Practical testing of Chro Moly 4130 tubes and Docol 800 DP-tubes

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Summary

ME-Racing is investing the possibilities to use tubes made from Docol 800 DP instead 4130 Chrome Moly tubes in the chassis of one prototype Pro Mod car.

SSAB has carried out tensile testing, testing of T-joints and Three Point Bending for both Docol and CrMo-tubes.

The conclusions to be drawn are:

- The mechanical properties of the Docol 800 DP-tubes are very similar to the 4130 Chome Moly tubes. The Docol tubes have slightly lower yield strength but higher tensile strength. The elongation values of the Docol-tubes are better than in the 4130 Chrom Moly tubes.
- The Docol-tubes showed a better behaviour at fracture compared to the CrMo-tubes.
- The results from the tests of the welded T-Joints were quite similar even though the thickness and the diameter of the Docol tubes were smaller.
- In the Three Point Bending the relatively small difference in dimensions of the tubes were significantly influencing the results. The Docol-tubes showed a lower initial stiffness compared to the CrMo-tubes and hence a lower maximum load and energy absorption. Identical dimensions would however most probably result in equivalent performance at Three Point Bending.
- The CrMo-tube with the locally reduced thickness positioned at three o´clock showed reduced performance at Three Point Bending.

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1 INTRODUCTION

ME-Racing is investing the possibilities to use tubes made from Docol 800 DP instead 4130 Chrome Moly tubes in the chassis of one prototype Pro Mod car.

In order to find out if this is possible SSAB has made a number of tests to compare the differences in the behaviour in the two different materials. The tests were performed in three different ways to find out the behaviour and the parameters of the different tubes.

To be able to compare the two different types of tubes we chose to pick as equal dimensions as possible, see the table below:

Material	Outer Dia.	Wall thickness
4130 Chrome Moly	41,27 mm (1 5/8")	2,11 mm (0,083")
Docol 800 DP	40,0 mm	2,0 mm

Since the dimensions are slightly different this will be an advantage for the Chrome Moly tubing in this stage since they have bigger diameter as well as greater wall thickness.

The tests performed were:

- Tensile testing
- Tensile testing of welded T-Joints
- 3 point bending

2 TENSILE TESTING

The tensile testing of the tubes showed a completely different behaviour on the two different types of tubes. The Chrome Moly tubes burst in a spiral pattern see figure 1. In order to get accurate elongation values manual evaluation was carried out on the 4130 tubes. The Docol 800 DP tubes showed global necking prior to fracture indicating a more ductile behaviour, see figure 1.

The mechanical properties of both types of tubes are found in figure 2.

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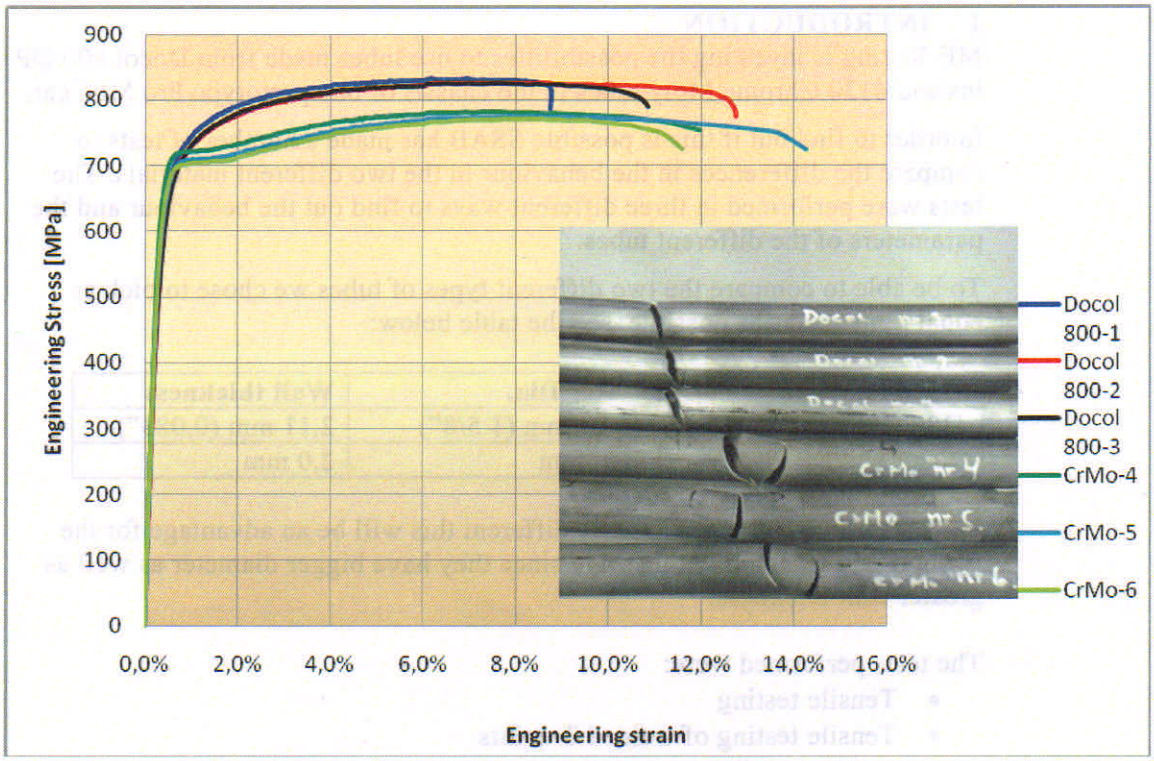

