THE BLIND HOLE INFLUENCE IN RESIDUAL STRESSES DETERMINATION

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Abstract: *The blind hole method with deformation blank test is mostly used to determine the residual stresses in the engineering constructions. The method accuracy is influenced of the hole depth realized in the part. The paper treats the blind hole depth influence on the deformations produced by releasing of the stresses*

Key words: *strains, stresses, finite element, deformations, residual stresses, FE analysis, mesh, and blind hole.*

1. INTRODUCTION

For the knowledge of the state of residual stresses in the parts, in different manufactural phase, is necessary to evaluate this kind of stresses using some techniques (preference semi destructive and nondestructive) with higher precision. Even if was realized important some progresses in the residual stresses field determination is necessary important efforts for development of the adequate techniques, preference semi destructive and nondestructive, cheapest and exactest [1].

Among the used methods for residual stresses determination, only blind hole method with deformation blank test and those that use X diffraction beams are considered acceptable and favorable for engineering applications.

The blind hole principle with deformation blank test consists of circular hole realizing, with 1.5-3 mm diameter, the depth appreciatively equal with hole diameter and the measure of produced deformations by stresses releasing. These deformations, putted in the analytical relations from elasticity theory will determine the resultant stresses and those directions. After making circular hole (with drill by circular milling machine) the stresses will release and the hole will get an oval shape (this thing indicate the residual stresses direction existing in the parts).

Consequence of the made measurements, Rendler and Vigness plotted the variation graph of the strains function of fraction between depth and diameter of a hole. So, the optimal hole depth for totally releasing residual stresses is equal to the hole diameter and for higher depth the deformations remains constant. Using finite element analysis was established the optimal hole depth in residual stresses determining.

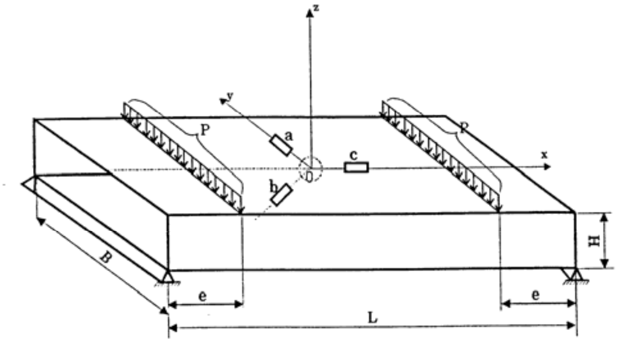


Fig. 1 The bending loading of steel specimen

2. THE INFLUENCE OF DRILLING DEPTH

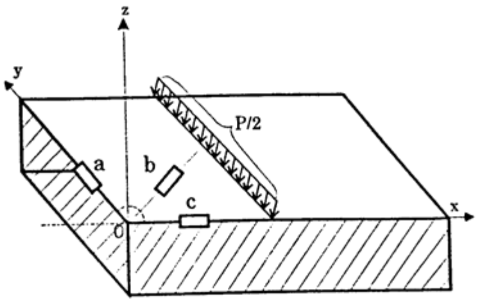
The study was realized by finite element analysis on a steel specimen rectangle cross-section (90 x 7 mm) and L = 760 mm length bending loaded by force P = 125 N (figure 1).

Because the specimen have geometrical symmetry of loading the study was realized only on a quarter of specimen (figure 2).

The modeling is made using a fine meshing around hole for increasing the precision of stresses determination. In the center of the strain gauges, pinned on the specimen surface, was realized the drilling gradually of one hole: 0,25 D_0, 0,5 D_0, 0,75 D_0, D_0 and 1,2 D_0 (D_0=3,15 mm).

For every stage of drilling was determined the nodal displacements δ around hole (figure 2) on the strain gauges directions (table 1).

This analysis permitted the study of hole depth influence upon the nodal displacements, influence that is plotted in figure 4.



