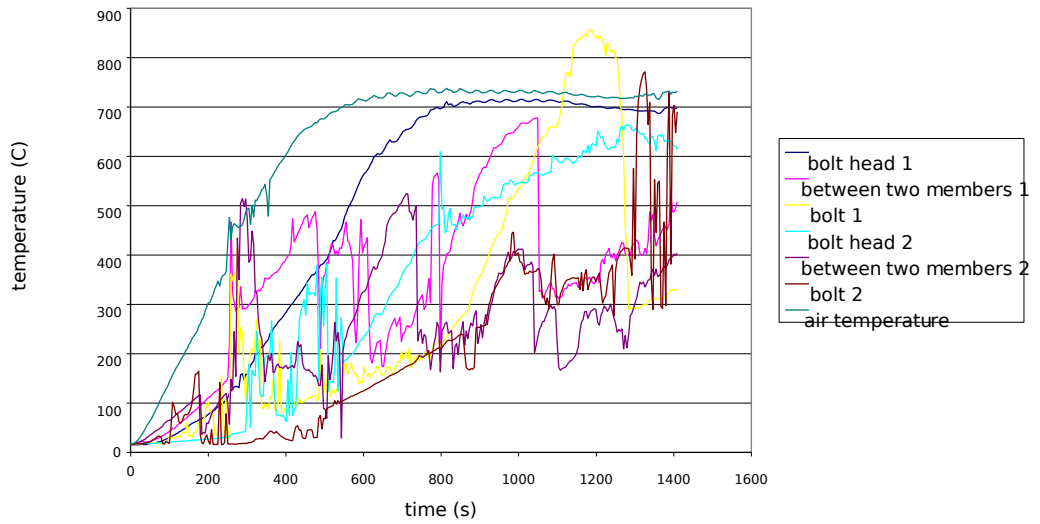


750mwww: www connection with 5 bolts

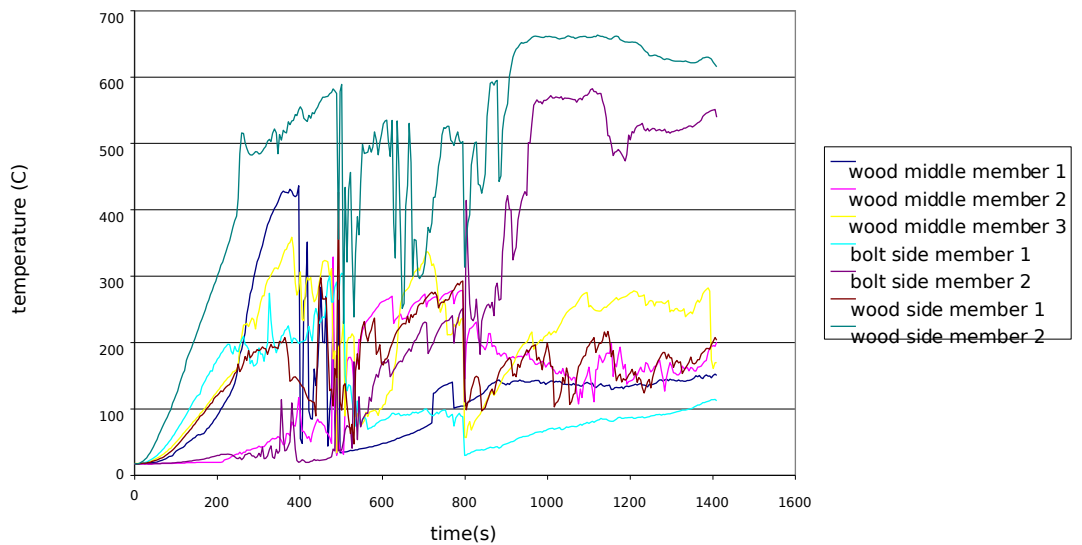
Fire test, www connection, 750mwww



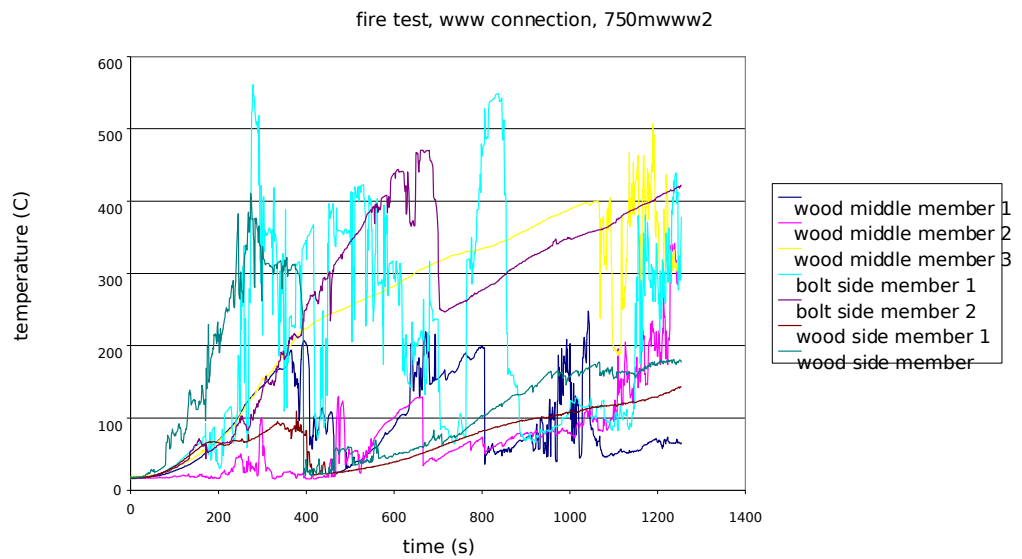
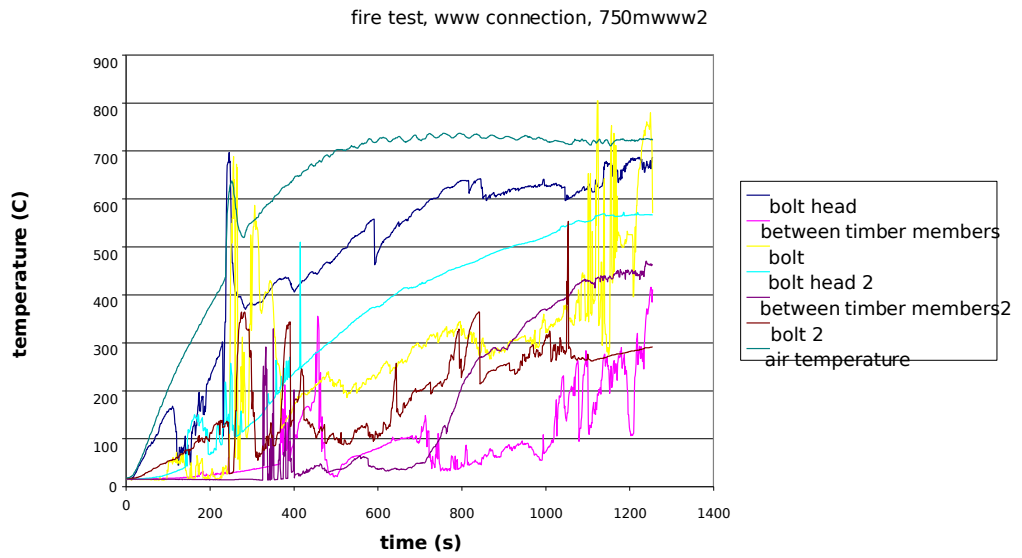
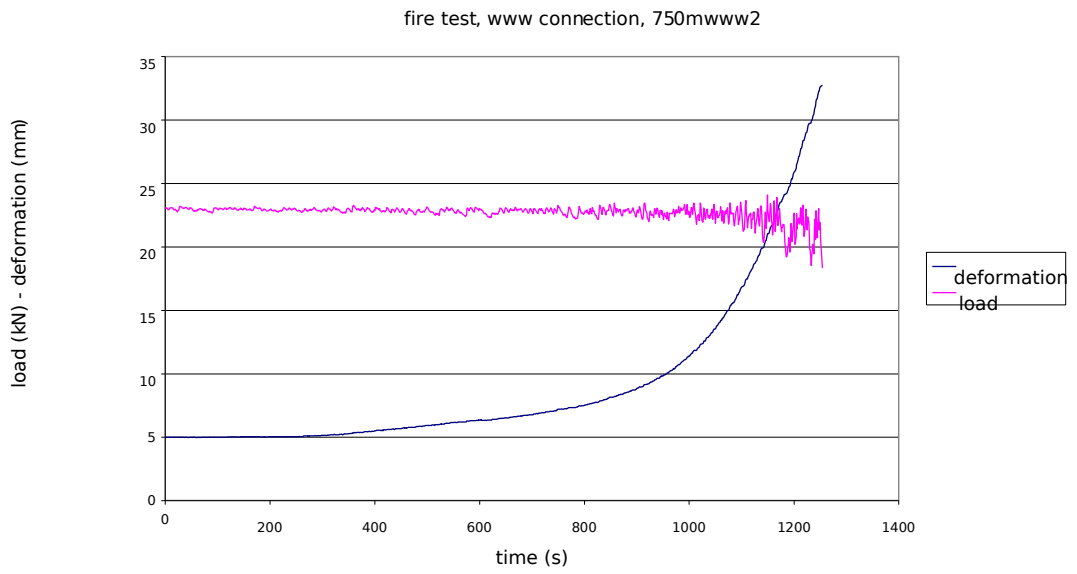
Fire test, www connection, 750mwww



