

## **EXPERIMENTAL RESIDUAL STRESS ANALYSIS AT WELDED PIPELINES**

### **EXPERIMENTÁLNÍ ANALÝZA ZBYTKOVÝCH NAPĚTÍ VE SVAŘOVANÉM POTRUBÍ**

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*Abstract: The paper continues the published work on the 39<sup>th</sup> International Conference "Experimental Stress Analysis 2001". There were published the results of residual stress measurements after the rolling and roll bending of strips. This paper includes the results of measurements after the following technological processes – spiral welding, pressure testing and annealing. The measurements were performed by means of the hole-drilling strain gage method.*

**Keywords: residual stresses, hole-drilling method, spiral welded tubes**

#### **1. Introduction**

The paper is devoted to the problems of residual stress formation at the spiral welded tubes during the technological manufacturing program and the possibilities of its reduction by means of following technological processes. The paper fluently continues the published contribution on the 39<sup>th</sup> International Conference EAN in Tabor. There were published the results of residual stress measurements after two technological processes – strip rolling at the Steckel rolling mill and after roll bending before the welding. This paper includes the results of residual stress measurements after the following technological processes – spiral welding, pressure testing and annealing. Two materials were used for the electric resistance spiral weld process making of tubes – structural steel B 37A and microalloyed steel. The residual stress measurements were performed for two variants of every technological process in order to obtain the basis for the incidental optimization of manufacturing program of spiral welded tubes. The hole-drilling strain gage method was used for the residual stress measurements.

#### **2. Residual stresses after spiral welding**

The spiral welding follows after the roll bending of rolled strip, two different technological processes of spiral welding were used and compared. Main attention was paid to the residual stress measurements near the spiral weld at the internal boundary of tubes. Fig.1 shows the places of sticking of strain gage rosettes for the residual stress measurements by means of hole-drilling strain gage method. The established residual stress distribution at the weld neighbourhood of one specimen is shown on Fig.2. The evaluation was performed on the assumption that the Hooke's law is available for the whole range of measured strains. In this way evaluated residual stresses are bigger than the yield point of material at the weld neighbourhood. Actually the stresses are close to the yield point and they make the plastic strain zone possible. Fig.2 shows the results for tube from B37A material, Fig.3 shows the residual stress distribution for tubes from microalloyed steel. Fig.3 shows the results performed for two different technological processes of roll bending. We can see, that the residual stresses are after spiral welding too high.

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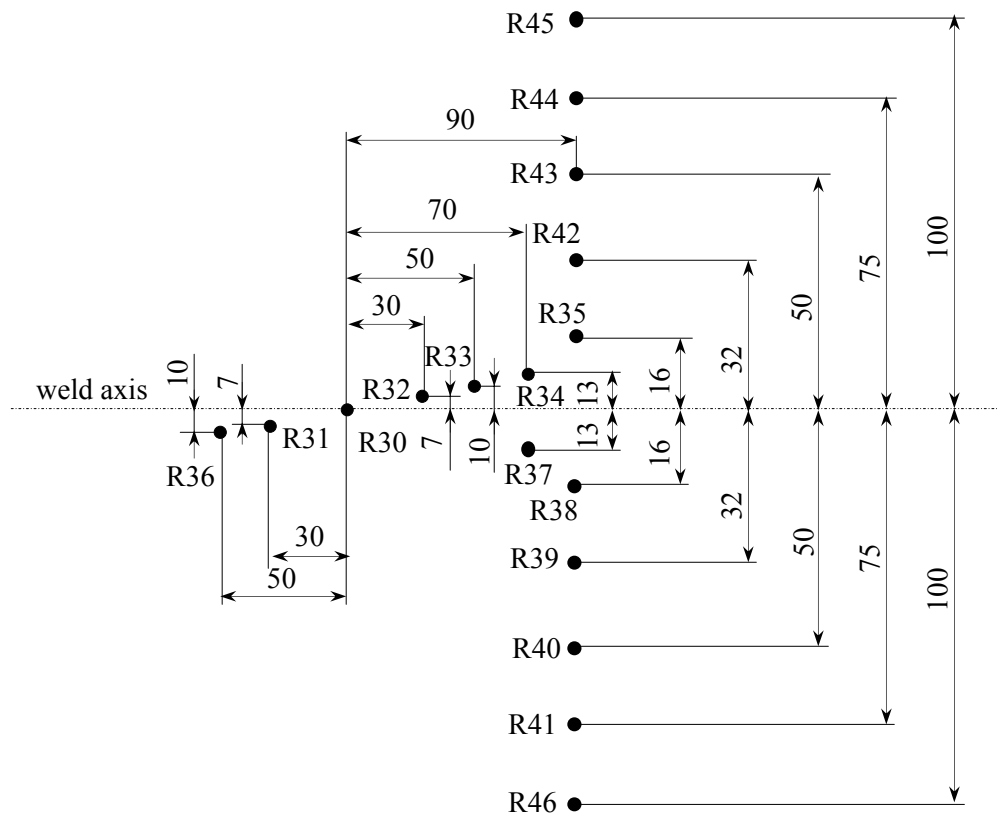


