15th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2011, Prague, Czech Republic, 12-18 September 2011

TEST ANALYSIS WITH ULTRASOUND OF WELDED UNIONS AT CONSTRUCTION OF CAGE BLIND SHAFT IN TREPCA MINE

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ABSTRACT

*On the underground transportation system of the Trepca mining industry, there is used the cage of the blind shaft, which is made for operation in Trepca's horizon's, which perform in a constructive way from level **V** until level **XII.***

Blind shaft cage in mines is used for worker transporting, for ore transporting, for furnishing horizon's with machinery and equipments, oils, explosives etc. This project treated experimental test with ultrasound of welded unions in shaft cage after welding process.

Keywords: cage, ultrasound, seam, examination, error

1. INTRODUCTION

Ultrasound shows the movement of mechanical vibrations. Depending on the frequencies differ: infrasound, normal sound, ultrasound and hyper sound.

Mechanical vibrations are related to measurement .Electromagnetic waves can move in vacuum.

Movements of mechanical vibrations developed in the form of longitudinal or transversal waves. The speed of longitudinal and transversal waves depends on the density of the material ρ , elasticity E, and coefficient of Poisson P.

$$V_l = \sqrt{E(1-P)/\rho n(1+P)(1-2P)}[m/s]. \quad \text{... (1)}$$

$$V_t = \sqrt{E/2\rho n(1+P)}[m/s]. \quad \text{... (2)}$$

Cage of blind shaft is build by the constructive steels, and attachments are built from the coast iron and brass, for mentioned materials of cage which are examined by ultrasound, are presented in table 1.

Table 1. Amount for ρ, E, P, V_l, V_t

Material	E [N/m^2] 10^{10}	ρ[kg/m^3]	V_l [m/s]	V_t [m/s]
Steel St 52-3	21	7900	5850	3230
Steel St 60-2	21	7800	6100	3300
Cast iron	12	7200	6260	3080
Brass	10	8500		

2. REVIEW PROCESS WITH ULTRASOUND

For constructive steel of cage of the blind shaft, the speed of longitudinal waves is V_l = 5920m/s, while for transversal waves is V_t = 3230m/s [3].
Starting from the speed of wavelengths have:

$$\lambda = v / f[mm]. \quad \text{... (3)}$$

When working with transverse waves, for the same frequency, gain length smaller waves.
Ultrasound produced the piezoelectric effect respectively vibrations that produces quarts when he brought electricity. For this vibration used the quartz crystals $Si0_2$, barium titan $BaTi0_3$ or lithium sulfate Li_2SO_4.
At the boundary between two materials, occurs refraction and reflection of ultrasound, depending on the material environments.
The sound changes depending on the material expression:

$$\sin\alpha / \sin\beta = \nu_2 / \nu_1. \quad \text{... (4)}$$

The quantity of reflected sound is:

$$R = (\rho_1 V_1 - \rho_2 V_2)/(\rho_1 V_1 + \rho_2 V_2). \quad \text{... (5)}$$

And the quantity of sound that passes

$$D = 2\rho_1 V_1 /(\rho_1 V_1 + \rho_2 V_2). \quad \text{... (6)}$$

For the ultrasound examination should be passed in three processes:
a- Transfer process of sound
b- Reflection process (echo)
c- Resonance process

Transfer process of sound based in recording of power weakened in the case of (error)
Working with two head one of which is emits ultrasound and the other serves as the sound receiver. This mode is suited for research of major errors.

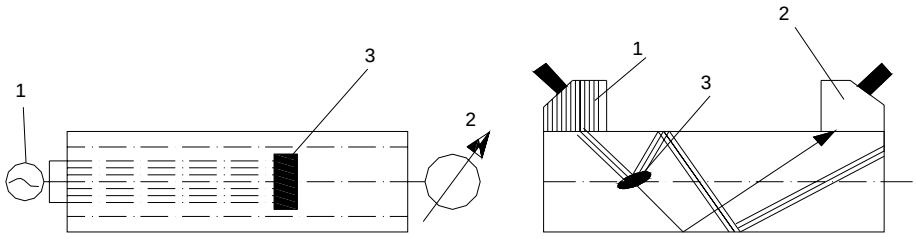

Figure 1. Processes of transfer of sound a) a-control with normal head, b)-heads are steep, 1-imitators, 2 - receiver, 3 - error.

Recently is developed method with Lambie wave, which serves to control the thickness of small parts. This method relies on the use of waves "superficial" which obtained when the angle of refract β =90º.
Reflection process is based on the sound which is reflected from the opposite surface of the part. Usually the issuer and the receiver placed in the same head, and the material is controlled only by one side.
On the opposite side can be recorded voice which weakest exponentially, which in case of error occurs "echo" uneven. Position and its size defines the position and size of the error