fire test, www connection, 750mwww



750mwww2



3 Pictures of some connections:



www connection with 5 bolts after a fire test



Sws connection with one bolt after a fire test



Wsw connection with one bolt after a fire test

4 Pictures of modes of failure:



Sws connection with four bolts after a fire test once the char has been removed. The mode of failure is mode j (the timber is crushed)



www connection with 5 bolts after a fire test. The timber on the side members is crushed so this is mode g.



100 C heating test on a sws connection made of 45 mm timber. The bolts are straight so the mode of failure is mode j.



Ambient test on a sws connection with 63 mm timber and 12 mm steel plates on the sides. The bolts seems to be bent on mode m.

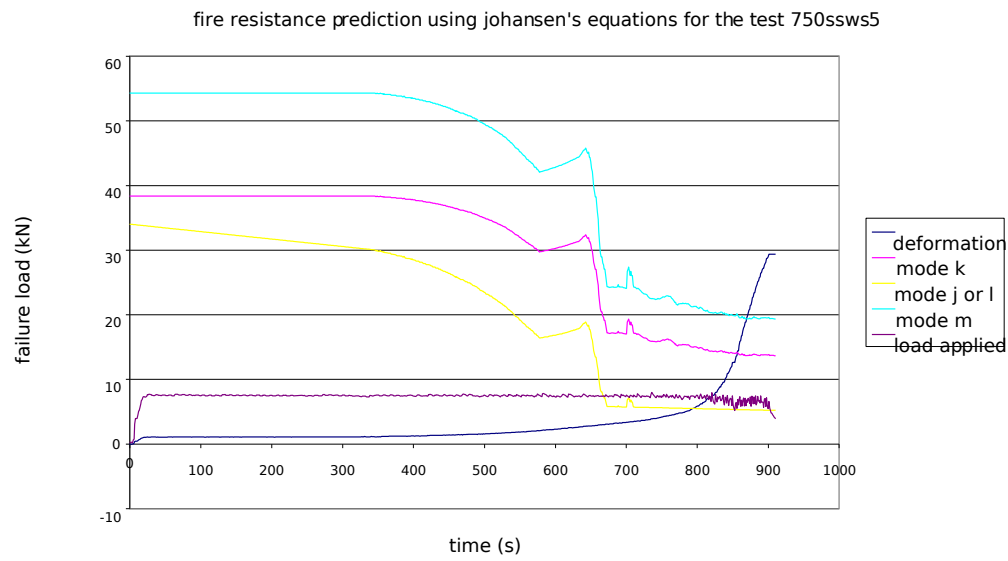
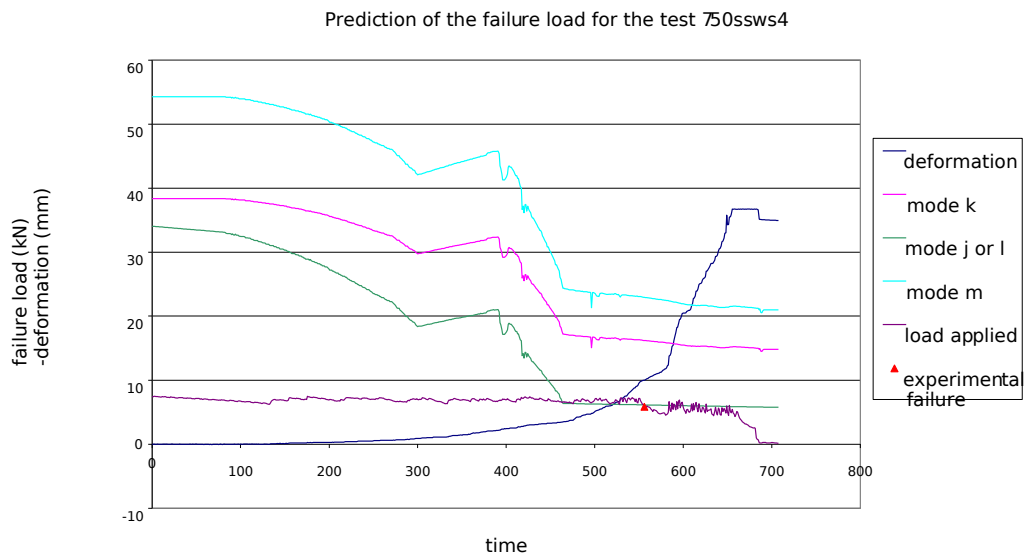


Ambient test on a sws connection with 45 mm timber and 12 mm steel plates on the sides. The bolts are straight so the failure is mode.

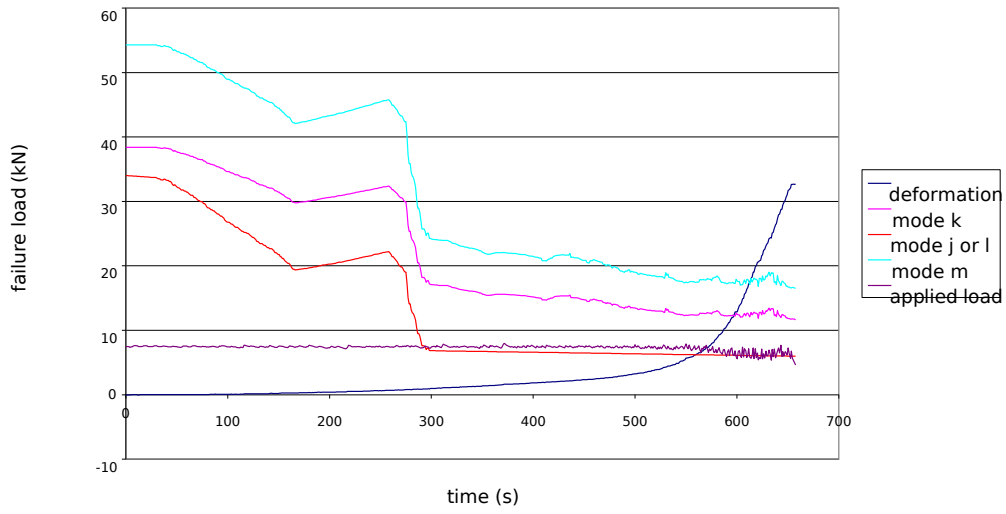


280 C heating test on a sws connection with 63 mm timber. The wood started charring on the sides. The bolts are straight so this is mode j.

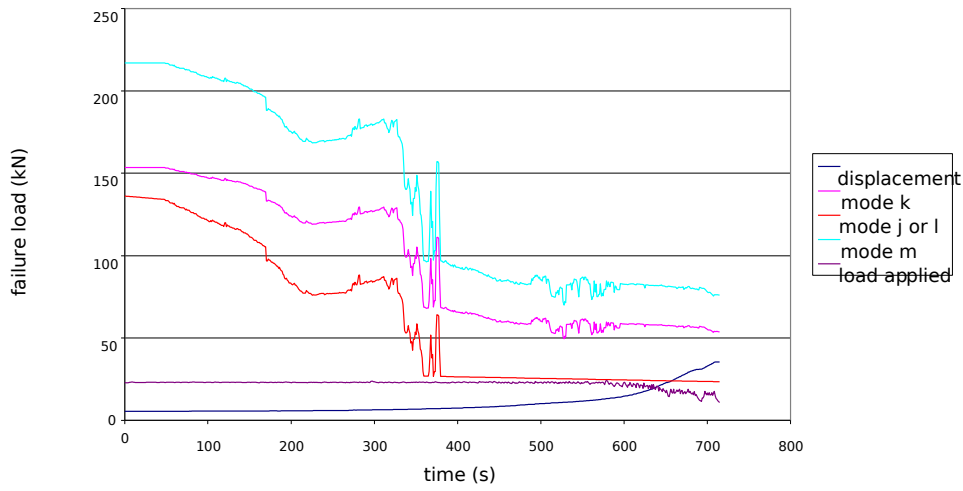
5 Prediction of time to failure using Johansen's equation with the results from the tests:



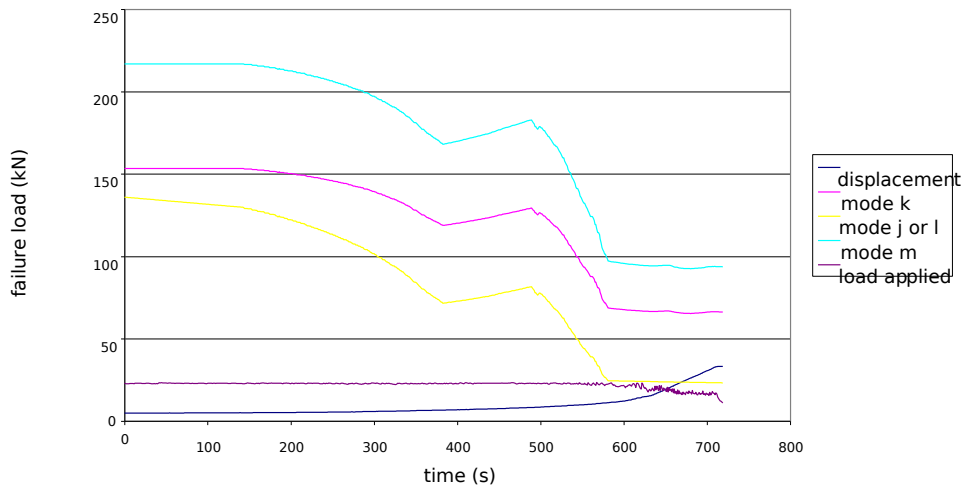
prediction of fire resistance using johansen's equations for the test 750ssws6



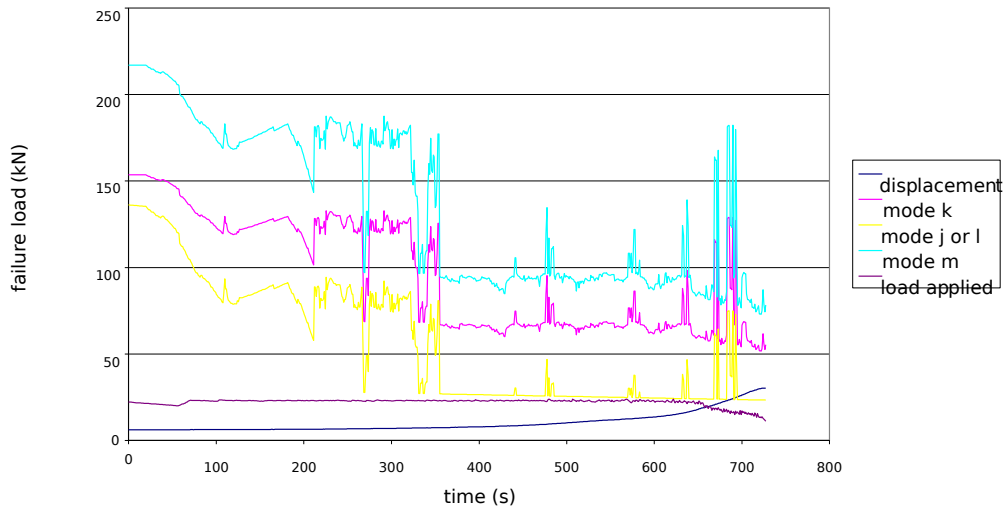
prediction of the fire resistance for the test 750msws1, using Johansen's equations



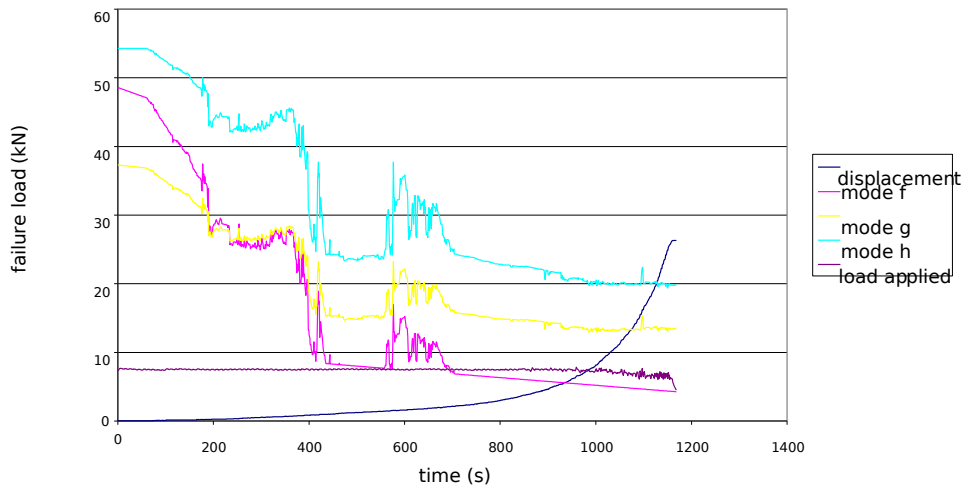
prediction of the fire resistance for the 750msws2 test, using Johansen's equations



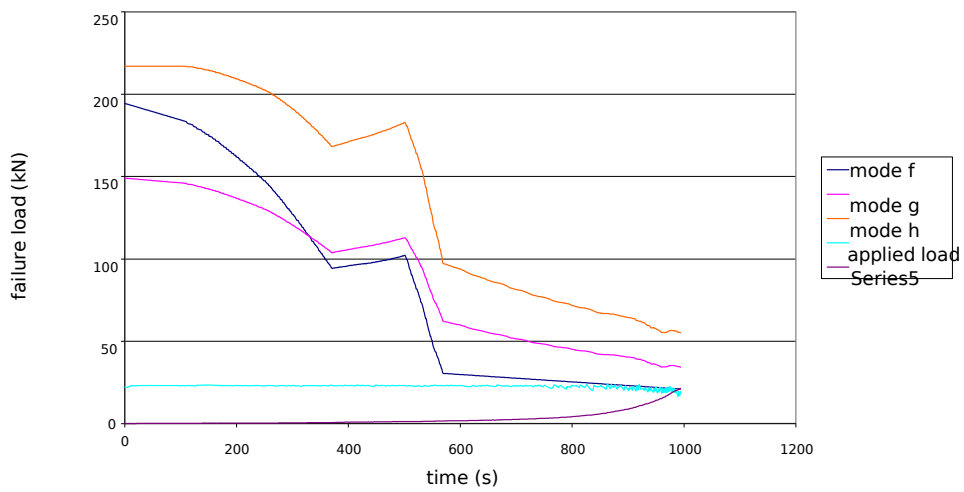
prediction of the fire resistance of the 750msws3 test, using johansen's equations



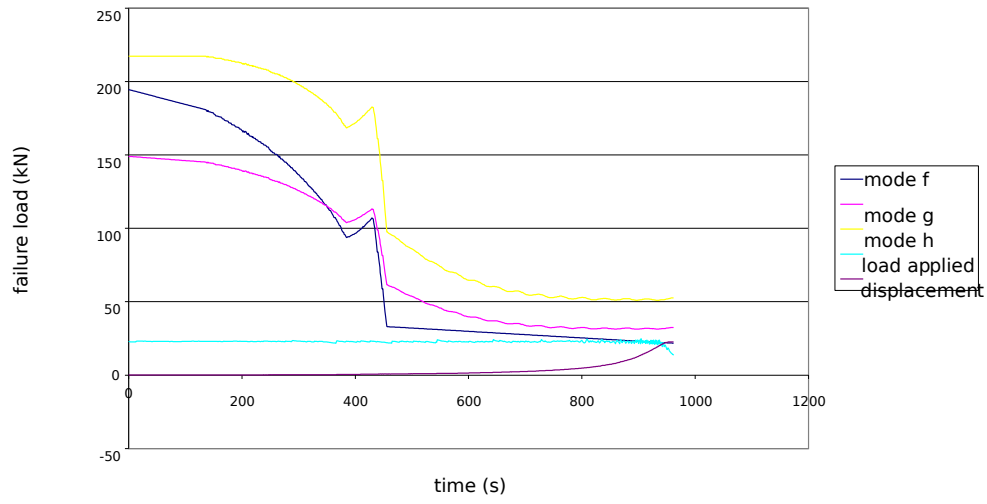
prediction of the fire resistance of the 750msw2 test, using johansen's equations