Figure 1: Tensile tests of the tubes.

Test nr	Test direct.	Area mm²	Rp0,2 N/mm²	Rm N/mm²	A5 %	A50mm N/mm²	A80mm %	Remark
1		234,63	668	832	19	26	20	Docol 800 DP
2		236,68	661	826	20	26	21	"
3		236,12	660	825	17	22	18	"
4		267,28	703	780	11	14	12	4130 CrMo
5		261,78	673	773				"
6		261,50	681	771				"

Figure 2: Measured Mechanical Properties of the both types of Tubes. The elongation was possible to measure manually only on one CrMo-tube.

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3 TENSILE TESTING OF T-JOINTS

In this test two tubes were tig welded together in a T-Joint. The free ends were 500 mm long in all directions. The tensile load was applied in 45 degrees on the short tube welded to the longer one, see figure 3.

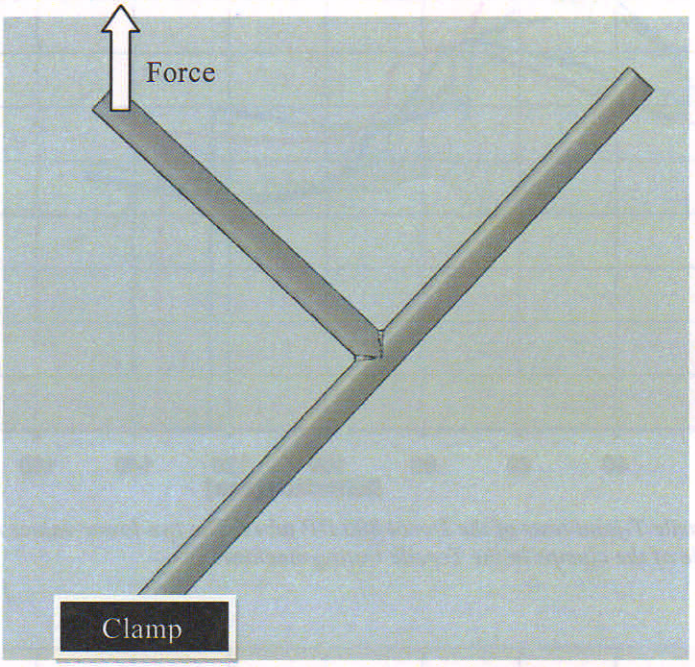

Figure 3: The set up in the Tensile Testing Machine

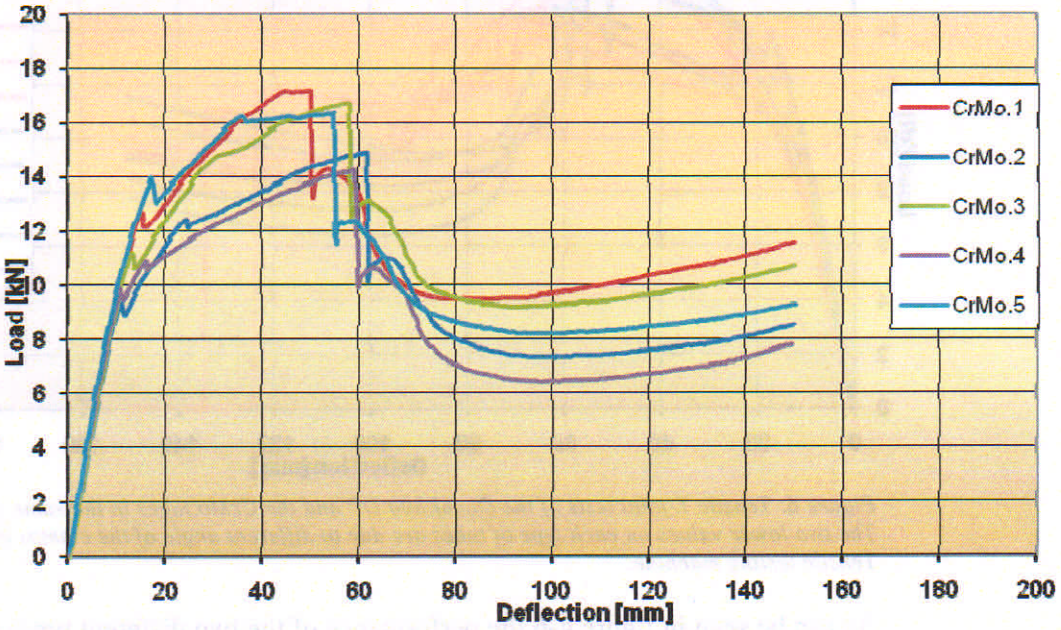

Figure 4: Tensile T-jopint tests of the 4130 CrMo tubes. The two lower values are due to different angle of the clamps in the Tensile testing machine.

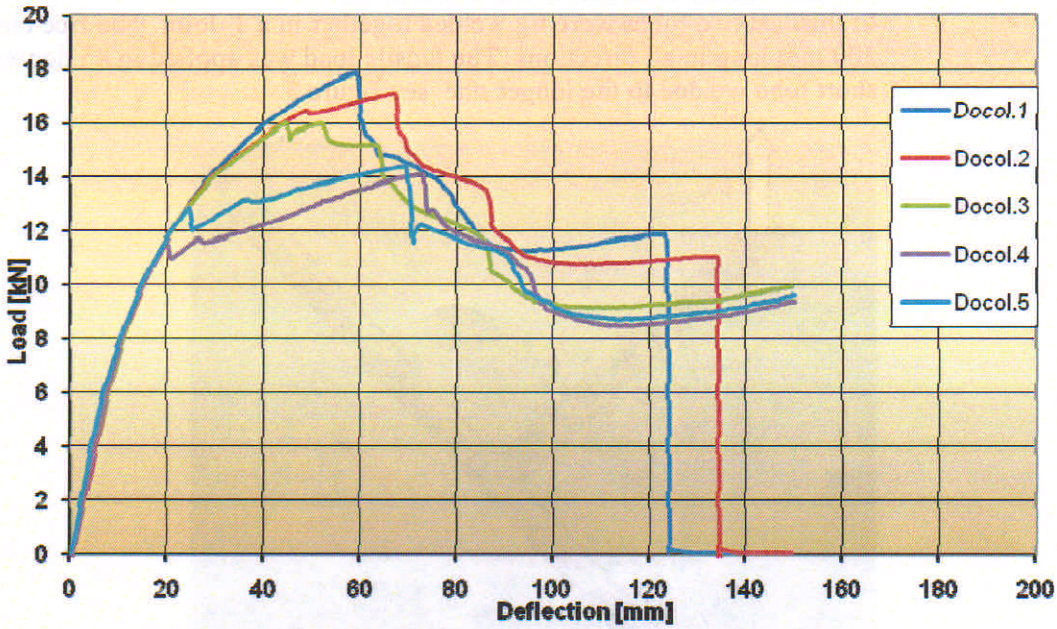

Figure 5: Tensile T-joint tests of the Docol 800 DP tubes. The two lower values are due to different angle of the clamps in the Tensile testing machine.

