Leica Geosystems

Case Study METSO Karlstad

Portable Metrology Provides Quick & Easy Solution for Paper Mill Machine Alignment

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HEXAGON METROLOGY

Setting up the Leica Geosystems Total Station takes up a mere 2 minutes, whereas the previous systems consisting of a theodolite and a level took about 10 minutes to set up. The time savings amass exponentially because one Total Station setup can cover several measurement points, while a theodolite-based system needs to be set up anew for each new point being inspected.

A typical paper line machine may have in excess of 20 rolls needing alignment. Anywhere between 20 and 40 meters in length, it may weigh more than 250 tons. The red line traces the paper path in the machine.

When paper is racing through the roller maze at more than two kilometers per minute, everything has to be aligned perfectly. And that is exactly the challenge faced by Metso Paper, a world leader in pulping and papermaking. Its facility in Karlstad, Sweden specializes in the design and manufacture of lines well known for their high-quality towel and bathroom tissue grades.

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A typical tissue line, depending on its width and rated capacity, is about 10 meters wide and exceeds 30 meters in length, and is as tall as a 3-storey building. Weighing a total of several hundred tons, it is an elaborate construction consisting of a steel supporting structure holding the moving parts in place.

An endless belt of running wire mesh is used to form the sheet of paper. It runs parallel to the so-called felt, an endless belt of woven cloth material that contacts the sheet as it passes through the paper machine. The felt guides, cushions and dries the wet paper sheet. And the paper sheet itself originates from the paper stock, which is a slurry of wood fibers (cellulosic material) suspended in water, with the water content of about 97 percent. When the paper sheet reaches the so-called Yankee dryer – mounted in the large round structure (top picture on page 5) – the immense steam and pressure reduce the water content to nearly zero within mere two seconds.

And then there are the rollers, probably the most recognizable parts in any paper machine. Weighing in excess of 10 tons each, rollers are metallic cylinders mounted horizontally and are used to smooth, press, dry or otherwise process the wet (or semi-wet) sheet of paper. Most rollers have a fixed diameter across their entire length, but some rollers (called "controlled crown") are designed to be expanded or contracted in diameter to accommodate deflection at the center and achieve constant pressure across the line of contact between different rollers. The rollers in the Yankee dryer establish contact with the paper sheet, causing the water and moisture to evaporate.

A lot of the machining work is performed in Karlstad, including the large cantilever beams and other key components, whereas the rollers come from the Finnish Metso subsidiary. Because the parts are so complex and so large, every machine is assembled at Metso during a "dry run" to verify that everything fits perfectly together, and then all the components are disassembled and shipped to the customer, where they are re-assembled. Of course, not all components are assembled in the factory because they are too heavy, such as the Yankee dryer. An average machine, depending on its size, takes anywhere between two to three months to build.

The moving mechanical parts are crucial in the paper manufacturing process, and getting them aligned in respect to one another is important not only to avoid jams and tears but also to allow for the high operating speed, which is required to achieve production yields of hundreds of tons per day. But not only moving parts need to be aligned; the framework needs alignment as well. All in all, more than 20 different axes need alignment.

Alignment used to be a much more daunting task than it is today. In the past, a combination of theodolites and leveling instruments was used to achieve roller alignment accuracies of 0.1 – 0.2mm, which is no small undertaking when one considers the sheer size and weight of the components.

Roller alignment the old way

Unlike modern metrology instruments, a theodolite does not "work" in a 3D coordinate system. Rather, it merely measures angles, albeit very accurately. For decades, it was the only way to align rollers. The so-called datum line, which runs along the entire machine being assembled, is used as a reference. The tripod holding the theodolite is placed on the datum line exactly on the notch that indicates the correct position of the front end of the roller being aligned (also called "master end"). This theodolite positioning needs to be done precise to the micron, and is heavily dependent on the operator's skills and the sharpness of his vision.

A skilled operator with an eagle eye will perform the positioning well; an operator who is either less experienced or less meticulous in performing his work may produce completely useless measurement data.

After the parallelism of the roller has been checked using the theodolite, a level is used to check its height. The physical positioning of the theodolite may take up to 10 minutes, depending on how much experience the operator may have under his belt. And this positioning needs to be repeated for each consecutive roller being checked: the operator needs to invest about 10 minutes of his time to reposition the theodolite for each new point needing inspection.

The operator aims at the front of the roller to the best of his ability. Depending on how much out of place the actual position of the front of the roller is, the theodolite will produce an angle readout indicating the deviation from the ideal position, or the difference will be read out on a scale on the roller itself. The front position of the roller is then physically adjusted until the desired position is achieved.
The same type of measurement is then performed for the other end of the roller, after which the roller is aligned to gravity using a level, assuring alignment. The distance between individual rollers is determined using a simple gage instrument.