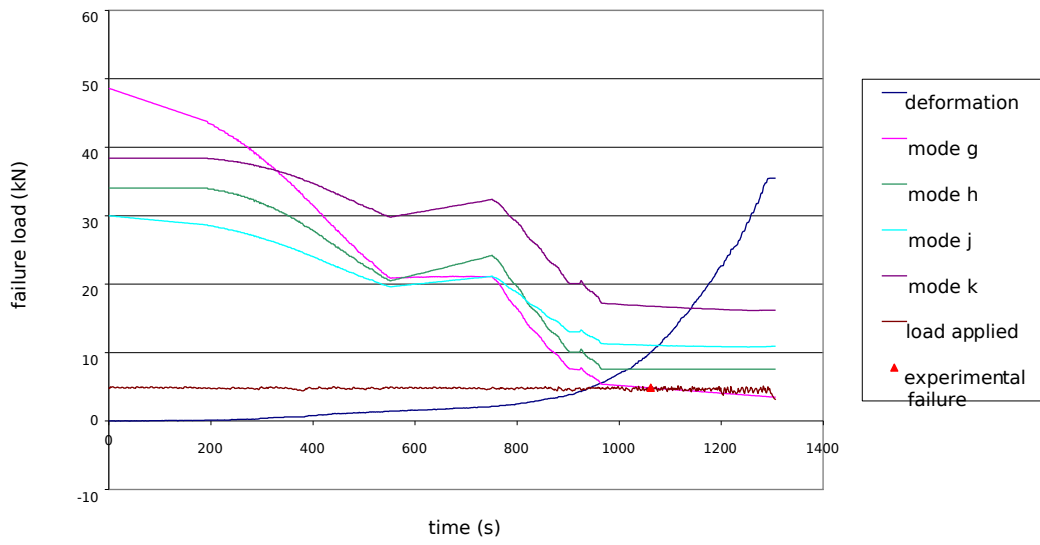
prediction of the time to failure of the test750msw2 using Johansen's equation



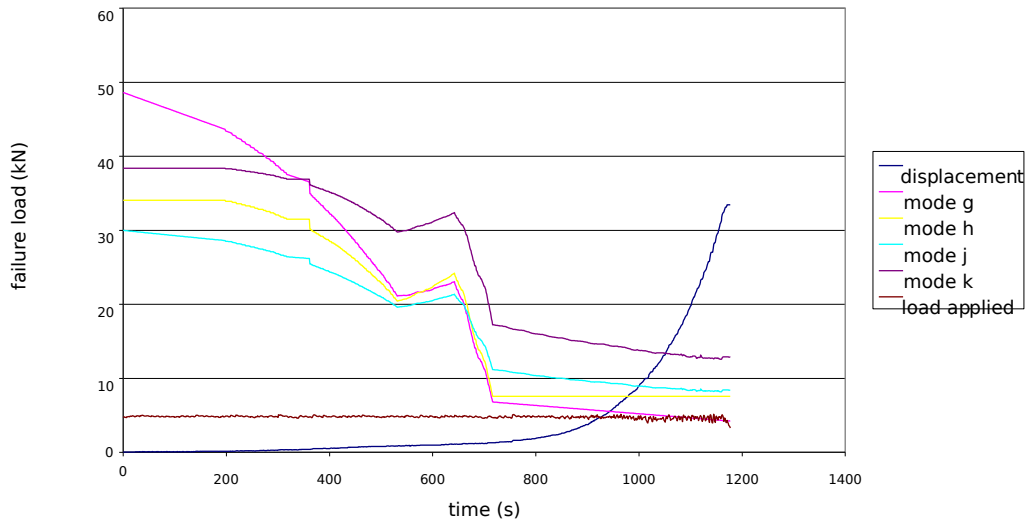
prediction of the time to failure for the test 750mws3



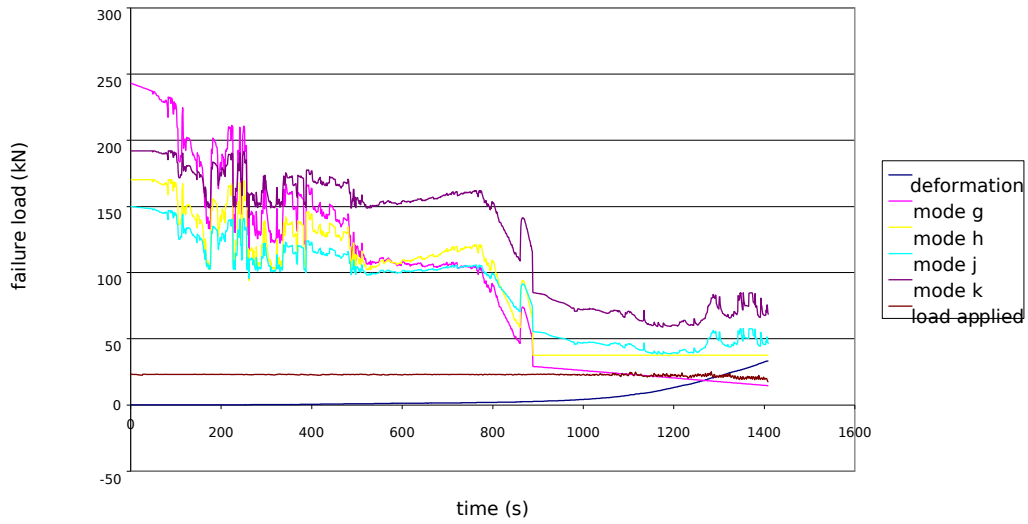
prediction of the failure load of the test 750swww



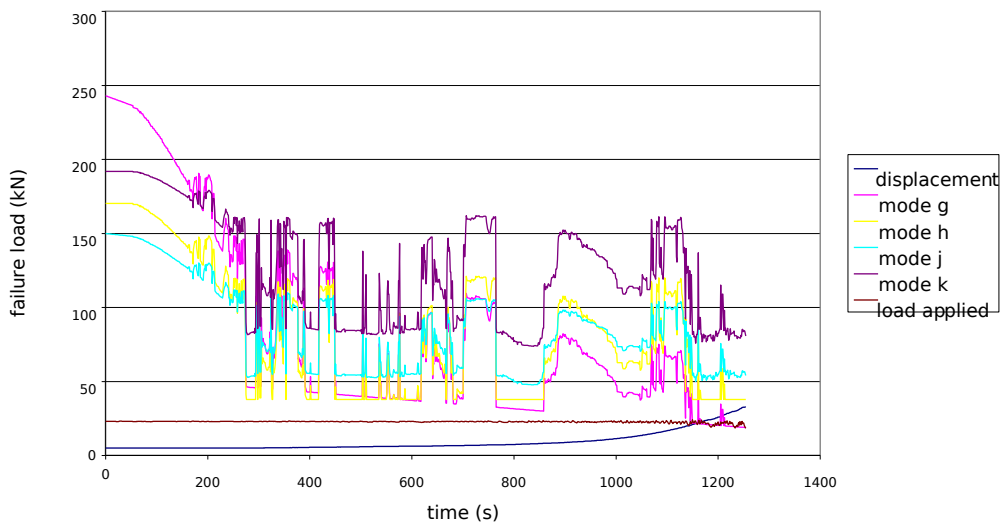
prediction of the fire resistance using johansen's equation for the test 750swww2



prediction of the fire resistance of the test 750mwww1, using johansen's equations