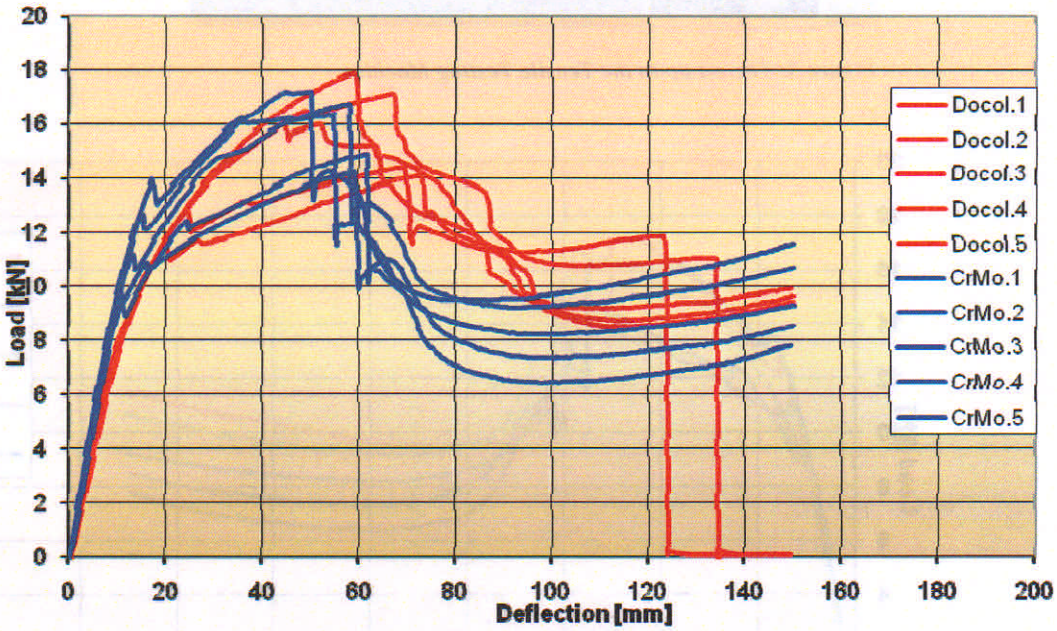

Figure 6: Tensile T-joint tests of the Docol 800 DP and the CrMo tubes in the same graph. The two lower values on each type of tubes are due to different angle of the clamps in the Tensile testing machine.

As can be seen in figure 4-6 the performance of the two different types of tubes are equivalent when it comes to static strength of the T-joint, although the dimensions of the CrMo-tubes are greater than the Docol 800DP-tubes.

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4 THREE POINT BENDING TESTS

In three point bending the difference in diameter and the thickness have a rather big influence of the result. Since the 4130 CrMo tubes have both bigger diameter and greater wall thickness this will be an advantage for this tubes.

The set up in the Bending Machine was 800 mm between the supports and the Tool Radius was 150 mm, see figure 7.

The results are found in figure 8. As can be seen there is a significant difference already in the initial stage. The smaller Docol 800DP-tubes show a lower stiffness (only depending on the geometry of the cross-section and the Youngs modulus) compared to the CrMo-tubes. In case of identical dimensions of the tubes and hence equivalent initial stiffness the performance (peak load and energy) most probably all tubes would have about equivalent performance.

The welds on the Docol tubes were placed in 0, 90 and 180° to the applied force in order to investigate how the weld could affect the bending resistance.

In the tests performed on the 4130 CrMo tubes the wall thickness was measured on several places and since the thickness was found uneven we placed the thinnest part of the tube just as we did with the weld on the Docol tubes.

As can be seen in figure 6, the biggest influence in the results were when we put the thinnest wall thickness at 90 degrees from the applied load (kl 3 in figure 8) on the CrMo tube.

