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ONLINE MONITORING WITH ALMEN-ROUNDS

R.G. Bosshard
Blasting Technology Engineer,
Switzerland-Voketswil

ABSTRACT

Process accompanying online monitoring can be a valuable improvement in quality assurance and research. This paper gives a description of such a task performing *tool and its practical utilization.*

KEYWORDS

Intensity measuring, intensity monitoring, ALMEN-technique, ALMEN-rounds.

REVIEW

Until end of 1993, it was more a scientific job[1], to record online an intensity gradient of a shot peening process. Then a field-proved intensity monitor came on the market and such monitoring job were tremendously simplified.

PRINCIPLE

All practical intensity definitions are somehow connected to the old but famous ALMEN-idea, with the rectangular shaped, standardized metal strip. So it is understood, that when working out details and designing a shot peening monitor, ALMEN-based features should be considered but should not stand in the way of more creative solutions. So the rectangular strip has been converted to a round one, but all the philosophy and intensity measurement remains the same. Only the arc height measuring device is fixed to the ALMEN-block and the unit gets exposed to the shot stream in this configuration. Such an arrangement allows the monitoring / *measuring of the arc height, right from process start (zero) to the maximal achieved* intensity with a certain arc measurement. The mechanical and interface outfit bases on the known and field approved rebounce-type sensor[2] introduced in 1991.

1. EQUIPMENT

There are three elements : The Test Specimen, The Sensor Head and The Monitor.

1.1 The Test Specimen

The so called ALMEN-Round Fig. 1 is a cut out from a standard ALMEN strip of either "A", "N" or "C" - thickenss and of original quality "Premium". The precision Laser-cut operation guarantees a ALMEN-strip equivalent round disk in every respect. Additionally such rounds get dragged over a 280 grain

sheet of emery cloth, then being cleaned, examined, corrosion protected and packed.

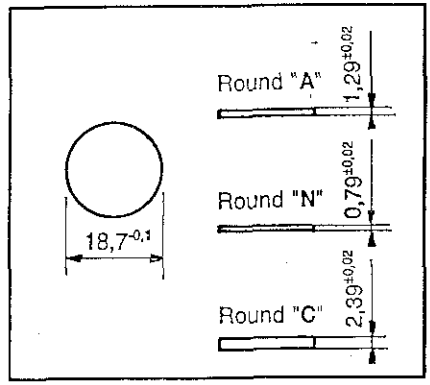

Fig. 1. Test Round Specification

1.2 The Sensor Head

A heavy, specially shaped steel bar, rectangular at one side, carries a finger like dome. On top of this dome the ALMEN-Round specimen gets tightened with a swivel nut. The specimen is only fixed peripherically on both sides on a tiny rim. The dome bears a pin touching the specimen on the inner side, the other side of the pin works on a strain gauge, actually transmits the deflection of the specimen. This will induce a output signal exactly linear to the deflection. The unit Fig. 2 is treated to highest hardness in order to withstand the hazardous conditions when exposed to the shot stream. A protected cable also connects to the monitor box or interface outside the peening area.

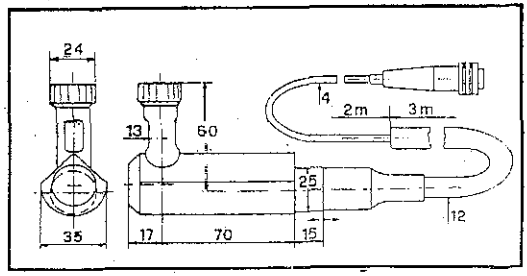

Fig. 2. Sensor head

1.3 The Monitor

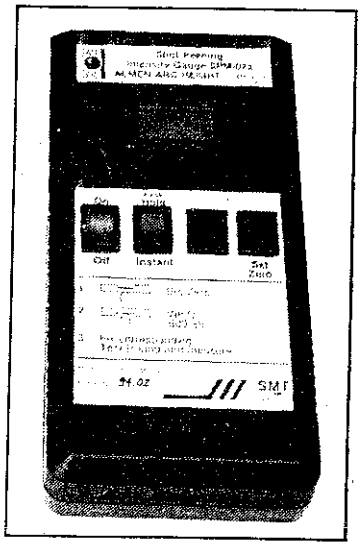

Fig. 3. Handhold Monitor

Commercially available is a hand hold battery operated monitor Fig. 3 that allows the 3-digit reading of the ALMEN arc high in metric or inch-system. Additionally an analog out signal 0-1 V is provided. One toggle switch ON/OFF, one switch for DATA HOLD and the ZERO knob allow the operation of the outfit. For O.E.M. or may othe applications, numerous interfaces are available or can be recommended to communicate with PC's or CNC equipment.

2. DISPLAY AND OUTPUT SIGNAL

If the sensor head does not carry an ALMEN-Round, the display will read 800 µm above the allowed maximal arc height of 609 µm admitted by standard ALMEN strips. Consequently, if a ALMEN-Round is fitted, the monitor should read around 000µm, with the calibration disc fitted, the reading must be 000µm. Accordingly, the analog out signal will work identically. So it the ALMEN-Round is exposed to a shot flow that therefore being deformed, the increasing arc height can be observed in the same way as the shot is attacking the surface. If transmitted to a strip chart recorder, the result as in Fig. 4 is the typically known ALMEN intensity curve. Such a shape will be obtained if the shot flow works constantly on to the ALMEN-Round. If the shot works in a reciprocating manner, a stepped curve Fig. 5 will be the answer.