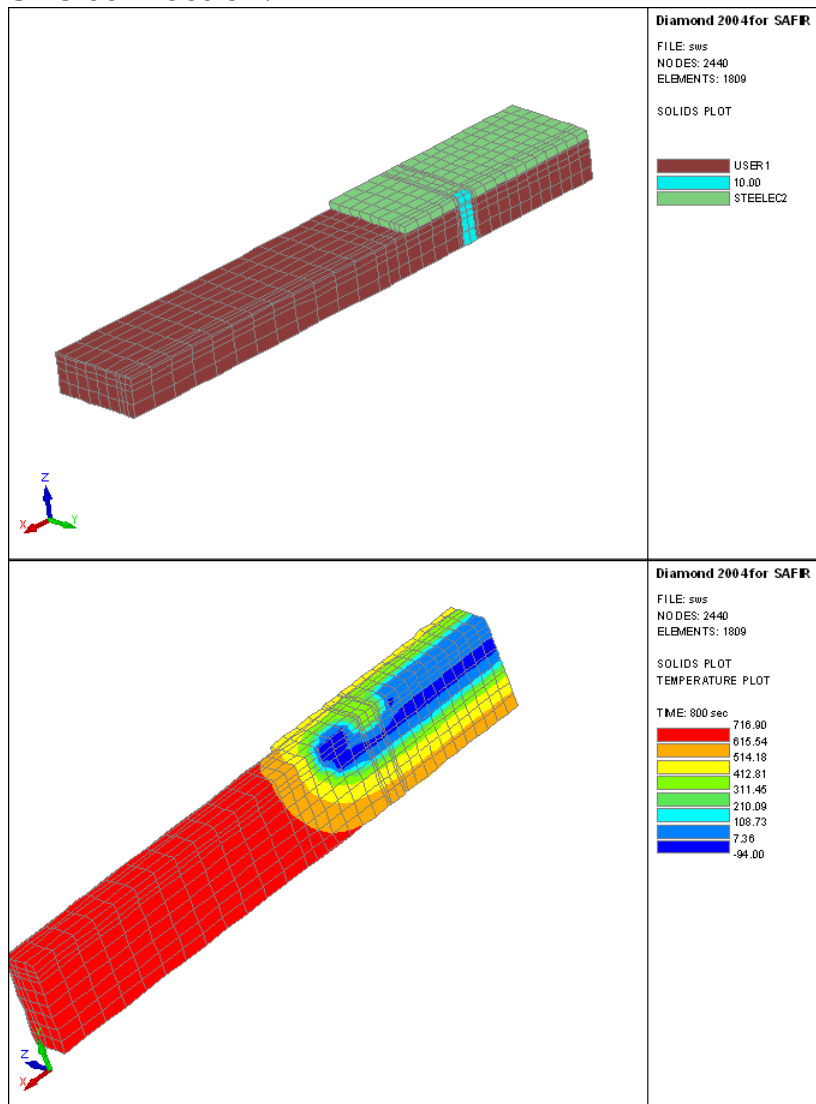


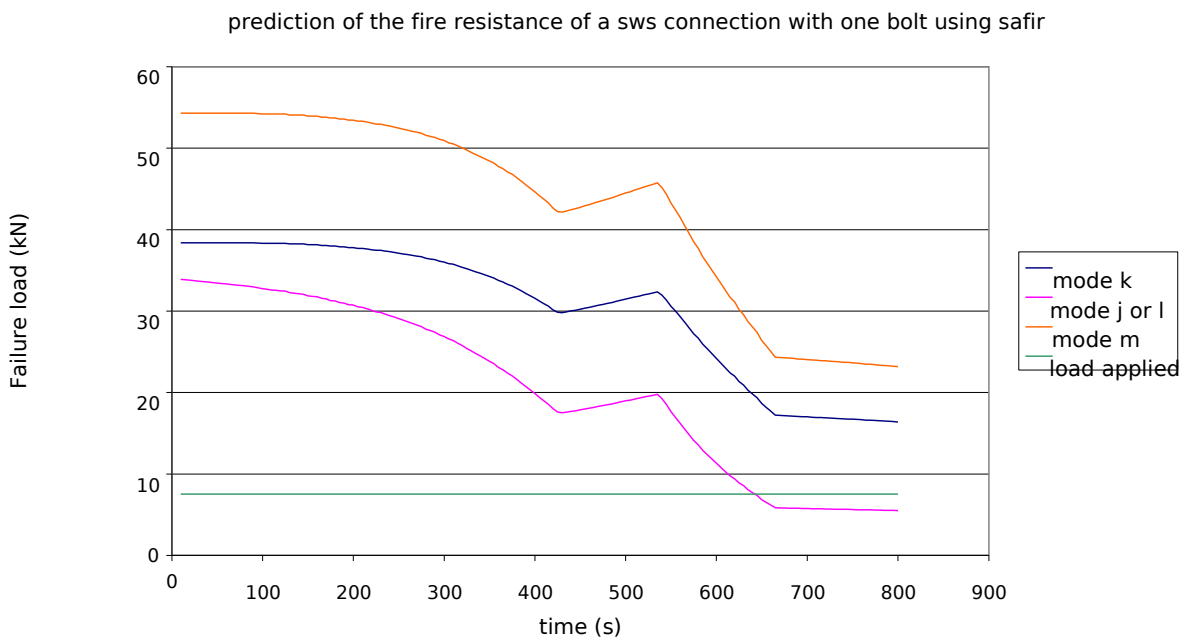
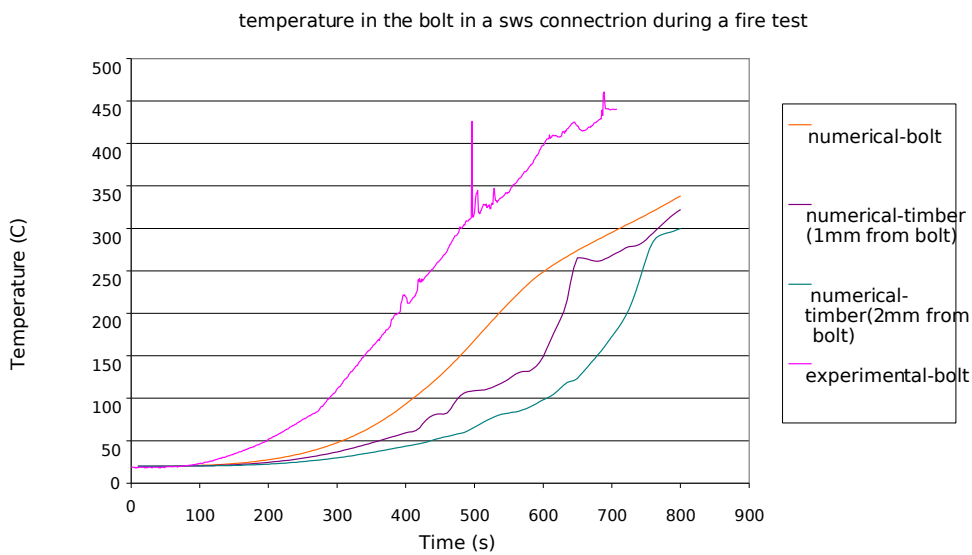
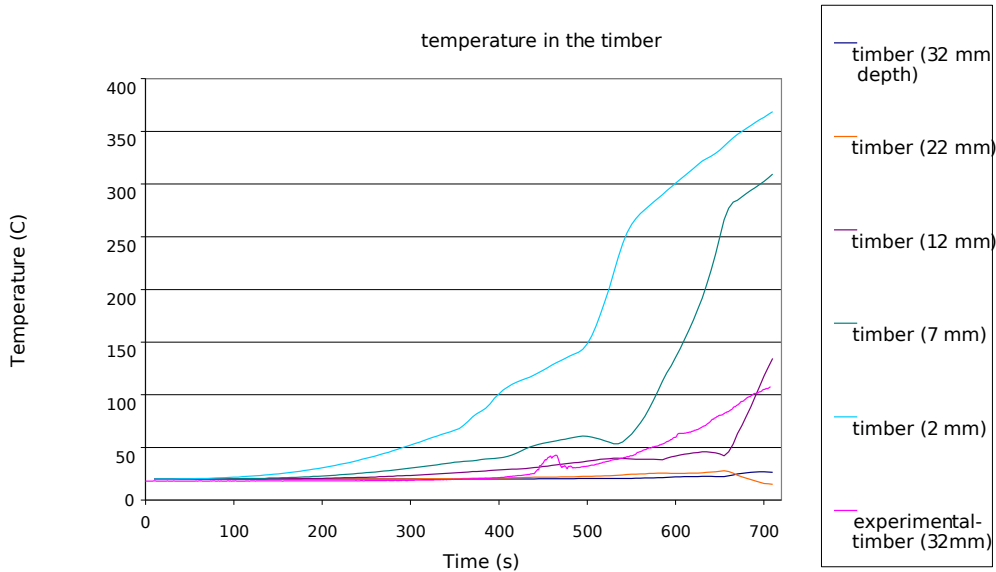
prediction of the failure for the test 750mwww2, using johansen's equations