Resonance method based on the waves interference return waves emission. If the size of the material is equal to the sum of half wavelengths, resonance is achieved, and the thickness of the material is:

$$S = n \cdot \lambda / 2 = n \cdot \upsilon / 2f\,[mm]. \qquad \text{... (7)}$$

n- Integer
λ- Wavelength
υ- Ultrasound speed
f- Ultrasound frequency
This method serves to measure the thickness, bilaterally control, corrosion places etc.
While selecting the type of probe (head) should be think about, should be think about control of material. Welded steel parts controlled with 2-4 MHz frequency and for parts of cast iron 0, 5 – 2 MHz.
Frequency relates to the size of the error –the sensitivity of the recording. Errors smaller than the wavelength can not reflect ultrasound and therefore can not detect. To control welding seam mostly worked with head inclined, which emit transverse waves. The angle of refraction is:
α = 80º - for up to15 mm thickness
α = 70º - for thickness up to 15 to 30 mm
α = 60º - for thickness from 30 to 60 mm
α = 45º - for thickness over 60 mm
The road which passes ultrasound *L* depends on the material's thickness and the refraction angle α which is noted on head ultrasound [2].
For the curved part of the correction is necessary, depending on the diameter D
On examination with ultrasound as the material for easy movement of the head is used thick oil.

$$L = 25 / \cos\alpha\,. \qquad \text{... (8)}$$

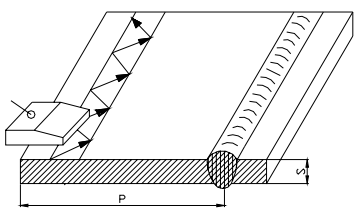

Figure 2. Seam control with ultrasound

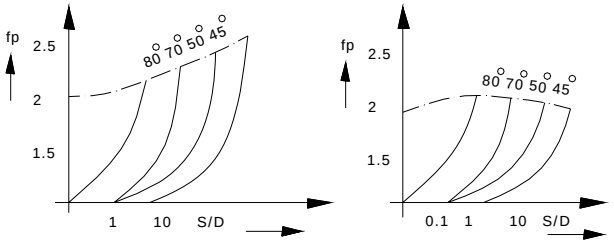

Figure 3. Correction factor fp,

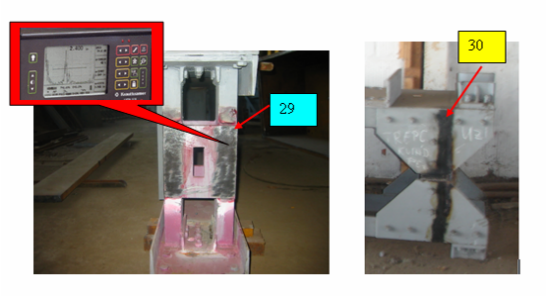

Photo 1. Review of the head of the counter weight

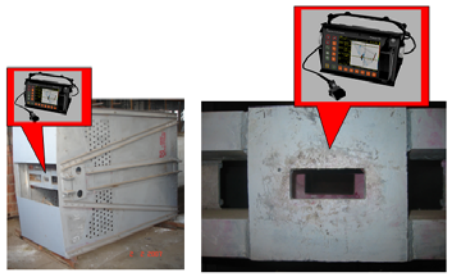

Photo 2. KBSH review head

3. PARAMETERS OF REVIEW BY ULTRASOUND

During the review process of the welded joints of the blind shaft cage in the mine Trepca are using the parameters according to standard [4].

Table 2. Parameters of the test with ultrasound

1	Object to review	KBSH
2	Place	F.P.P „TREPCA"
3	Standard	EN 1714 A
4	Level approval	1712 - 3
5	Type of review	Welding unions
6	Number of review	(x) first
7	Review equipment	USN 52 L
8	Head review	MWB45-4
9	Calibration of equipment	47dB; 4MHz; AVG
10	Record size	KSR 1 [mm]
11	Correcting surface	2 (dB)
12	Review position	cross
13	Medium connecting	oil
14	Condition part	clear
15	Indicators L	2
16	Indicators Q	3
17	Distance from reference points	1 [mm]
18	Value on Echo	Hu (dB)3
19	Depth	[mm]
20	Length	[mm]
21	Position of wave transmission	4 [mm]
22	Longitudinal error	(L) = 2
23	Transversal error	(Q) = 3
24	Exceeding the record size	2

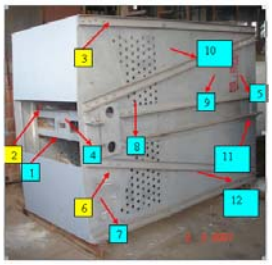

Photo 3. Review of the right side of KBSH

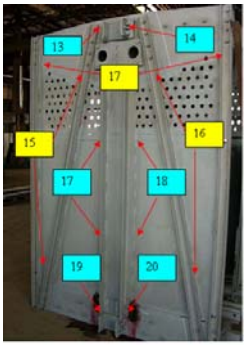

Photo 4. Review of the left side of KBSH

4. CONCLUSION

During the examination by ultrasound USN 52L MW B45-4 of cage, according to the standard for examination with ultrasound EN 1714 there are few defectoscopy elements or dislocated elements.
Errors observed are dislocations, lack of welding and errors in the bud.
According to the results obtained, is noted that beyond the errors shown under the standard conditions above.
Parts that are negatively appreciated should be repair and complete with the seam welders.

5. REFERENCES

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