

Pulsed laser beam welding – start thinking big!

Repair welding of a shock absorber housing

In the perception of welding technology, pulsed laser beam welding as an application for large-scale components in combination with a high deposit welding volume appears to be a contradiction – not to say like an (industrial) fairy tale from the Thousand and One Nights, in this case one



Fig. 1 • Shock absorber housing with mechanically machined bearing seat surfaces prepared for welding. (Pictures: Alpha Laser Southeast Asia Co., Ltd.)

from Thailand. However, the latest developments and concrete examples from real professional life prove us wrong – demonstrated by a customer order that Alpha Laser Southeast Asia Co., Ltd. successfully executed at its main location in Chonburi/Thailand in November 2022. The project was managed by Thanapol Pradissun, a technology expert with many years of experience working for Alpha Laser SEA.

The machine component to be welded was a shock absorber housing weighing 3.5 t and made of cast iron with nodular graphite (EN-GJS-500-7/Material No. 5.3200) (Fig. 1). At both ends the housing measures a wall thickness of 80 mm, with an inner diameter of 775 mm and a length of 700 mm. The shock absorber housing is part of a steel sheet rolling mill of a Japanese company based in Thailand, which specialises in the coil production of cold-rolled, galvanised and electroplated steel sheet, with a total annual production volume of about 1.6 million tonnes. In the continuous, rough production process, the shock absorber housing is mainly subjected to mechanical pressure and shocks. Chemical attacks or corrosion play no role in this case.

Welding task – from preparation to execution

The bearing seating surfaces had been affected as a result of bearing damage. Deep grooves, run-in marks and notches had crept into the surface. Since this machine

part is indispensable for the ongoing production process, a repair was required as quickly as possible. A new purchase was not an alternative, as the delivery time was twelve months. The job consisted of build-up welding the four bearing seats located on the inner circumference, three of them 130 mm wide, one 190 mm. To prepare the surfaces to be welded, they were turned 0.5 mm below the finished size in an external mechanical workshop. After consultation with the client, the welding was to add 1.2 mm, which provided sufficient material for the mechanical finishing.

The pulsed laser beam welding machine type “AL Flak 1200” from the German manufacturer Alpha Laser was used to carry out the build-up welding. Prior to welding, the optimum welding parameters were determined on the basis of an individually created component WPS (Welding Procedure Specification). The machine was programmed accordingly. The basis for this was a material-specific procedure test according to DIN EN ISO 15614-7. The operators of the pulse laser welding machine were qualified according to DIN EN ISO 14732:2013-12.

For the base material to be welded, cast iron with spheroidal graphite, the filler metal “Inconel 625” (Material No. 2.4831), standard designation: AWS A5.14 (ERNiCrMo-3)/EN ISO 18274 (SNI6625), was selected. The selection of this nickel-based alloy is justified by its properties with regard to tensile, compressive and

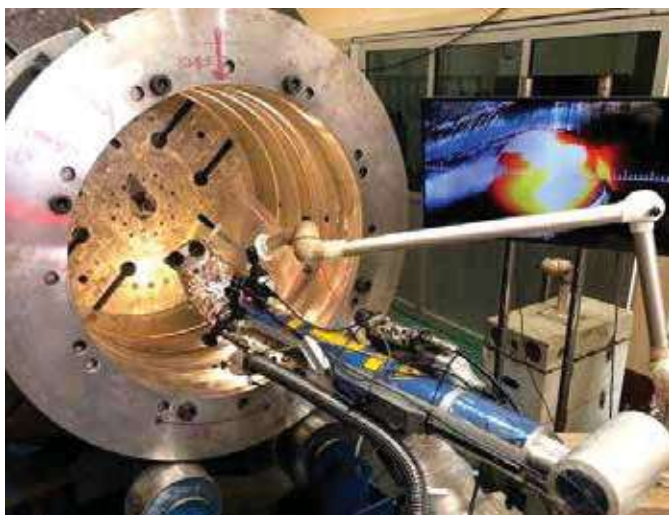


Fig. 2 • Automatic pulsed laser beam welding process.



Fig. 3 • Temporary monitoring of the weld seam quality by Prof. Gerd Kuschner.



Fig. 4 • Partially finished welded bearing seat.



Fig. 5 • Completely welded bearing seats.



Fig. 6 • Shock absorber housing after dye penetrant testing.



Fig. 7 • Mechanically prepared bearing seat shaft.

alternating strength. As was the case with the base material, no primary requirement was placed on the filler metal with regard to corrosion resistance. Due to the high pulse laser power of 1,200 W, a wire diameter of 1.6 mm could be used. This meant that there was no need to use a thinly drawn filler metal – as required for pulsed laser beam welding with lower power – which would have resulted in higher costs. In order to be able to clamp the bulky component onto a tilting turning device, two auxiliary flanges were mounted on both ends of the shock absorber housing (Fig. 1b).