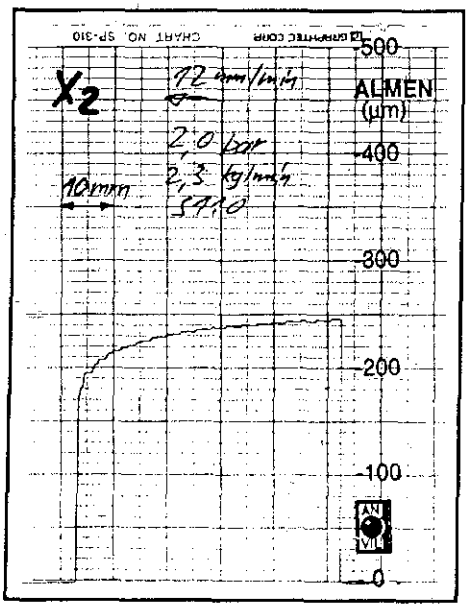

Fig. 4. Curve Continuous Flow

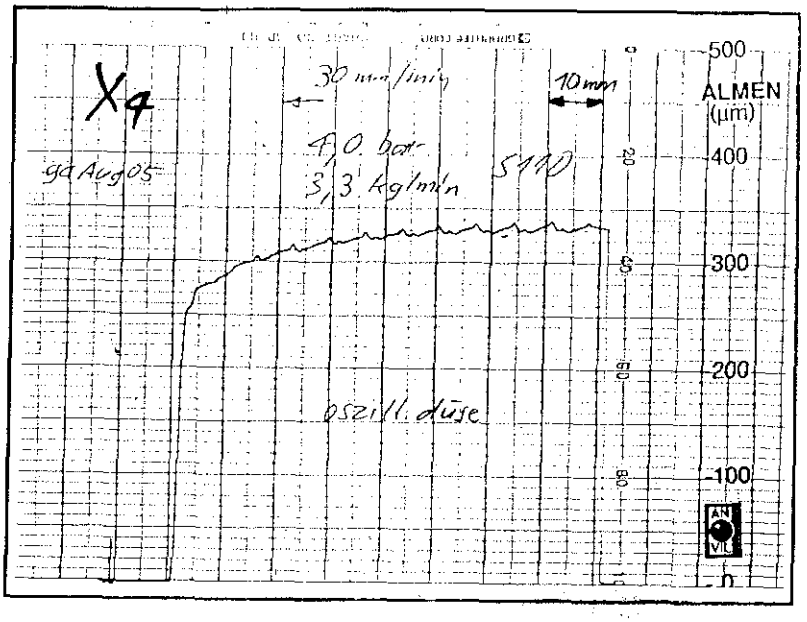

Fig. 5. Curve reciprocating flow

3. USE OF THE EQUIPMENT

3.1 Saturation determination

To measure the intensity of a given machine setting, the sensor has to be exposed to the shot stream in exactly the same way as the original workpiece will be placed. Also for this application, the monitor must be connected to a recording device such as a simple strip chart machine, a hybrid recorder or a PC-interface. The result will be the commonly known knee-shaped ALMEN-curve. The standardized "double time - 10% increase" figure known as ALMEN-saturation, can be easily worked out from the curve obtained. A corresponding software is presently under development.

3.2 Intensity determination - part related (static)

A common way to verify intensities, is the installation of one or more rectangular ALMEN-blocks eg. on scrap parts or dummy pieces. For exactly the same purpose, an ALMEN-Round-holder has been developed. After processing one or more ALMEN-Rounds, the rounds then must get fixed onto the sensor to measure the arc height.

3.3 Intensity determination - machine related (static)

Similar to the part related application mentioned before, the method is quite handy to monitor a machine set-up at the beginning and at the end (or at intervals) of a peening process. Specially with robotic equipment, all parameters including, nozzle positioning, can be checked.

3.4. Intensity determination - part related (on-line)

In some cases it might be possible to fix the standard sensor in relative position to the part to be processed. This enables to monitor the intensity-profile on-line.

3.5 Intensity determination - machine related (on-line)

The same idea as for machine related static application applies here. But in this case, two or more sensor units are necessary because one piece ALMEN-Round can only be used once in case full process intensity is applied to it.

3.6 Recheck of ALMEN-strips

(the conventional rectangular shaped strip)

As such already processed standard ALMEN strips are spherically bent, the geometry fits perfectly on to the sensor measuring rim. The value measured is identical to the original ALMEN-reading.

