Inspection Trends

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Best Practices In Visual Inspection

By Jeff Noruk, Blake Holmes, and Bob Bruss

Laser Tool Offers Alternative for Precise Visual Weld Inspection

Three-dimensional laser precision measurement technology is now available for hand-held visual weld inspection purposes

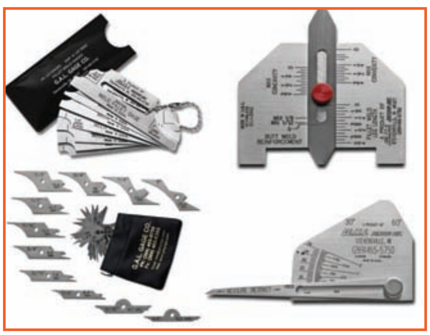

Fig. 1 — A variety of commercially available manual weld gauges.

For many years, manual weld gauges have remained the go-to tool for every inspector performing nondestructive visual weld inspection. Examples of these type gauges are shown in Fig. 1.

Simple in design, these gauges have done what they were intended to do: give simple feedback as to whether a weld meets the minimum weld quality standard requirements. However, these devices are limited to the types of joints and weld sizes they can measure, and various joints require different gauges and techniques. Many types of gauges are on the market today, with most doing only one specific task. In fact, one company even sells a fanny pack to carry all these gauges. Even with the correct gauge for an application, the inspector gets only a go/no-go result since most manual gauges do not give actual measurements. These gauges are also only useful for basic welds and joints so, for example, if a fillet weld has unequal leg sizes or an angle that is not 90 deg, additional calculations and equipment are required to accurately measure the weld. These subjective measurements are then typically recorded manually making the whole process quite time consuming and open to possible errors.

Fig. 2 — User interface screen.

Three-dimensional laser precision measurement technology has been around for decades, but due to equipment size, cost, and complexity has been mainly reserved for robotic and hard automation applications. With recent developments in computer component size, battery life, and wireless technologies, laser-based measurement tools have been developed for hand-held weld inspection purposes. With simple interfaces not unlike a current-generation smart phone (Fig. 2), these tools are easy to use, small in size for tight-area access (Fig. 3), and repeatable so that subjectivity is reduced, thus minimizing the possibility of error. A simple click of a trigger can yield many useful measurements such as leg sizes, convexity/concavity, and toe angles, as well as the detection of discontinuities such as undercut and porosity. Figure 4 offers a pictorial view of the possible measurements with a T fillet weld joint. This information can then be downloaded and saved into a database for reporting or to be maintained as a permanent record. If this sounds too good to be true, it's not, it's simply combining the technology that's already available today into a wireless hand-held device.

To help point out the advantages of the laser precision tool, the following scenario of measuring a skewed fillet (Fig. 5) is reviewed.

Laser Tool vs. Fillet Gauge for a Skewed Fillet Weld

Fillet Gauge

1. Choose correct fillet gauge for specific weld.
2. Consult AWS D1.1, *Structural Welding Code — Steel*, to get correct calculations for the skewed joint.
3. Determine the included angle of the fillet joint.
4. Consult the skewed fillet calculator.
5. Measure the leg sizes of the fillet.
6. Decide if the weld fits within the pass/fail criteria.
7. Manually record results.

Fig. 3 — Checking weld size on heavy-plate pressure vessels.

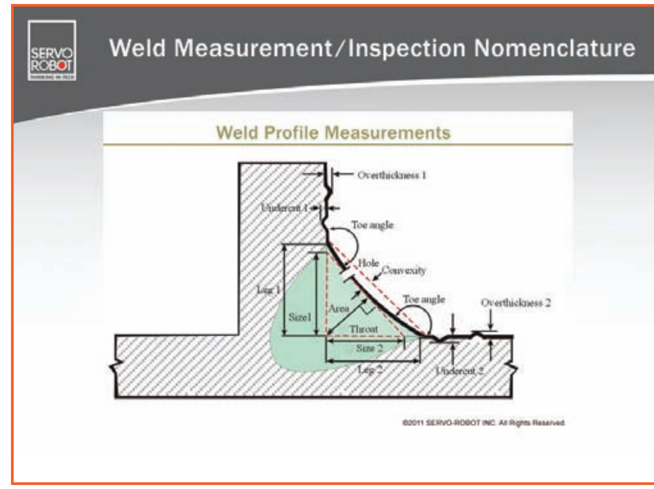

Fig. 4 — Weld feature measurements and defects detected.

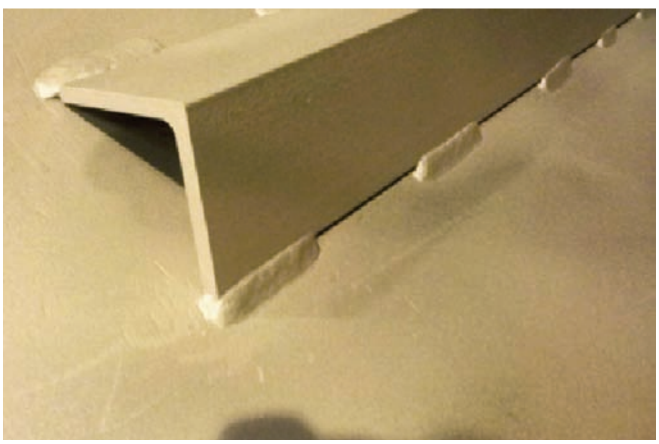

Fig. 5 — The skewed fillet to be measured with a fillet gauge.

Results Found: Angle of skewed fillet joint, go/no-go evaluation of the leg sizes and throat.