Fig. 1: The places of sticking of strain gage rosettes

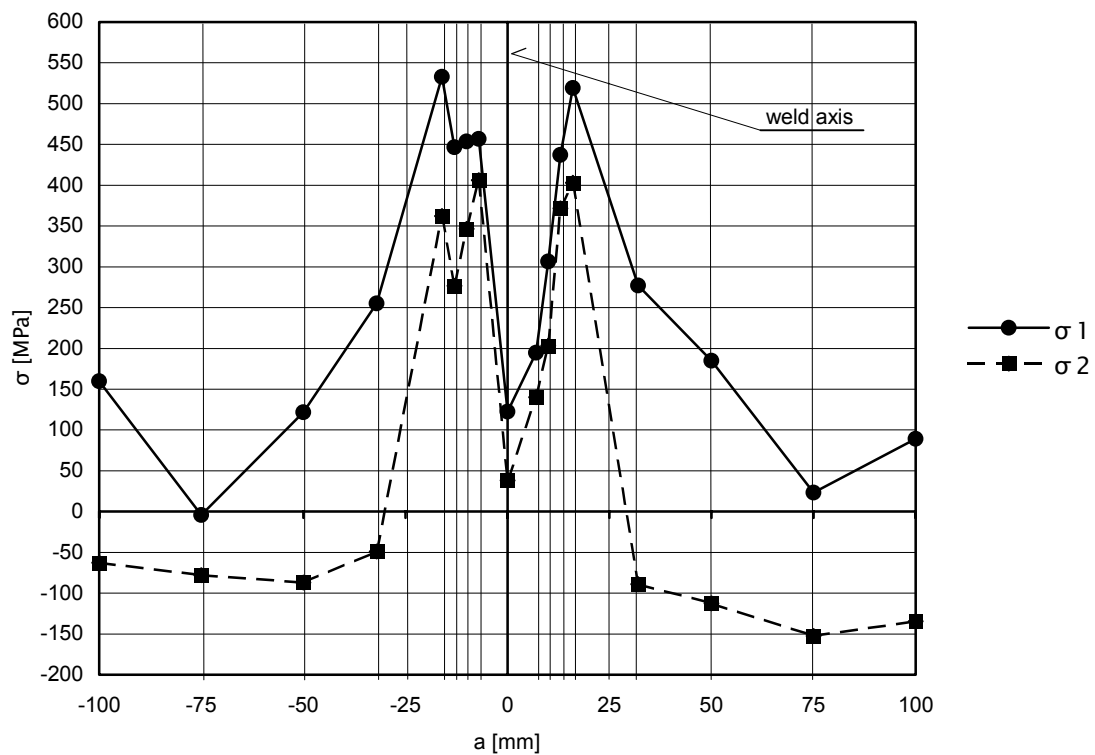


Fig. 2: The residual stress distribution at the weld neighbourhood

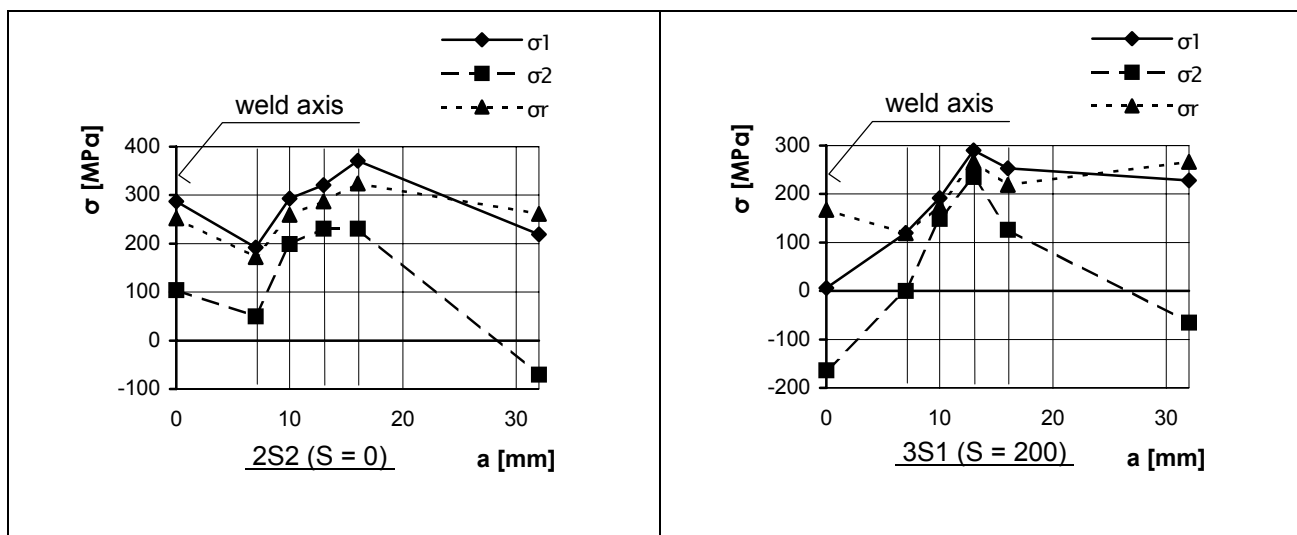


