



REFERENCE BLOCK DESIGN FOR HIGH RESOLUTION ULTRASOUND IMMERSION TANK TESTING

Daniel KOTSCHATE¹, Dirk GOHLKE¹ and Mark EISENTRAUT¹

¹Bundesanstalt für Materialforschung und -prüfung, Germany

²Brandenburg University of Technology Cottbus, Germany

contact e-mail: daniel.kotschate@bam.de

Abstract: In respect of modern approaches in material sciences and highly increased requirements on materials on safety relevant components, quality management and non-destructive testing reclaims a steadily increased meaning. The destructive meaning of measuring the degree of purity is defined in DIN EN 10247 through metallurgical investigations, especially microsections.

For and comparable, but non-destructive testing due ultrasonic testing, the material the SEP 1927 is a well-defined industry standard. A novel and alternative way of reference block construction was focused by this work. The proposed amendments, regarding the manufacturing and machining, are less time and cost consuming.

Verified by measurements the presented reference block fits the same acoustical characteristics and the requirements of the guideline.

Introduction

The SEP¹ 1927 is a well-known and defined standard for purity grade estimation of modern materials in Germany and the European Union. For better comparison of measurement setup of different steel manufacturer, the SEP 1927 defines a full description of the necessary sensitivity calibration on a reference block (figure 1). During recurrent measurements on different materials, several reference blocks have to be machined according the described standard. Unfortunately the machining process for each reference block is a highly time and cost consuming part. Especially faults during the last process, the drilled flat bottom holes in certain depths, could be result in a knock-out criterion for the whole block. During the assisted work on a bachelor thesis, the a novel and alternative attempt of a simplified version was designed. To fulfill the acoustical dependencies given by the guideline the 3D model of the new reference block was first simulated through CIVA, proved by sample measurements and compared to the original reference block of the guideline.

¹Stahl-Eisen-Prüfblatt



1 Design process

During the design process of the final construction, three different drafts were developed and compared to each other to gain the positive and negative considerations of each draft. As result the best draft was chosen and manufactured at BAM². The aim of this construction was to fit at least the same or better acoustical results with the same or lower machining effort. Due cutting the whole cylindrical block in separate planes the whole manufacturing process

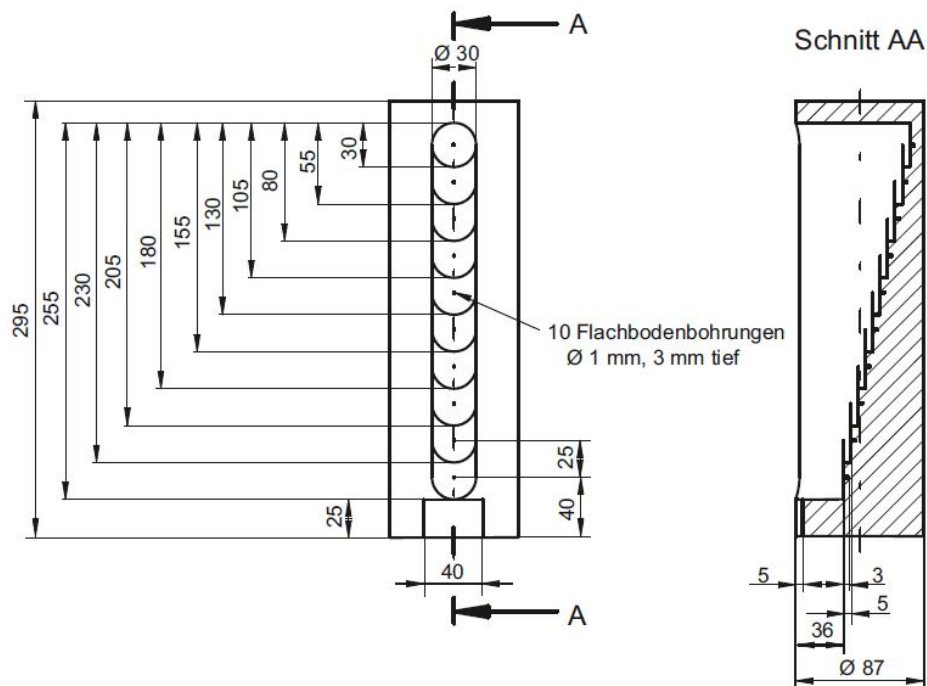


Figure 1: SEP 1927 reference block

could simplified dramatically. Due the cylindrical shape each block could representing a concrete sample for material thickness and could be machined in a separate way (fig. 2). After cutting and drilling the sample blocks for each desired depth, the machining process is already finished. Of course, there are as many reference parts as sample points for the DAC³ are needed. With increasing the number of reference parts, the whole process would came unmanageable. For better handling, an mounting option was needed to guarantee the alignment of each part, hold all reference parts, and align the whole reference block with the measurement setup itself.