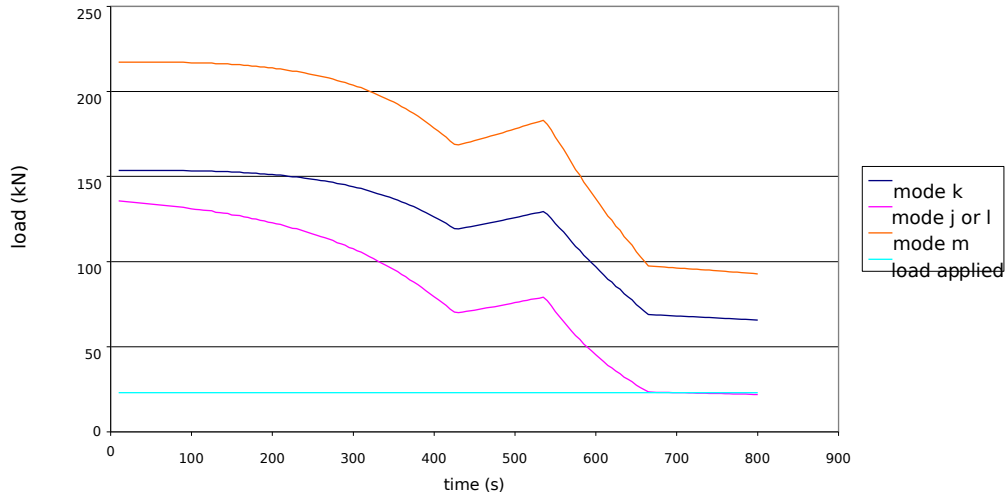
6 Safir results

Sws connection:

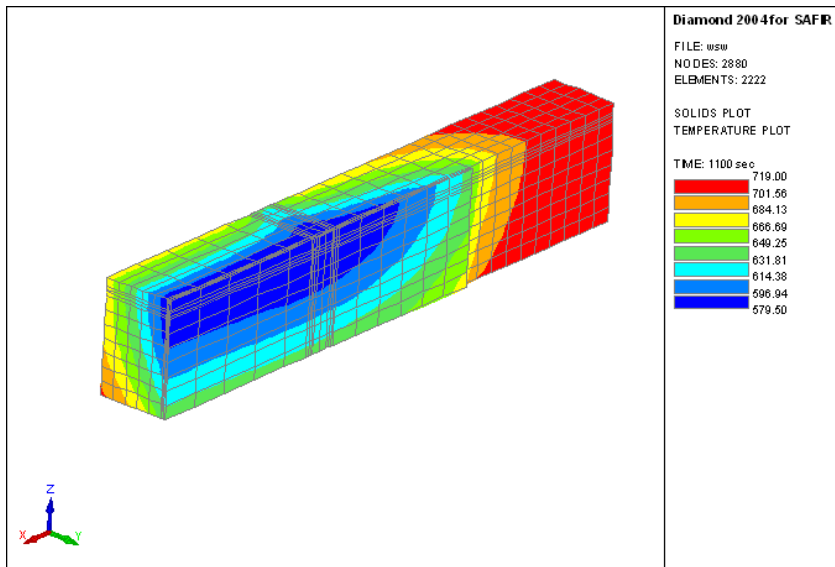
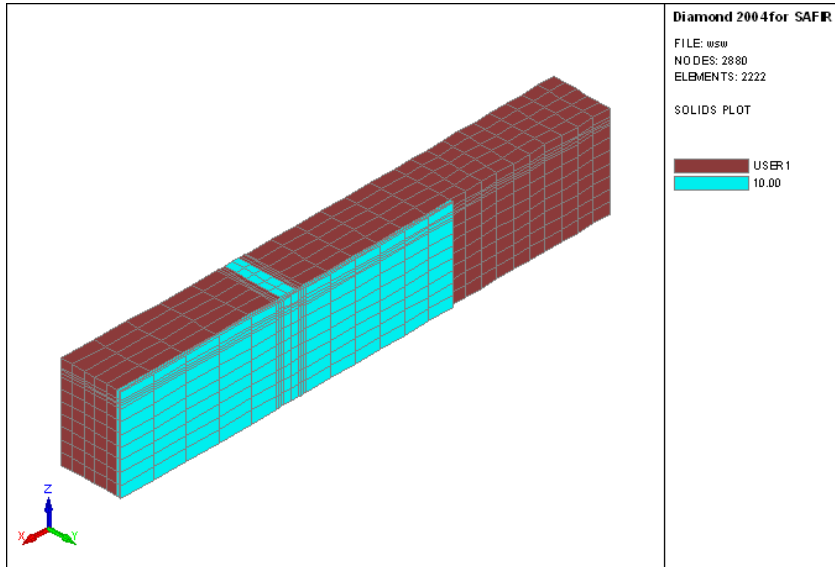




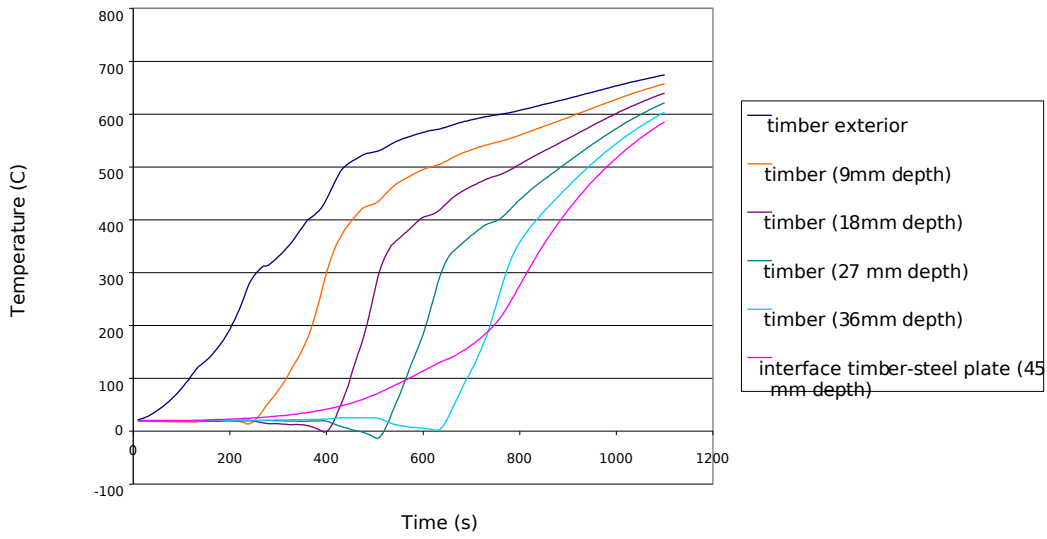
Prediction of the failure load of a sws connection with 4 bolts using the results of safir in Johansen's equation



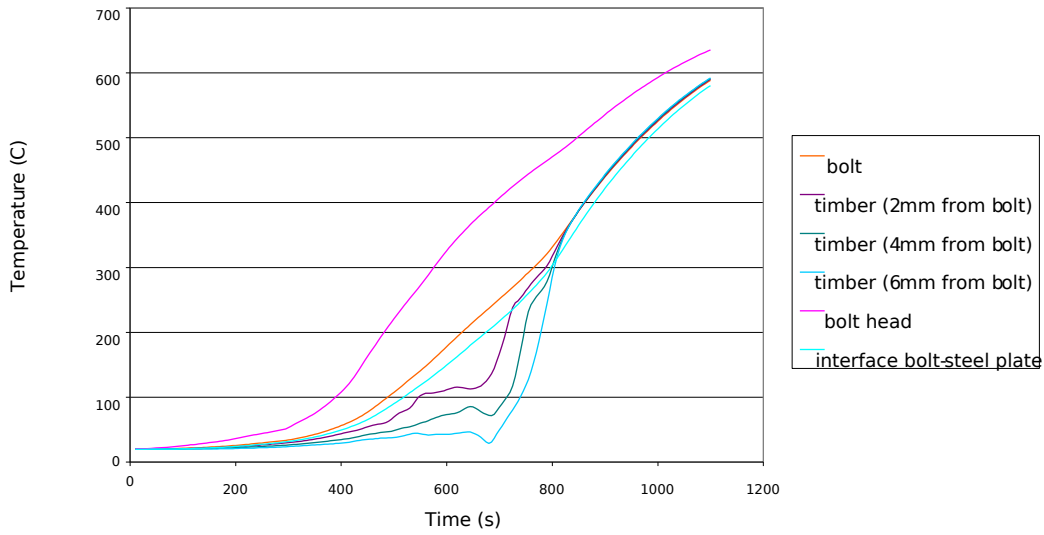
Wsw connection:



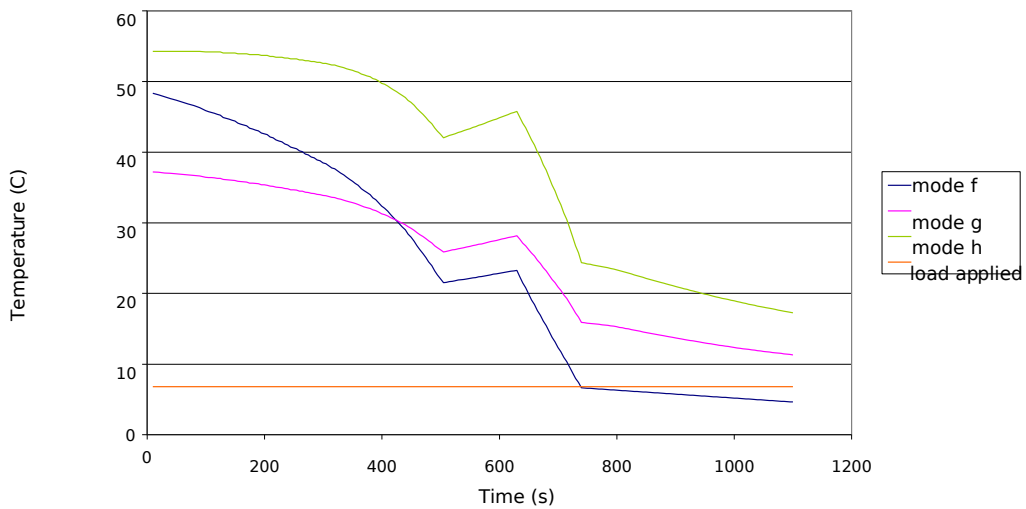
temperature in the timber in a wsw connection at different depth during a fire



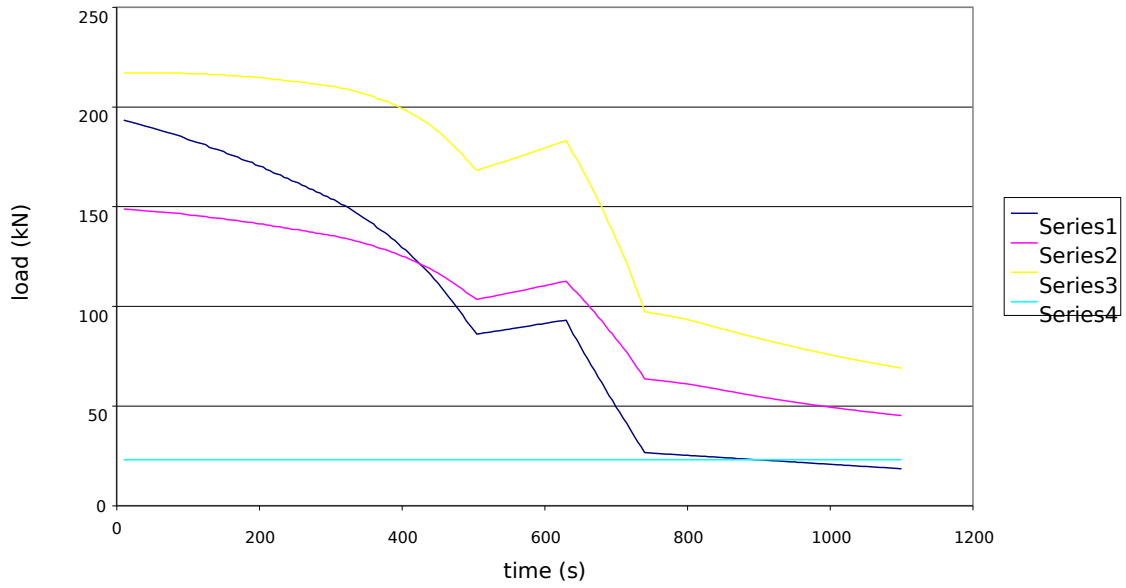
temperature in a bolt and in the timber around in a wsw connection during a fire



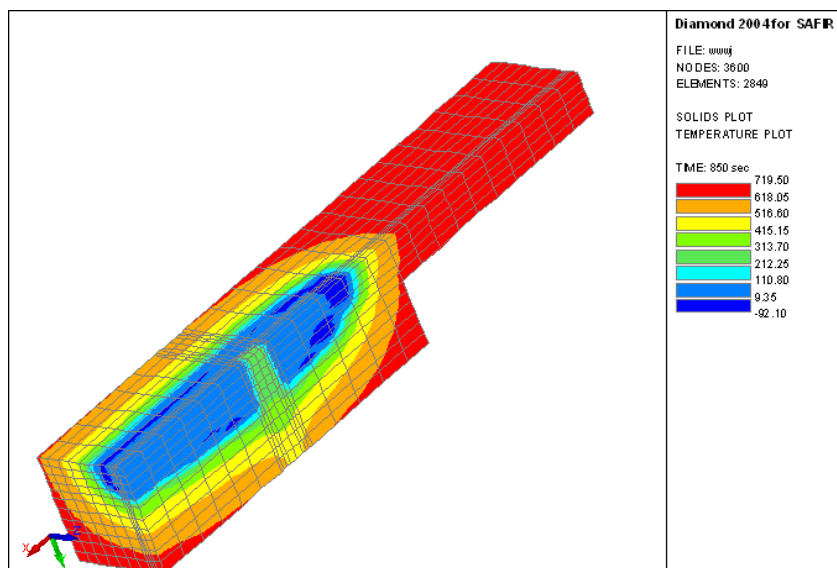
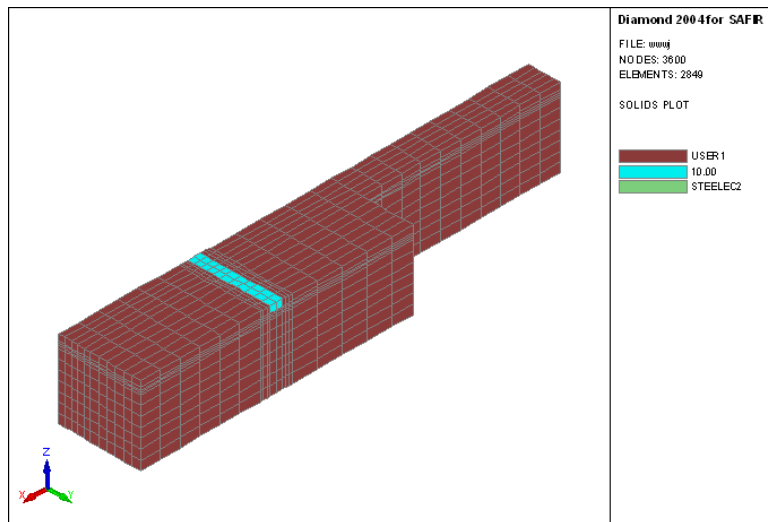
prediction of the fire resistance of a wsw connection with one bolt using safir



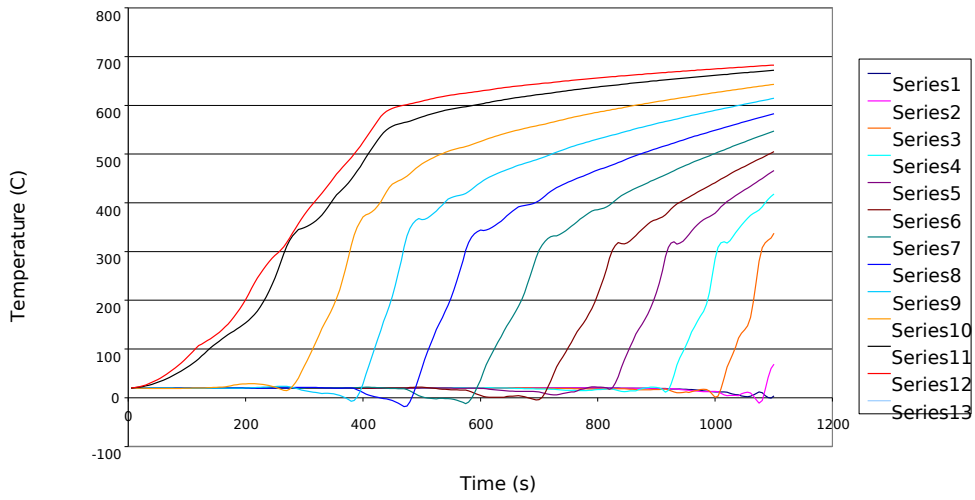
prediction of the failure load of a wsw connection with 4 bolts using safir