Fig. 3: Residual stresses at the weld neighbourhood of tubes before the pressure testing

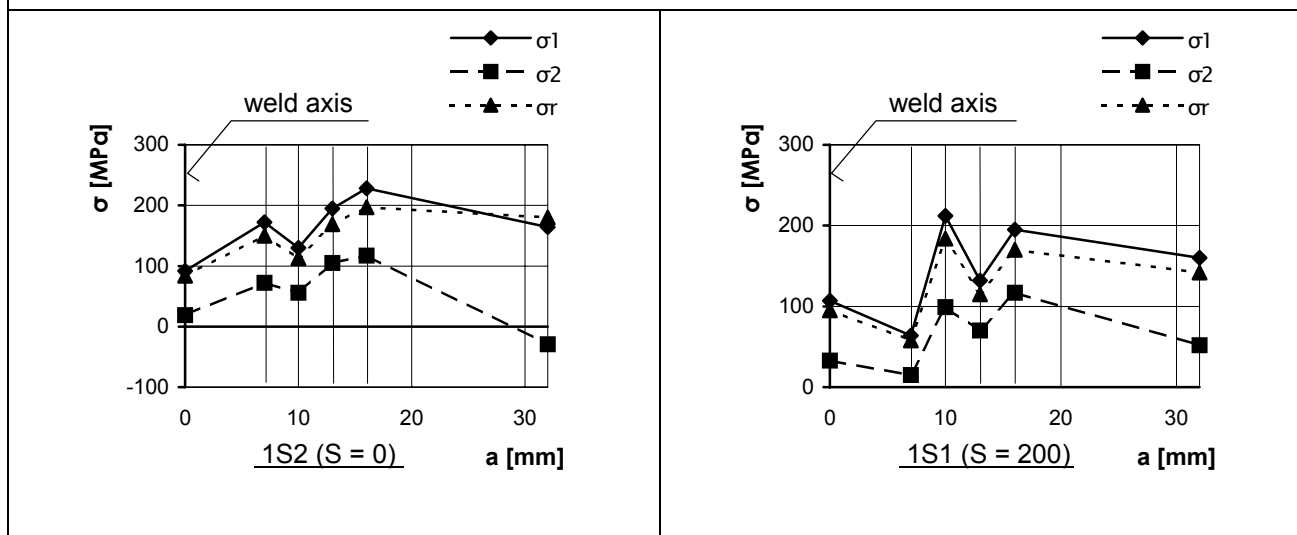


Fig. 4: Residual stresses at the weld neighbourhood of tubes after the pressure testing

