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JOINING MATERIALS BY METALOCK REPAIR METHOD

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This paper presents joining of material, usually of grey cast iron, by the metalock and masterlock joining methods. There is a complete joining procedure presented, which includes metalock keys and masterlock plate. Examples of successful applications of these two methods of material joining are presented within demanding reparation processes. The paper also elaborates comparison of tensile test carried out by using metalock repair method and welding on grey cast iron SL 25.

Key words: repairing, metalock, cracks, cold joining, metalock keys

INTRODUCTION

There are many possibilities of repairing cracks in a material, as variety of procedures have been developed [1], such as metalock procedure, which dates back to 1937, when it was patented by L.B. Scott. This procedure was further developed in the 20th century, primarily in the oil industry. [2]

Metalock technology refers to cold joining of material, usually to repair cracks that occur on large structures and on materials that cannot be easily welded, such as grey cast iron.

Apart of preventing heating during the joining process, it facilitates avoidance of additional heat treatment, thus resulting in a small input of heat to material and in less additional impact on mechanical properties of joints, such as hardness, impact energy, etc. [3,4].

Metalock technology is used in almost all areas of oil industry, chemical industry, military, naval architecture, etc. It is applied on hard-to-weld constructions, such as casts that need to be repaired. There are many advantages of this procedure, such as:

- low heat input,
- on-site application,
- no additional deformations or changes in surface shape,
- possibility to repair large constructions,
- possibility to perform repair in explosive and other dangerous environment,
- corrosive and chemical stability.

Apart of the above-mentioned advantages, there are some disadvantages, as well:

- it is impossible to perform the procedure on inaccessible positions,
- it is not appropriate for high pressures,
- there is dimensional limit from 6mm – 200mm.

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The procedure can be performed by using metalock keys in combination with metalock screws, and by using masterlock keys in combination with metalock screws.

TECHNOLOGY OF METALOCK AND MASTERLOCK JOINING OF MATERIAL

Proper application of these repair technologies presupposes complying with procedure rules to ensure prevention of crack propagation and to repair damaged parts.

There are various causes for crack occurrence. The crack propagation itself can be rapid or slow. [5]

Technology of metalock joining of parts consists of:

a) Problem analysis – determining possibilities of performing metalock procedure referring to its aspect of technological efficiency.
b) Testing of cracks - determining the direction of crack spreading and the size of cracks by using some of the non-destructive testing quality control technologies.
c) Determining the key set-up – by determining exploitation conditions at the sample, crack dimensions are used to determine the number, size and direction of the key set-up.
d) Drilling of nest holes - by using template, holes are drilled to 80% of the base material depth. In order to prevent expansion of cracks and occurrence of new cracks, it is necessary to set up the keys correctly, so that they alternate within each other.
e) Forming of nest – joining of holes to conform to the shape of the keys.
f) Sealing of cracks - in order to assure tightness, there are copper or aluminum rollers placed at max. up to 25 bars underneath the keys.
g) Insertion of the keys - the keys are inserted into prepared nest. Keys are made of steel W. No. 1.7033.

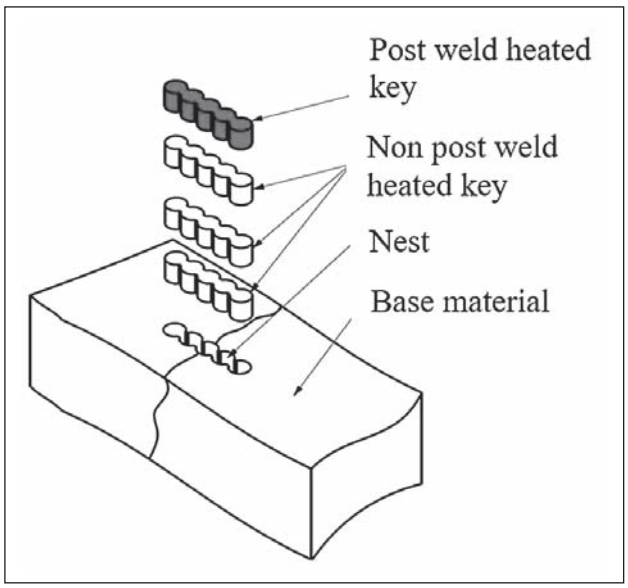


Figure 1 The order of metalock keys set-up [2]