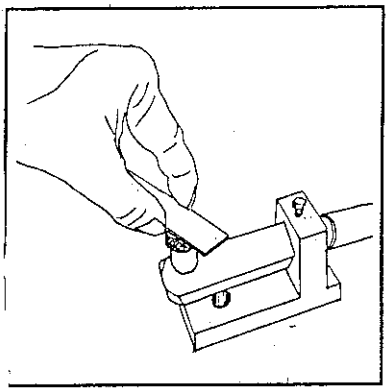

Fig. 6. Checking standard ALMEN-strips

4. TECHNICAL DETAILS

4.1 Standardization

As this is a new equipment with insufficient experiences in some respects, as acceptance as an national or international standard is not feasible. At the time being, nevertheless, intentions are announced and work on details goes on. At present, all ALMEN-Round activities are based on the mechanical configuration as shown in Fig. 7

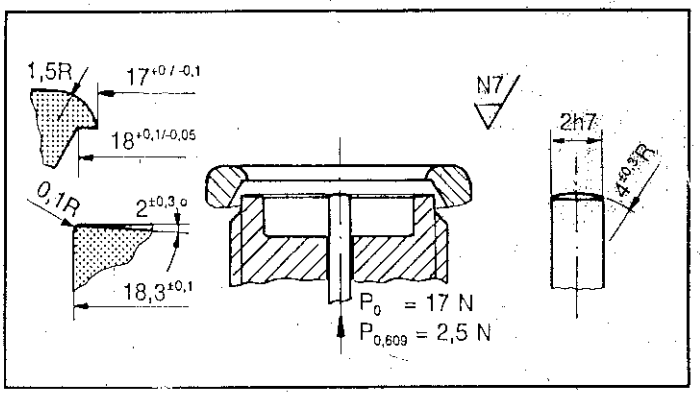

Fig. 7. Mechanical Configuration

4.2 Calibration

The set will have to be calibrated according to latest quality assurance recommendations, also such a procedure is provided for. The first operational action is the "zero setting" with a calibration disc, which is individually a reference to either "A", "C" or "N" original ALMEN-strips. Consequently the

procedure has to be applied for the maximum deflection which has been defined as 0.0024 inches, 0.609 mm respectively. This actually is the maximal allowable arc hight for all strips. As the ALMEN-Round technique works with a preload and at least the thin "N"-Rounds are somewhat pressure sensitive, the calibration discs are prepared for a compensating effect. The corrections are, on the base of 17N load (Fig. 7), 013 µm for "N"-Rounds, 003 µm for "A"-Rounds and 000 µm for "C"-Rounds. It has to be understood, that the "A"-Round correction is nearly negligible, as this value is near manufacturing and wear out tolerances.

4.3 Accuracy

Indications about the accuracy of this monitoring system are fairly complex. As the complexity of this subject on original ALMEN-strips is well known, similar arguments are facts also for the here described monitoring system. From the practical point of view, the ALMEN-Round system is designed in every respect, to give at least 3 times better overall accuracy compared to the original ALMEN-technique. To gain confidence, the most simple way is field testing. Both ALMEN systems can be exposed to a peening process at the same time with the same parameters. The following table Tab. 1 lists the main differences between strips and rounds :

Tab. 1 Differences between Strips and Rounds

	ALMEN-Round	ALMEN-Strips
Shape	Round	Rectangular
Thickness	Identical	Identical
Material	Identical	Identical
Heat treatment	Identical	Identical
Hardness	Identical	Identical
Direction of rolling	Not defined	Defined
Surface	Identical or better	Identical
Flatness	Better than corresponding standard	To standard
Torsion sensibility	No	Yes
Clamping	Circular	With four screws
Embedding	Diaphragm like fitted with a defined preload over full process	Solid rest on block only at beginning of process, then starts to buckle up
Calibration of Guage	Standard routine to calibrate to zero and verify gain	Only latest models to calibrate zero and verify gain

5. CONFORMITY

This monitoring system claims to give exactly the same results as the original ALMEN method. However some differences cannot be ignored,even the influence on the final result is negligible. Further experimental work shall tell more about this aspect.

6. PROBLEMS

From the technical point of view, early problems in respect of highly useful mechanical devices have been solved. Also the ALMEN-Round production has been established successfully, only the "C" size Rounds are somewhat tricky to be cut out of the "C" strips. This is because the longside strip-edges are fully rounded and therefore affecting the recommended "A"-Round diameter of $18{,}7^{-0.1}$mm.

7. ECONOMY

For many applications, the ALMEN-Round principle together with the online monitoring could reduce costs. Equipment costs will be higher, on the other hand a considerably shorter manipulating time could be expected. With modern data recording, also this process can be more efficient. Presently, ALMEN rounds are more than double the price of strips.

8. CONCLUSION

As with the described a true online ALMEN-test procedure can be performed and industry and research has a new tool to improve peening-monitoring tasks. Also the method is predestinated to be combined with a PC's capabilities. So it is possible to record online the ALMEN intensity and the well known "knee" with the 10% increase-definition can be detected simultaneously.

9. OUTLOOK

Introducing a new idea against a psychological barrier (50 years ALMEN-strips) is a challenge. Also minor changes in shop handling and documentation can make things difficult. But future worldwide experiences will show, to what extent the ALMEN-Round principle will find its way as a new tool.

REFERENCES

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