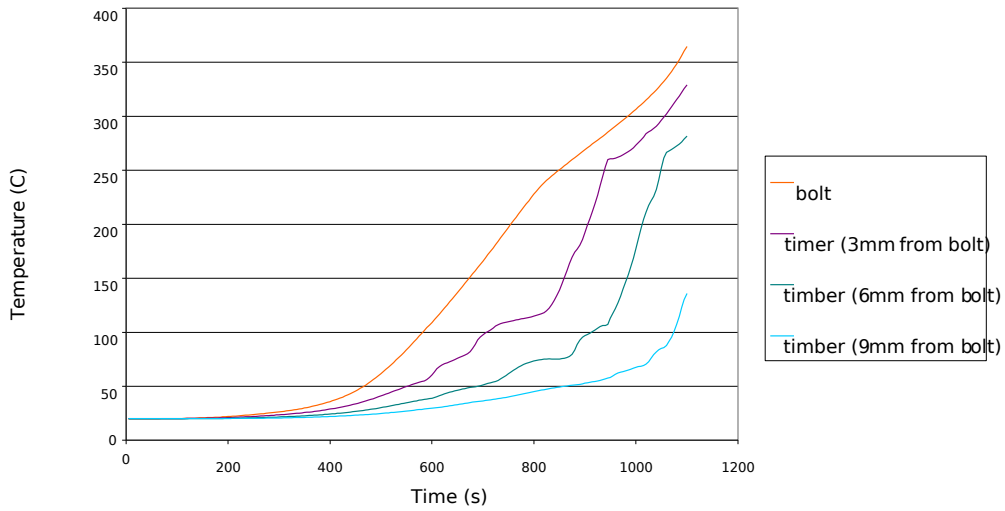
www connection



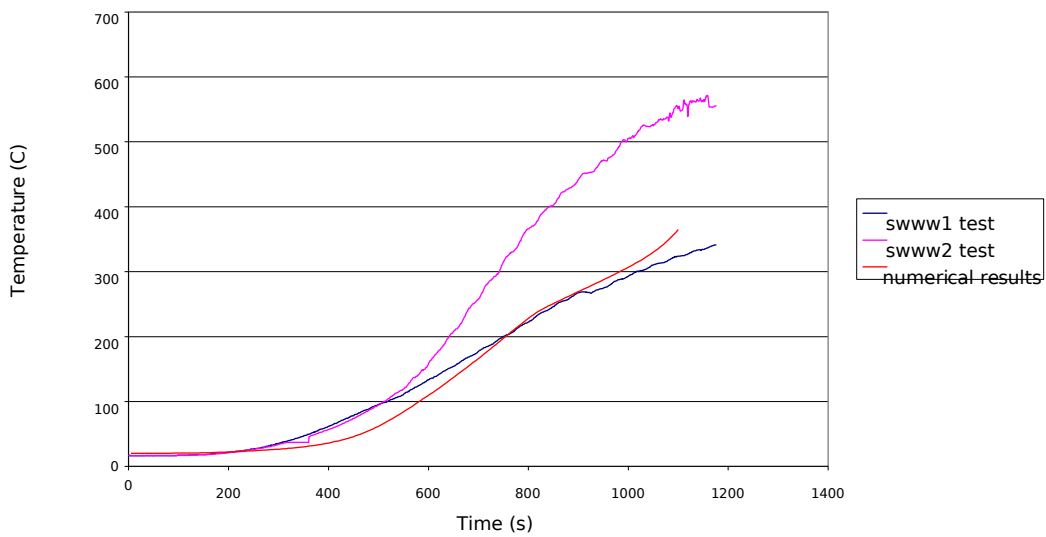
Temperature in the timber of a www connection for different depth during a fire



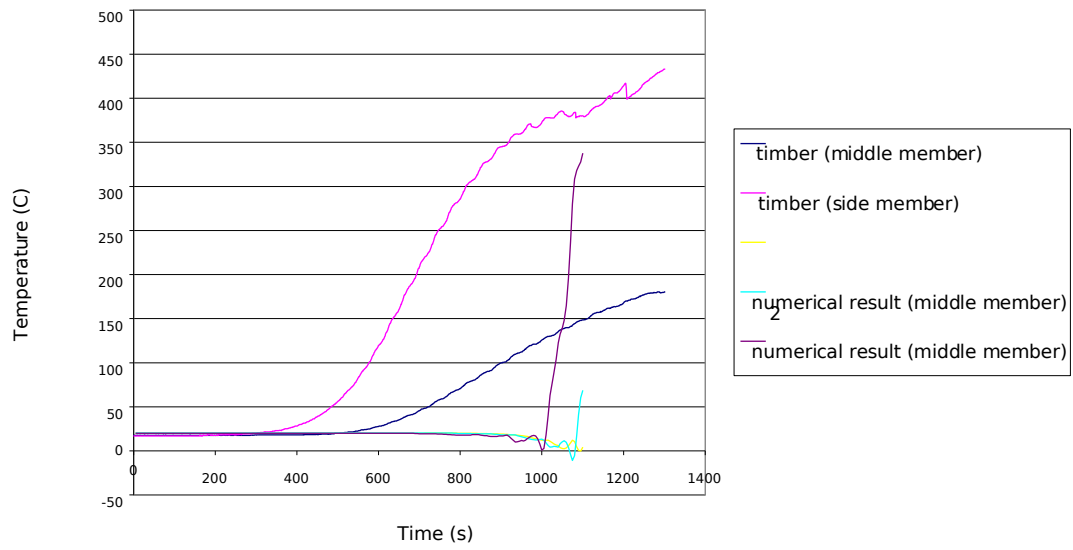
temperature in the bolt and in the timber around in a www connection during a fire



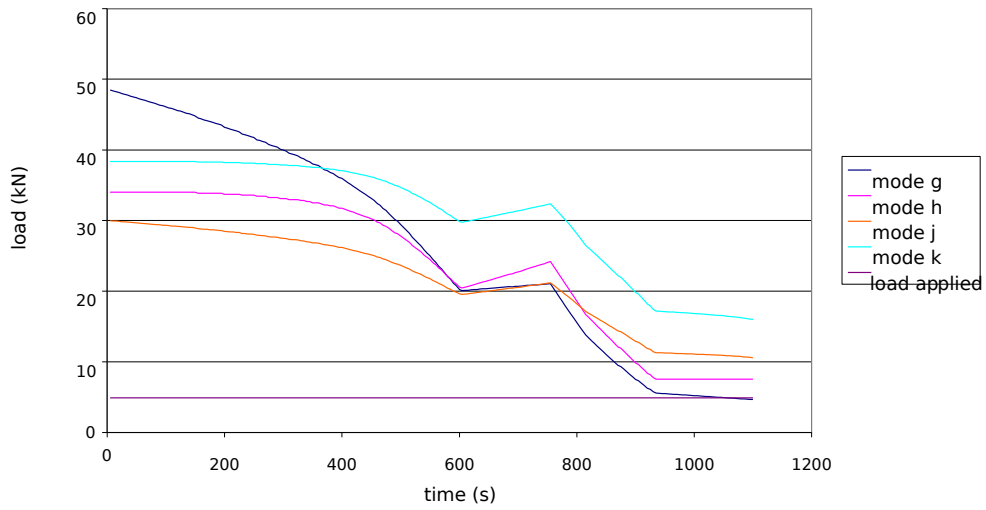
temperature in the bolt



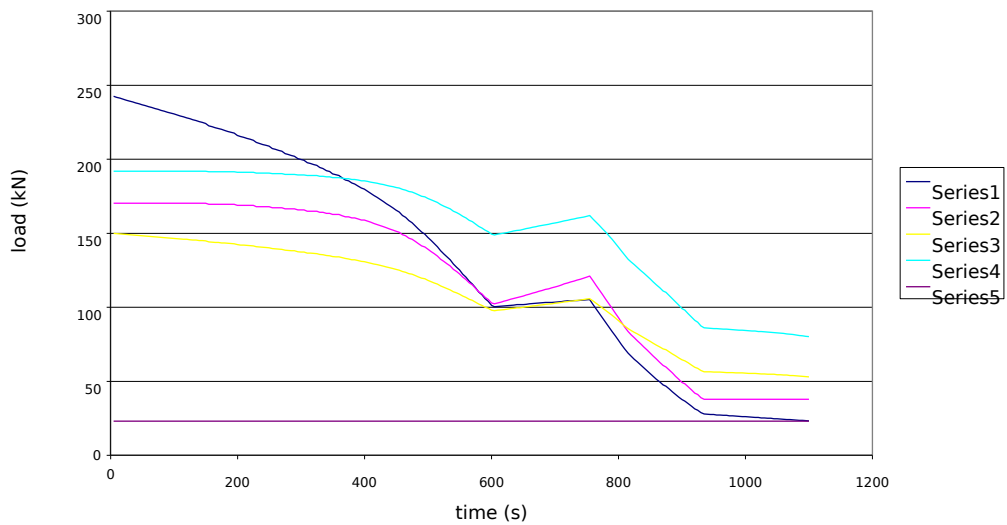
temperature in the timber in a www connection during a fire



prediction of the time to failure of a www connection with one bolt during a fire using safir



prediction of the failure load of a www connection with 5 bolts using safir



7 Manufacturing process of LVL timber