How was the welding carried out?

The deposition welding was carried out as a continuous welding process with the workpiece rotating and the laser head static (Figs. 2 and 3), resulting in the welding position PA (tub position). The fibre laser operated with a power of 960 W at a pulse frequency of 36 Hz and a pulse duration of 3.4 ms, which was matched to the welding task. This resulted in a melting pool width of 4.2 mm. The 1.6 mm welding wire was

automatically fed to the melting pool from a commercially available wire basket spool (BS 300).

The result was a single-layer weld in which the required seam height of 1.2 mm to be applied was achieved. The total welding time for all four bearing seats – in total an area of 1.42 m² – amounted to 74 h, whereby about 60 kg of welding filler was applied. Thus, a deposition rate was achieved with pulsed laser beam welding that comes close to that of conventional tungsten inert gas (TIG) welding (Figs. 4 to 6).

Reasons for pulsed laser beam welding

The comparison with conventional TIG welding in pulse mode (welding with electric current) explains the advantages of the technology of pulsed laser beam welding (welding with stimulated light). Based on this, the following advantages result:

- no cost- and time-intensive preheating or post-weld heat treatment of the component,

- no critical microstructural changes to the base material in the weld area,
- almost no welding distortion.

Further applications with similarly high build-up welding volumes

Numerous comparable work tasks have already been successfully carried out. For example, the 170 mm wide bearing seat of the shaft of the shock absorber housing discussed in this article, which was damaged by deep grooves, run-in marks and notches, was also repaired by pulsed laser beam welding (Figs. 7 and 8). The material of the bearing seat shaft is high-strength carbon steel. The diameter of the shaft is 470 mm, “Inconel 625” (DSI M NICR625) was used as filler metal.

Another example is a surface build-up weld within the application described in this article. The shock absorber housing is a precision component. Its reference surface (Figs. 9 and 10) ensures a precise fit in the machine. This 600 mm × 260 mm surface was also build-up welded in a single layer,



Fig. 8 • Temporary monitoring of the weld seam quality through the eyepiece of the pulsed laser beam welding machine.



Fig. 9 • Shock absorber housing with reference surface.



Fig. 10 • Detailed view of the reference surface welded by pulsed laser beam welding.



Fig. 11 • Simultaneous pulsed laser beam deposition welding on both rotor shaft ends.

1 mm thick. This was followed by mechanical processing.

As a third example, the rotor shaft of a 37 MW steam turbine (**Fig. 11**) was successfully repaired by deposition welding in 2019. A report of the turbine repair was published in the German-language technical journal “Der Praktiker” issue 6/2020 and as an English translation in “Welding and Cutting” issue 2/2020. Pulsed laser beam welding was also used for the deposition welding of “worn-in” bearing seats of a 16 t squirrel-cage rotor made of the material AISI 4340 (**Fig. 12**).

What do these real-life examples teach us?

The technology of solid-state lasers and pulsed laser beam welding machines has developed so rapidly in recent years – from the 500 W Nd:YAG laser to the 900 W fibre laser to the current 1,200 W fibre laser – that it is now possible to repair large-format components in combination with a high build-up volume economically and



Fig. 12 • Squirrel-cage rotor before deposition welding.

to meet the highest quality requirements. There are almost no limits to the variety of materials that can be welded with the pulsed laser beam – from unalloyed carbon steel to high-temperature steels to high-strength fine-grained steels, ferritic and austenitic steels, duplex steels,

“Inconel”, “Monel”, aluminium, titanium and “Hastelloy”.

Another advantage in terms of welding technology is that conventional wire diameters (for example 1.2 mm, 1.6 mm, 2.0 mm) available on wire basket spools (BS300) can be used at this high laser power.

er. This eliminates the use of thinly drawn, cost-intensive welding wires.

More and more companies from the oil and gas, petrochemical, steel and heavy industry sectors are learning to appreciate the manifold possibilities of pulsed laser beam welding and its advantages. Communicating the fact that this rapidly developing technology can now also serve these industries at the highest quality level is one of the main tasks of Alpha Laser Southeast

Asia Co., Ltd. which will transfer this positive development from its headquarters in Thailand to the entire Southeast Asian region.

It is no exaggeration to say that a new era of pulsed laser beam welding technology has begun for the size of the components in connection with the volume of the build-up, and that its technology will become the standard in the areas of "Maintenance, Repair and Operations" (MRO), or has

already become so for many customers. The beginning of this era was heralded by the motto: "Pulsed laser beam welding – start thinking big!"

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**Pulse Laser Welding
(almost) unlimited Applications**



Pulse Laser Welding Note [27]



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