Laser Inspection Tool

1. Select fillet weld task in the drop-down menu.
2. Scan the fillet weld in question (included angle of the skewed fillet is irrelevant to the scan) — Fig. 6.
3. Store results in a database.
4. Open results in an Excel® software format for viewing and reporting.

Results Found: Angle of skewed fillet joint, leg sizes, throat size, weld area, undercut on legs 1 and 2, convexity/concavity, toe angle on legs 1 and 2.

It is faster to take the measurement of a weld with the laser inspection tool, and it yields more-precise results and stores the data for easy retrieval and reporting.

Inspection Applications

With one laser inspection tool, joints such as T, butt, corner, and lap can all be measured by simply switching tasks from one type joint to the next. Typical weld sizes can range from small gas tungsten arc welds to multipass submerged arc welds. It is even possible to measure joints before welding, thus giving you an opportunity to prevent problems from occurring earlier in the manufacturing process. Since these devices can yield so much information about your welding operations, it gives engineers the opportunity to improve quality, reduce overwelding, and find upstream problems in part and tooling preparation.

Best Practices

Visual weld inspection is the most prevalent nondestructive examination (NDE) method used today to ensure that the welding manufacturing process is done correctly and meets all applicable standards. Because of the capabilities of this new laser-based precision measuring tool, you need to look at the existing best practices associated with traditional visual weld inspection and determine how these will change. Let's look at some specific areas of the visual testing process.

Qualified People: As is true with all NDE methods, you need to start with the people side of the equation to make sure the person doing the visual weld inspection is qualified to do the work with respect to using the measuring tool and is familiar with the requirements to be met. Using a laser measurement tool does not change this requirement, but because there is the possibility to preprogram the inspection tool, the inspector doing the work only needs to know how to use the tool properly to do a valid inspection.

Measuring Tools and Methodology: Gauge repeatability and reproducibility are fundamental to using any type of gauge or measuring device correctly. Typical manual gauges used for weld inspection normally change only from wear so a calibration is not really relevant. However, there is a large margin for error with respect to how the inspector uses the gauge, and thus two inspectors may get different results. A laser inspection tool, such as the WikiScan, when used per the approved operating instructions, is quite repeatable when measuring standard AWS-type weld joints and welds. Subjectivity is largely eliminated, thus reducing the need for redundant inspections and the fallout from those redundancies, which is to increase unnecessary repairs.

Do the Job Right the First Time: Typically, inspection is seen as

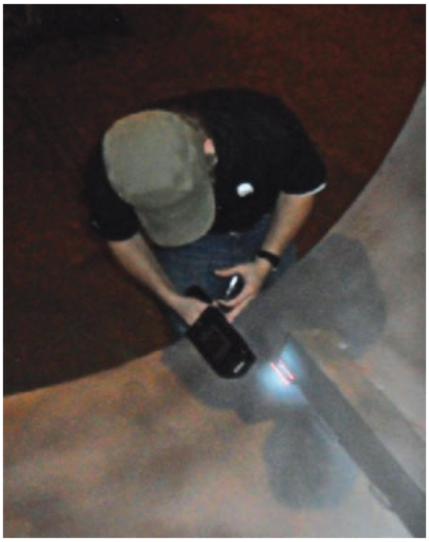

Fig. 6 — The same skewed fillet shown in Fig. 5 being scanned with the hand-held laser inspection tool.

occurring after the weld is made and the results are locked in stone. While there have been attempts to use gauges for weld joint fitup checking, their go/no-go nature has made it difficult to get quantifiable data to act on. However, with laser-based measuring tools, you can accurately check fitup (included groove angle, mismatch, etc.) before starting welding, thus giving you the chance to prevent making a bad weld. Even further upstream, you can use this tool during the procedure qualification work so as to accurately determine the robustness of the design and welding process.

Documentation and Information Sharing in a 24/7 World: The older practice of using a gauge to measure a weld, writing the results down on a piece of paper, transposing them to a computer spreadsheet or database, and then printing a report is labor intensive, prone to error, and slow. The around-the-clock world we live in with engineering being done in one country, the product manufactured in another, and the actual use of the product taking place in yet another, means information must be in an electronic format that is easily transmitted. With a laser measuring tool, not only can you automatically do the inspection and get the results entered into an Excel file as noted in the skewed fillet scenario, but then you can add a picture to the record as well as verbal comments and e-mail this to anyone in the world. Imagine being onsite doing a critical weld inspection and being able to immediately send all this information to your manager, the owner of the product being inspected, or anyone else who needs to know the result to make a timely decision.

Welder Training and Assessment: Welder training and assessment methodology had remained fairly static for many years until the computer started impacting this field. The computer has made virtual reality (VR) a very useful tool for teaching welding without having to burn as much wire and make as much smoke. Whether VR or conventional training is employed, the techniques used to evaluate the welder's skills still involve eyeballing and manual weld gauging. Laser vision measurement allows you to precisely measure the weld size and check for defects, thus quantifying the results such that an accurate score can be given. This benchmark can then be used later to determine whether the welder's skills are improving, degrading, or staying the same.

Conclusion

Now that the digital era is here for surface profile weld inspection, the possibility for advancements is endless. Useful tools such as a pyrometer for measuring preheat, interpass, and postheat temperatures could be a simple upgrade or attachment. There is even the possibility of such upgrades being available in an "app store" where programs are downloaded from the Internet and installed directly into the device.

JEFF NORUK (j.noruk@servorobot.com) *is president and BLAKE HOLMES* (b.holmes@servorobot.com) *is welding engineer, Servo-Robot, Corp., Milwaukee, Wis. BOB BRUSS* (rbruss@sbcglobal.net) *is president, Fusion Consulting Services LLC, Muskego, Wis.*