The abovementioned method is heavily operator-dependent. During all crucial measurements, the accuracy of the results relies on the good vision and judicious work performed by the operator. Change the operator and you will change the error deviation, as no two sets of eyes are the same. Plus, the operator may get physically tired if performing several hours of measurements at one time, which also may negatively influence the integrity of the results produced. And the main restriction of this traditional method of aligning rollers is that rather than working in the three-dimensional space, it only accounts for two dimensions: parallelism and plumb of the roll.

Bengt Lennartzon, Assembly Manager at Metso Paper, explains: "In addition to being very time-intensive and relying on the skill of the operator, the problem with the old instruments was that you needed to be in the reference line to conduct measurements. Our workshop is 160m long and there are always a lot of things in the way, from cranes and heavy machinery to people. In the past, we needed a level to account for the height and a theodolite for the parallelism, and

The position of the insertion axis and its parallelism to the rollers is checked with a reflector. The Total Stations can automatically locate the reflector, significantly shortening the inspection times and removing the human error factor from the equation.

Inspecting the position of hard-to-reach points, like this elevated section on the opposite end of the machine, is a straight-forward undertaking.

this has meant frequently repositioning both. At times, the optimal theodolite position was not available due to the situation on the shop floor, so we needed to work around that, which used to cost valuable time while we waited for things or people to move away."

Roller alignment using modern 3D metrology equipment

Migrating to the Leica TDA5005 Total Station has brought a slew of vast improvements. The most obvious one is in the ease of the instrument setup procedure itself. The Total Station no longer needs to be positioned on a specific location; rather, it merely needs a good line of sight to the roller whose alignment it is measuring. Just like a laser tracker, the Total Station collects true three-dimensional information of the points it is measuring in one go. In short, both parallelism and plumb are checked in one and the same step. And since the Total Station does not need to be meticulously positioned in front of a specific roller, several rollers can be inspected in one step without moving the Total Station to a new position, with the only prerequisite being a line of sight between the measurement point and the Total Station.

Measurement technician Jonas Hellqvist continues: "Now, the Total Station can be located anywhere on the shop floor as long as you can see the reference point being inspected. Setting up the instrument takes a mere 2 minutes. With the theodolite, it took more than 10 minutes just to set it up even if there was a line of sight to the measurement point. And I needed to repeat that procedure with each new roller. A Total Station does not have to be aligned, which saves a lot of time. Plus, we no longer need a level because the Total Station gives us three-dimensional information, which of course includes the height value."

By using reflectors, all the measurements can be performed in one go. And one of the most important factors in the measurement process is automation. Using the Leica Geosystems Total Station incorporates Automatic Target Recognition (ATR), thus removing the human factor from the equation. The operator no longer has to develop a "gut feeling" for theodolite placement or for aiming the optics. The Total Station automatically tracks the reflectors as it is being moved from point to point, producing documentable information about each position measured with the onboard Local Resection and Tie Distance software. All this to a large extent minimizes the dependability on skilled labor, which is a limited resource.

The onboard software and its methodology allow the operator to use the angle component of the instrument to its highest accuracy possible, thus meeting and even exceeding the accuracy requirement of 0.1mm in the roller alignment process. The reliability of the onboard software and its user-friendliness, coupled with the utility of the so-called roller alignment kit, which allows the operator to measure just 4 points on a roller to create two parallel lines to inspect the parallelism and perpendicularity (see illustration on opposite page), yield a quick, easy, highly reliable measurement system impervious to the influences by the operator. More simply put, it is a fail-proof system that creates repeatable measurement results of the highest integrity time after time.

Bengt Lennartzon concludes: "Using the Total Station is especially beneficial when I'm measuring points that are elevated high on the machine. If the roller was 5 meters up from the shop floor, with a theodolite I needed to be up there as well. With the Total Station, that requirement falls away; I can stay right here where am. Unlike with the old system, with which we always needed two operators to conduct the measurements, the Leica Geosystems Total Stations can in many situations be used by just one operator, freeing up skilled labor for other crucial tasks. We are saving time by not performing multiple repositioning of the instrument, the quality and the reliability of the information gathered has been increased by leaps and bounds, and all operators can produce the same high-quality measurements because they are merely operating an instrument and not relying on their skill or perfect vision."