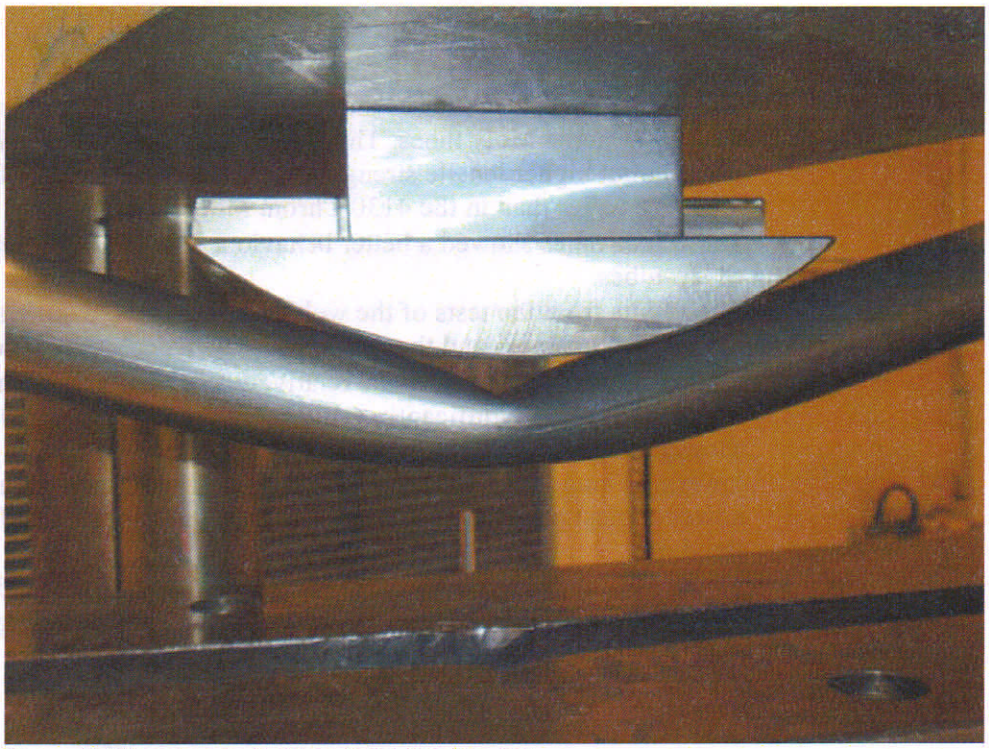

Figure 7: The set up in the Tree Point Bending test

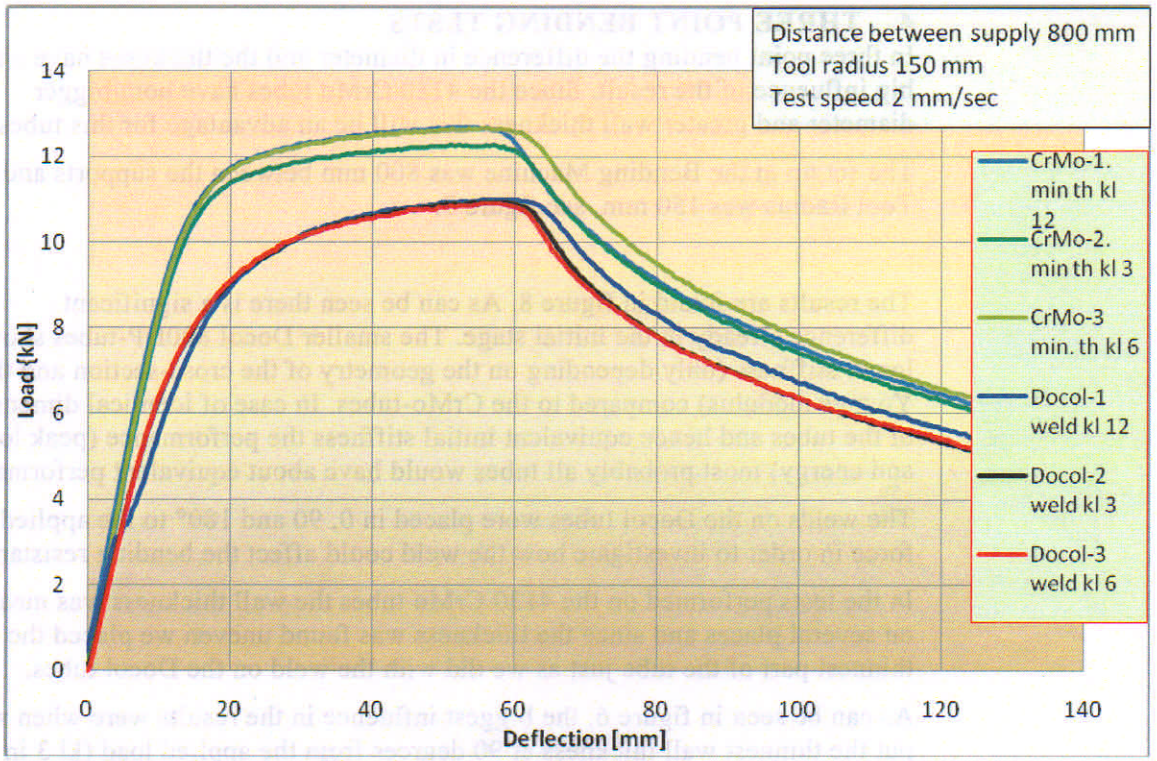

Figure 8: Three point bending test of the tubes.

5 CONCLUSIONS

- The mechanical properties of the Docol 800 DP-tubes are very similar to the 4130 Chome Moly tubes. The Docol tubes have slightly lower yield strength but higher tensile strength. The elongation values of the Docol-tubes are better than in the 4130 Chrom Moly tubes.
- The Docol-tubes showed a better behaviour at fracture compared to the CrMo-tubes.
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