There are five keys of different sizes, from 3,2 mm diameter and 3,2 mm thickness to 8 mm diameter and 6,5 mm thickness. The order of key set-up is shown in the Figure 1.

h) Drilling of holes for screws, cutting of threads and screwing the screws - screws are made of low-carbon steel, they are coated with adhesive and placed on cracks.
i) Clenching.
j) Grinding of the joint and anticorrosive protection.

By testing of tensile properties of material joined by metalock procedure, there are satisfying results obtained with 10 mm thick base material. [6]

The Figure 2 presents the diagram of tensile properties:

- Metalock procedure performed by key No. 4 produced of 7 ribs, with two keys in a row and one key in the depth
- Base material SL25

Another procedure of material joining is masterlock technology, which combines metalock screws and keys with masterlock plates for repair of damaged parts. The

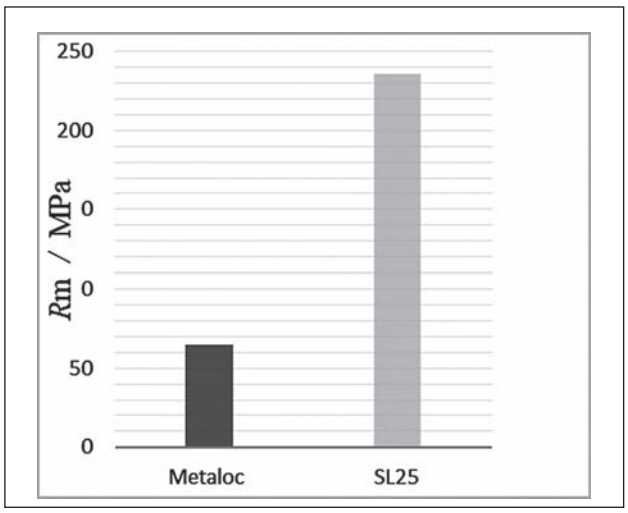
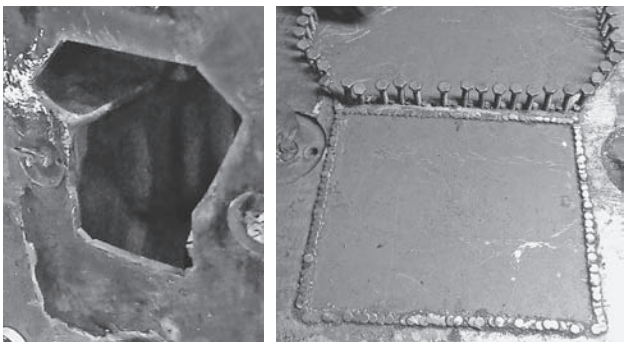


Figure 2 Diagram showing comparison of tensile properties [2]



a) **b)**

Figure 3 Masterlock technology of joining materials:
a) cutting-out of the damaged segment,
b) repair by masterlock plates

Figure 3 presents successful application of the masterlock technology.

Masterlock technology is similar to metalock technology. One half of metalock keys and screws holds into base material, while the other half holds into the masterlock plate. Masterlock procedure is usually applied for repairing of broken machine parts, large cracks, etc. [7]. The masterlock technology of repairing parts by joining consists of:

a) Removal of the damaged part by cutting it out - removal of complete crack, removal of damaged part.
b) Cutting of masterlock plate – the plate is cut to size that fits the cut-off part.
c) Joining of masterlock plate by using metalock keys and screws.

