Coordinate measuring technology XXL

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Abstract

The gap is increasing: ThyssenKrupp Rothe Erde manufactures increasingly large workpieces with ever smaller tolerances on behalf of its customers. Quality Assurance in Lippstadt, Germany, therefore sought out a precise system to measure the several-meter large components for offshore technology, large gears and tunneling machines – and convinced ZEISS to design a coordinate measuring machine with a six-meter X axis.

KEYWORDS: coordinate measuring machine, a six-meter X and Y axis

Five-meter diameter, 3.8 tons: the dimensions of steel rings are truly impressive. Nonetheless, the 108 boreholes on the ring have to be drilled in the specified position within a few tenths of a millimeter. Form, distance and diameter of the boreholes must be as accurate as the height of the workpiece, as well as the parallelism and flatness of the lower and upper surfaces. After all, once the supportring is mounted together with two additional rings to create a roller bearing, all components must work together optimally – and then the bearing turns smoothly and withstands the extreme stress that it will be subjected to: as a flexible connecting element, it enables the rotary motion between the pipeline of an oil platform and a docked tanker. This is the only way for the oil to be pumped safely onto the ship even in heavy seas. In order for the bearing to meet these requirements, ThyssenKrupp Rothe Erde subjects it to a demanding quality inspection process – a challenging task for a workpiece with a diameter of five meters.

Breaking new ground

“Be it offshore, a shovel excavator or wind turbines – the diameter of the ordered bearings is growing,” says Thomas Miller, Quality Manager at ThyssenKrupp Rothe Erde in Lippstadt, Germany. “In the past, bearings for wind turbines were 1.5 meters, now they have grown to three or four meters – and the demands on accuracy have grown with them.” At the beginning of 2013, Miller and his colleagues completed most of their in-process random sampling measurements with a 2x2 meter
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coordinate measuring machine. Larger bearings had to be measured with standard measuring equipment. This was a complex process and operator errors could not be ruled out. ThyssenKrupp Rothe Erde decided to invest in new equipment.

Fig. 1. “Be it offshore, a shovel excavator or wind turbines – the diameter of the ordered bearings is growing,” says Thomas Miller, Quality Manager at ThyssenKrupp Rothe Erde in Lippstadt, Germany

One of Miller’s colleagues approached a ZEISS event booth with a request: “We want a coordinate measuring machine – and a big one.” “In the beginning, discussions dealt with 4-5 meter systems,” states Miller. However, we had noticed that customers were demanding increasingly large parts. We decided on a 6-meter machine to provide us with a little room for the future.” ZEISS accepted the challenge. What makes designing such a large system so tricky is that the bridge to which the stylus is mounted spans the the X-axis over the measuring table like a bridge. This bridge is powered on one side by a motor that moves it in the Y direction to enable the stylus to scan the workpiece in this direction. The bridge can be powered on one side without any inaccuracies only up to a width of five meters. Anything larger requires motors on both sides that must move in unison.

Six meter X-axis

One year after signing the agreement, ZEISS installed a ZEISS MMZ G with a 6-meter X-axis and 6-meter Y-axis. ThyssenKrupp Rothe Erde also laid a foundation for the system based on the specifications provided by ZEISS. Furthermore, the Lippstadt factory also built a large, air-conditioned measuring facility that offers enough room to temper several workpieces for 24 hours prior to the measurement. “It was exciting to see the machine being set up here,” reports measuring machine operator Engin Yildiz. “We were very anxious to see it in action.” As it turned out, the XXL configuration of the ZEISS MMZ G only utilized the specified measurement uncertainty by around 60 percent even for large workpieces. A granite measuring table ensures that the parts are absolutely flat, after all, steel rings with a diameter of several meters tend to easily bend when there is any unevenness.
Because the switch to the new measuring machine had to occur without a transition period, ZEISS created a software interface that enabled the three measuring machine operators to continue working with the programs they were accustomed to. However, the measuring machine operators needed to get used to the dimensions of the workpieces. However, they have now had a good bit of practice hanging rings weighing up to 10 tons in chains and moving them to the measuring machine with a crane. Fine-tuning is not required because the stylus recognizes exactly where the part is. Once the measuring programs have been created, the measurement runs automatically. It takes around one and a half hours to measure the five meter bearing ring intended for offshore use.
Increased precision

Miller and his employees use the ZEISS MMZ G for random sampling measurements of the workpieces after various processing steps: after gearing, after turning, precision machining or assembly – it all depends on which process quality assurance has to check and which requirements that workpiece has to meet.

The high precision of the measuring machine enables ThyssenKrupp Rothe Erde to also verify narrow tolerances in the gearing. The previous coordinate measuring machine was not accurate enough – and also too small for parts larger than two meters. “Being able to measure parts up to six meters on a coordinate measuring machine is an enormous benefit and opens up new opportunities,” says Miller. In the past, two meters was the limit; today we start at two meters.”

From raw part to bearing

1) At ThyssenKrupp Rothe Erde in Dortmund, a steel block is cut into slabs and perforated. At temperatures over 500 degrees Celsius, it is rolled several times to achieve the rough size and ring shape. The ring is then trucked from Dortmund to Lippstadt.

2) In Lippstadt, the transformation of the rings into slewing bearings begins using special carousel lathes. It starts with the functional surfaces and the manufacture of contours, e.g. the tracks for the rolling element.

3) Depending on where the slewing bearing will be used, it may be necessary to add gearing. The gearing is applied using different manufacturing methods such as hobbing and shaping based on the module, form and required quality.

4) In order to transfer the resulting high forces and compression, the tracks of the rings must be partially hardened.

5) In another step, the boreholes are drilled and, if necessary, threads applied which are subsequently used to bolt the slewing bearings to the customer’s structures. This demands precise coordination of the boreholes with the customer and compliance with very narrow tolerances to ensure seamless assembly of the components at the customer’s site or the construction site.
6) Two or more rings are aligned exactly using precision machining methods such as grinding or hard turning depending on the bearing shape.

7) Assemblers combine the individual rings with the roller body and additional parts to create a finished bearing. This results in a roller bearing comprised of a lug, support and retaining ring.

References