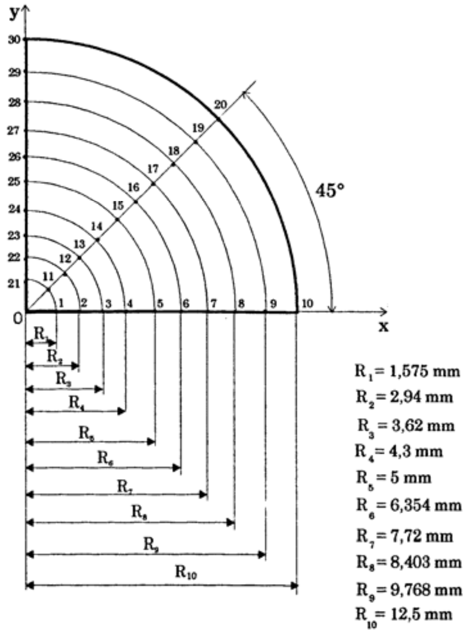


Fig. 3 The establish of FE

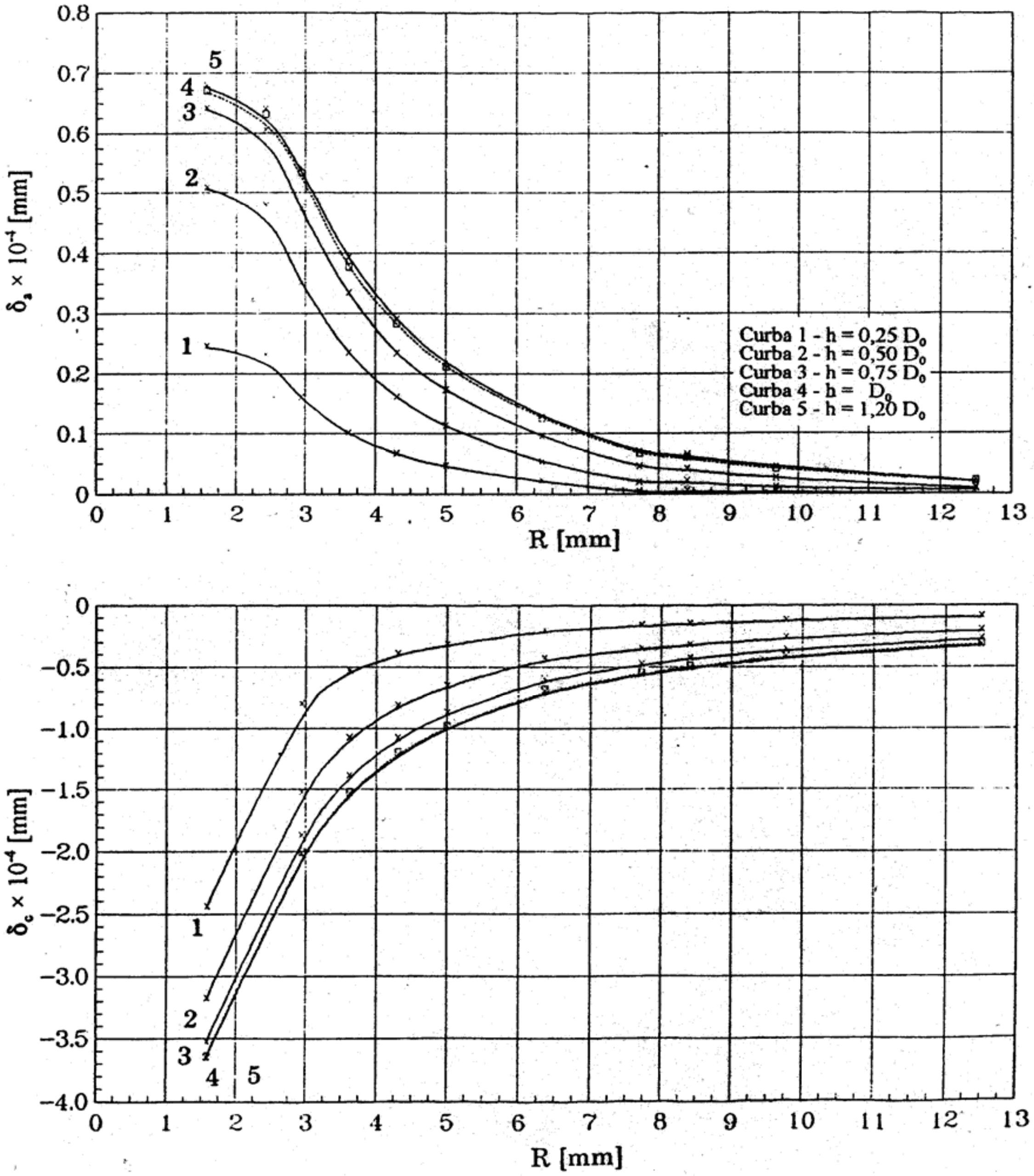


Fig. 4 The influence of drilling depth upon nodal displacements

3. CONCLUSIONS

Remark that the nodal displacements increase with the increasing of the hole depth, and for big diameter of a hole this increasing can be neglected.

So, was demonstrating by finite element analysis and experimentally that the depth of hole is not necessary to exceed the hole diameter (for facilitating the defect repairing due to the drilling operation).

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Table 1.