EXAMPLES OF SUCCESSFUL APPLICATION OF METALOCK AND MASTERLOCK JOINING

Examples of successful application of metalock technology to join materials:

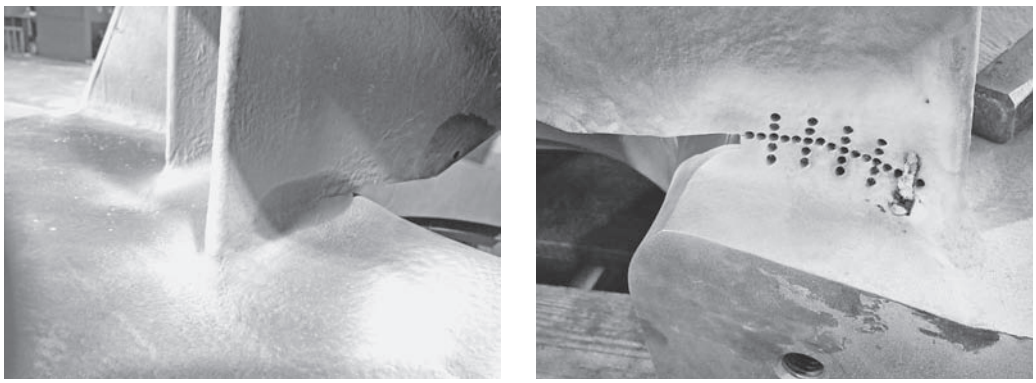
a) Successful repair of boat engine turbine blades is presented on the Figure 4. The repair lasted for 4h.
b) Crack in the compressor cover was caused by mechanical blow. The repair lasted for 10h. The Figure 5 presents testing of crack spot and defining of dimensions and directions of cracks, as well as application of metalock procedure to repair the crack.

Examples of successful application of masterlock technology to join materials:

a) The Figure 6 shows successful repair of engine block, which damage was caused by cracking of connecting rod. Complete repair lasted for 7 days.
b) Repair of boat engine block. The Figure 7 presents repair of the crack caused by cracking of connecting rod. The repair lasted for 3 days.

CONCLUSION

Metalock and/or masterlock technology provides possibilities for rapid, on-site and efficient repair of damaged structures without additional overheating and heating of materials during repair. Such technology is applicable in repair of parts that cannot be easily welded, such

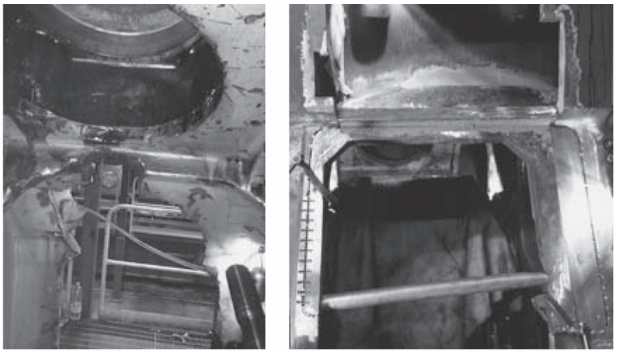


a) b)

Figure 4 Repair of turbine blade: a) crack in the blade, b) Repair of the crack

a) b)

Figure 5 Repair of compressor cover: a) appearance of crack, b) repaired crack



a) b)

Figure 6 Repair of engine block: a) appearance of crack, b) repair of crack

a) b)

Figure 7 Repair of boat engine block: a) appearance of crack, b) repaired engine block

as casts. The examples presented in this paper show successful application of the procedures, by restoring strength and toughness to the damaged parts while preventing crack propagation. Tensile properties of the metalock procedure also provide appropriate results.

Both metalock and masterlock technology shall be properly applied by considering characteristics of material that shall be joined. The quality of repairs also depends on the skills and knowledge of metalock technicians.

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Note: Responsible translator Martina Šuto, MA in English and German language, University of Osijek, Osijek, Croatia