from Neven Jeremic

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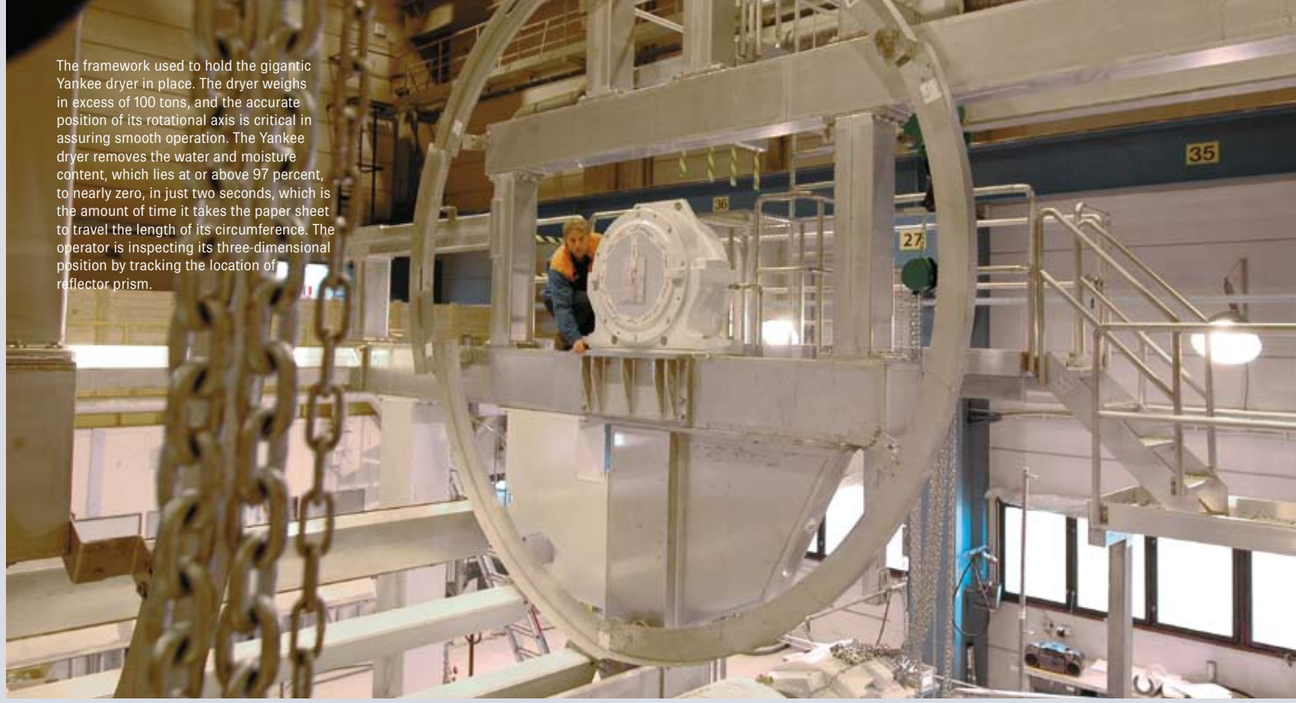

The framework used to hold the gigantic Yankee dryer in place. The dryer weighs in excess of 100 tons, and the accurate position of its rotational axis is critical in assuring smooth operation. The Yankee dryer removes the water and moisture content, which lies at or above 97 percent, to nearly zero, in just two seconds, which is the amount of time it takes the paper sheet to travel the length of its circumference. The operator is inspecting its three-dimensional position by tracking the location of reflector prism.

The so-called roller alignment kit (made up of the floor fixture tool and the roll fixture tool) allows the operator to measure just 4 points on a roller (2 points with the fixture leveled horizontally and 2 points with the fixture leveled vertically) to create two parallel lines to inspect the parallelism and perpendicularity of the roller. This simple procedure greatly reduce operator workloads and assures that no matter which operator is using the Total Station, the data yielded is of the same high integrity each and every time.

The sheer size of paper machines is best seen in this image of the installed machine. Metso Paper sends skilled engineers to perform final equipment alignment at the customer's site.

Whether building the fastest car, the biggest plane, or the most precise tooling, you need exact measurements to improve quality and productivity. So when it has to be right, professionals trust Leica Geosystems Metrology to help collect, analyze, and present 3-dimensional (3D) data for industrial measurement.

Leica Geosystems Metrology is best known for its broad array of control and industrial measurement products including laser trackers, Local Positioning Technology (LPT) based systems, hand-held scanners, 3D software and high-precision total stations. Those who use Leica Metrology products every day trust them for their dependability, the value they deliver, and the world-class service & support that's second to none.

Precision, reliability and service from Leica Geosystems Metrology.

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