Nod	Displacements x 10^{-4}mm		The nodal displacement after drilling x 10^{-4}mm									
	Direction	Before drilling	$h=0,25D_0$	δ	$h=0,5D_0$	δ	$h=0,75D_0$	δ	$h=D_0$	δ	$h=1,2D$	δ
0	1	2	3	4	5	6	7	8	9	10	11	12
1	Ox	-2,523	-4,975	-2,452	-5,714	-3,191	-6,061	-3,538	-6,177	-3,654	-6,186	-3,663
2	Ox	-4,725	-5,536	-0,811	-6,26	-1,535	-6,607	-1,882	-6,743	-2,018	-6,757	-2,032
3	Ox	-5,828	-6,373	-0,545	-6,917	-1,089	-7,228	-1,4	-7,363	-1,535	-7377	-1,549
4	Ox	-6,927	-7,331	-0,404	-7,75	-0,823	-8,015	-1,088	-8,136	-1,209	-8,156	-1,229
5	Ox	-8,02	-8,346	-0,326	-8,682	-0,662	-8,905	-8,885	-9,075	-1,055	-9,084	-1,064
6	Ox	-10,25	-10,46	-0,21	-10,69	-0,44	-10,86	-0,61	-10,95	-0,70	-10,96	-0,71
7	Ox	-12,44	-12,61	-0,71	-12,8	-0,36	-12,93	-0,49	-13,00	-0,56	-13,01	-0,57
8	Ox	-13,54	-13,7	-0,16	-13,87	-0,33	-13,98	-0,44	-14,05	-0,51	-14,06	-0,52
9	Ox	-15,75	-15,88	-0,13	-16,02	-0,27	-16,12	-0,37	-16,17	-0,42	-16,18	-0,43
10	Ox	-20,17	-20,27	-0,1	-20,38	-0,21	-20,45	-0,28	-20,49	-0,32	-20,5	-0,33
11	Ox	-1,786	-3,437	-1,651	-3,855	-2,069	-4,058	-2,272	-4,126	-2,34	-4,216	-2,43
	Oy	0,5295	0,6196	0,0901	0,7005	0,171	0,7524	0,2229	0,7802	0,2507	0,848	0,3185
12	Ox	-3,34	-3,688	-0,348	-4,973	-1,633	-4,973	-0,768	-4,155	-0,815	-4,177	-0,837
	Oy	0,9876	0,8711	-0,1165	0,78	-0,2076	0,7557	-0,2319	0,755	-0,2326	0,755	-0,2326
13	Ox	-4,12	-4,356	-0,236	-0,457	-0,3663	-4,684	-0,564	-4,732	0,612	-4,742	-0,622
	Oy	1,218	1,136	-0,082	1,058	-0,16	1,024	-0,194	1,016	-0,202	1,016	-0,202
14	Ox	-4,9898	-5,077	-0,0872	-5,243	-0,2532	-5,345	-0,3552	-5,431	-0,4412	-5,45	-0,4502
	Oy	1,448	1,388	-0,06	1,326	-0,12	1,293	-0,155	1,284	-0,164	1,282	-0,166

Table 1. – continuing

0	1	2	3	4	5	6	7	8	9	10	11	12
15	Ox	-5,67	-5,821	-0,151	-5,962	-0,292	-6,049	-0,379	-6,081	-0,421	-6,095	-0,425
	Oy	1,68	1,632	-0,048	1,582	-0,098	1,554	-0,126	1,544	-0,136	1,541	-0,139
16	Ox	-7,158	-7,34	-0,182	-7,449	-0,891	-7,519	-0,361	-7,533	-0,375	-7,538	-0,38
	Oy	2,156	2,111	-0,045	2,077	0,079	2,057	0,099	2,05	-0,106	2,048	-0,108
17	Ox	-8,781	-8,876	-0,095	-8,967	-0,186	-9,027	-0,246	-9,056	-0,275	-9,061	-0,28
	Oy	2,61	2,586	-0,024	2,562	-0,048	2,548	-0,062	2,543	-0,067	2,541	-0,069
18	Ox	-9,55	-9,646	-0,096	-9,732	-0,182	-9,787	0,237	-9,815	-0,265	-9,820	-0,27
	Oy	2,84	2,823	0,017	2,803	-0,037	2,791	-0,049	2,787	-0,053	2,786	-0,054
19	Ox	-11,1	-11,19	-0,09	-11,27	-0,17	-11,32	-0,22	-11,345	-0,245	-11,35	-0,25
	Oy	3,316	3,301	-0,015	3,286	-0,03	3,277	-0,039	3,274	-0,042	3,274	-0,042
20	Ox	-14,25	-14,32	-0,07	-14,39	-0,14	-14,43	-0,18	14,45	-0,2	-14,45	-0,2
	Oy	4,293	4,288	0,005	4,279	-0,014	4,275	-0,018	4,271	-0,022	4,271	-0,022
21	Oy	0,7456	0,9894	0,2438	1,252	0,5064	1,385	0,6394	1,414	0,684	1,422	0,6764
22	Oy	1,391	1,548	0,157	1,74	0,349	1,863	0,472	1,922	0,531	1,93	0,539
23	Oy	1,715	1,8134	0,0984	1,947	0,232	2,046	0,331	2,09	0,375	2,106	0,391
24	Oy	2,039	2,104	0,065	2,197	0,158	2,27	0,231	2,319	0,28	2,327	0,288
25	Oy	2,362	2,406	0,044	2,473	0,111	2,532	0,17	2,571	0,209	2,578	0,216
26	Oy	3,009	3,029	0,02	3,06	0,051	3,102	0,111	3,132	0,123	3,136	0,127
27	Oy	3,665	3,664	0,0016	3,683	0,0174	3,709	0,0434	3,73	0,0644	3,734	0,0684
28	Oy	3,98	3,983	0,003	3,999	0,019	4,019	0,039	4,038	0,058	4,042	0,062
29	Oy	4,628	4,629	0,001	4,636	0,008	4,651	0,023	4,666	0,038	4,67	0,042
30	Oy	5,94	5,94	0	5,945	0,005	5,948	0,008	5,958	0,019	5,96	0,02