2 Comparison

To fit the considerations of the guideline, the geometry of the drafted reference block was simulated using CIVA and compared due referenced measurements in an existing immersion tank testing setup. For simulation the assumption of same material characteristics and

²Bundesanstalt für Materialforschung und -prüfung

³Distances Amplitude Correction

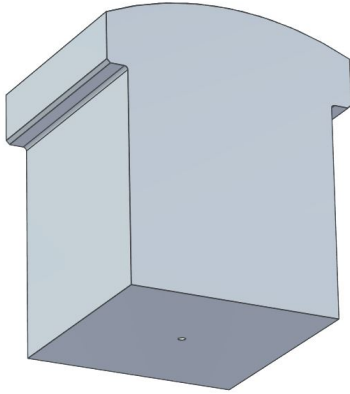


Figure 2: Depth dependent block

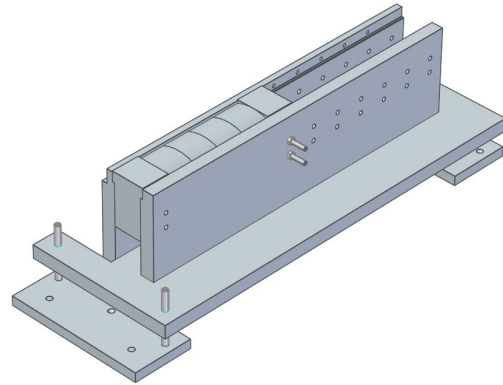


Figure 3: Full reference block

properties was done for both reference blocks. For both, simulation and investigation, the restrictions regarding the ultrasonic testing equipment of the SEP 1927 were followed.

2.1 Simulation results

For avoiding the geometrical considerations and keeping the time consuming machining process as low as possible, the investigation setup of the SEP1927 analysis was simulated under usage of CIVA.

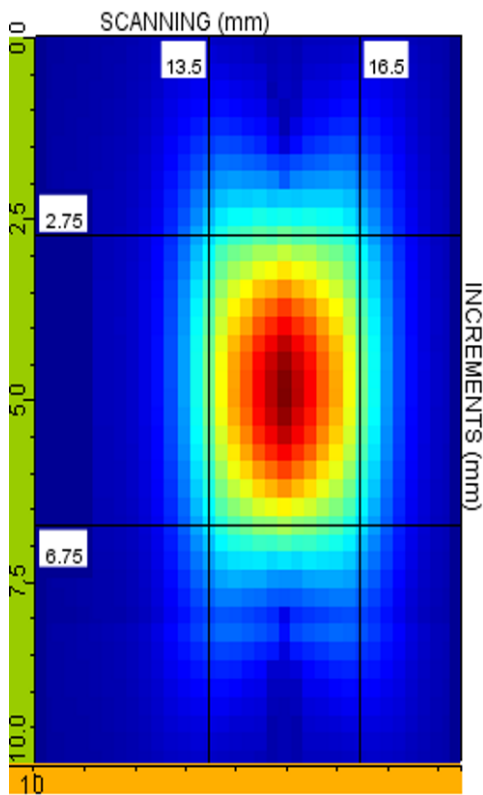


Figure 4: Old reference block simulation

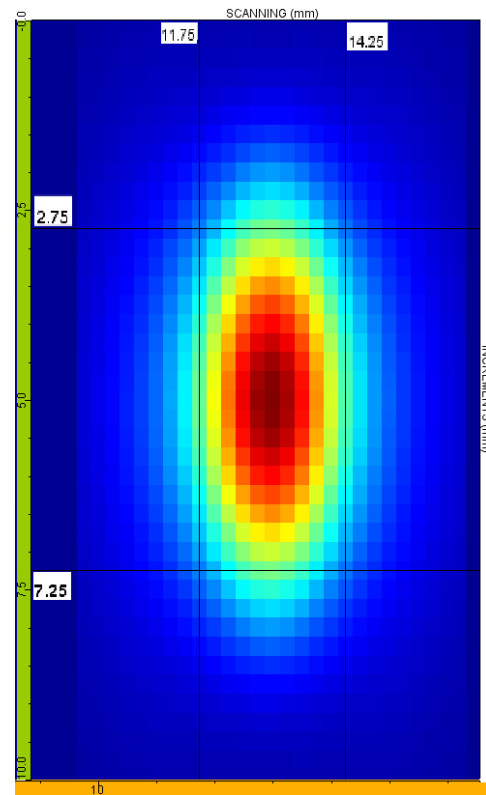


Figure 5: New reference block simulation

The figures 4 and 5 are showing the C-Scan representation of the artificial flaw (DSR⁴, 1mm). Under usage of the same investigations conditions (transducer, spatial and lateral resolution) the flaw size, depending on the acoustical limitations according the geometrical mapping, should be not changing for both reference blocks. due the investigation setup on same geometrical properties.

2.2 Measurement results

Under respect of the testing setup of the SEP 1927 analysis booth reference blocks were measured under same properties (water path, applied gain and material). Table 1 illustrates the full screen height value for different distances. The maximal noticed difference in reflected amplitude was $\pm 0,5$ dB. In this case the new reference block fits the requirements of the guideline nearly perfect.

Table 1: Measurement results

reference block	Depth [mm]	FSH [%]	V_R [dB]	DSR [mm]
SEP 1927	8	91	7.1	0.6
	18	62	3.7	0.8
	28	34	-1.4	1.1
	38	18	-7.0	1.5
New design	8	90	7.0	0.7
	18	62	3.7	0.8
	28	33	-1.7	1.1
	38	19	-6.5	1.3

3 Closure

Due the thesis an alternative approach of the SEP 1927 reference block was constructed and machined. The presented reference block fully fits the acoustical properties and was verified under usage of simulation tools and ultrasonic measurements in immersion tank testing. The presented draft reduces the risk of the mechanical knock-out criterion through broken drills during the manufacturing and makes the reference block more easy to handle. With option for laying or standing mounting, the new design is more flexible in the meaning of interchangeable. An additional enhancement of the spatial resolution of the required distance dependent amplification is also possible without machining a complete new reference block.

4 Acknowledgments

This presented work is based on a supervised bachelor thesis of Mark Eisentraut and was supervised by Dr.-Ing. Franziska König (Brandenburg University of Technology Cottbus, Germany) and M.Sc. Daniel Kotschate (Bundesanstalt für Materialforschung und -prüfung, Germany).

⁴Disc Shaped Reflector