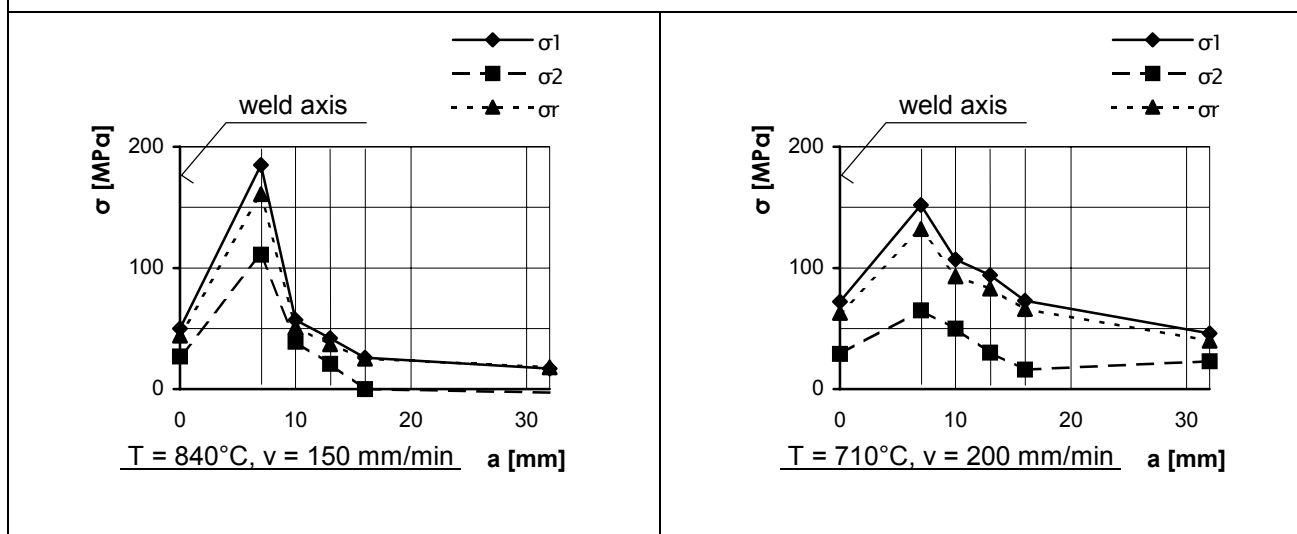


Fig. 5: Residual stresses at the weld neighbourhood of tubes after the annealing

### **3. Residual stresses after pressure testing**

The following technological process after the spiral welding is the pressure testing. Two different technological processes of pressure testing were tested. The results of measurements obviously proved, that one of them is suitable for the essential reduction of residual stresses at tubes and therefore this pressure testing process is exclusively used. Fig.4 shows the results of residual stress measurement at two tubes. Those tubes were produced by means of two roll bending processes. Comparison of results shows, according to Fig.3 and Fig.4, the significant reduction of residual stresses after the pressure testing.

### **4. Residual stresses after annealing**

The residual stress measurements after the annealing were performed only as a research, because the annealing isn't the common technological process. Two processes were examined and Fig.5 shows the results of residual stress measurement after annealing. The annealing considerably reduces the residual stress level at the weld neighbourhood. Unfortunately the processing of annealing is too expensive.

### **5. Conclusion**

The paper briefly informs on performed residual stress measurements at the production of spiral welded tubes. The influence of different technologies of welding, pressure testing and annealing were discovered both on the resulting values of residual stresses and on the development of residual stresses after particular technological processes. The gained results make possible to optimize the technological process and minimize the residual stresses at the products. At the same time they serve as the basis for the research of the stress corrosion cracking. The detailed results for tubes from B37A material are published in work [1], for tubes from microalloyed steel in work [2].

### **REFERENCES**

- [1] Macura, P., a. a.: The message from the residual stress measurement of welded tubes. Ostrava, 2000
- [2] Macura, P., a. a.: The results of residual stress measurement of welded and bended tubes. Ostrava, 2001

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