

1 ?????????? ?????? ?????????????????? ? ?????????????????? ??????

? ?????????? ??????? ??????, ? ??? ????? ? ? ?????????? ?????? ???, ? ???? ?? ?????????????????? ??????????????, ? ?????? ? ?????? ?????? ?????????????? ?? ??????, ?????????? ?????????? ?????????? ??????????, ?. ?. ?????????????? ?? ?????????????? ? ?????????? ??????, ??????? ?????????????? ?????????? ?????????????? ?????????????? ?????????????? ??????????.

????????????? ??????????? ??? ?????? ?????????????? ?????????? ?????????????? ?????????????????? ??????????????????  
 ?????????? ?<sub>2</sub>, ?????? ?????????? ?????????????? ??? ?????? ?????????????????? ? ?????????????? ? ??? ?? ?????? ???  
 ?????????? ??????????????. ??? ?????????? ?????????????????? ?????????? ?????????? ?????????? ?????????????? ??????????  
 ?????????? ?????????? ?????????????? ?????????????? ?????????? ?σ, ?????? ?????????????? ?????????? ??????  
 ?????????? ?????? ? ?????????????? ?????????? ? ?????? ?????????? ?????????? ?????? ?????? ?????? ??  
 ?????? ??? ?????????????? ?????????? [1-6].

????????????????? ??????????? ? ?????????? ?????? ??? ?????????????? ?????????????? ?????? ??? ? ??????????????????  
 ?????????????? [1]. ?????????? ??? ???, ??? ?????????????????? ?????????????? ? ?????????? ?????????????? ??????????  
 ?????????????? ?????????????? ?????????????? [7], ?????? ??????? ?????? ? ?????????? ?????????????????? ?????????? ??  
 ?????????????? ?????????? ??????, ?????????????? ?????????? ?????????????? ?????????? ??????  $\sigma$ -1 [2, 3].

? ??????????, ?????????? ?????? ???? ?????? ?????? ??????????????. ?????????????? ?????????????? ?????????? ?  
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????????? ?????????? ???????, ? ??? ?????? ?????????? ?????????????? ??????????????, ?????????? ? ??????????  
????????? ?????????? ???????, ? ?????? ? ?????? ?????? ?????????? ?????????? ? ?????? ?????? ?????? ??????  
? ?????????????? ?????? ??????? ?????? [8-14]. ? ?????? ? ?????????? ?????? ?????? ?????? ?????? ??????  
????????????? ?????????? ?? ?????????? ?????????? ?????????????? ?????????? ?????????????? ??? ??????, ?  
?????????, ?? ?????????? ?????????? ?????????? ?????????? ?????????? ??????????, ? ?? ???? ???? ?  
?????????????????????, ??????? ?????????? ??????.. ??? ?????? ??????????, ?? ?????? ?????????? ??  
????????????? ?? ?????? ?????????? ?????????? [1] ?????????? ?????????? ?????????? ?????????? ??????????

2 ?????????? ? ??????

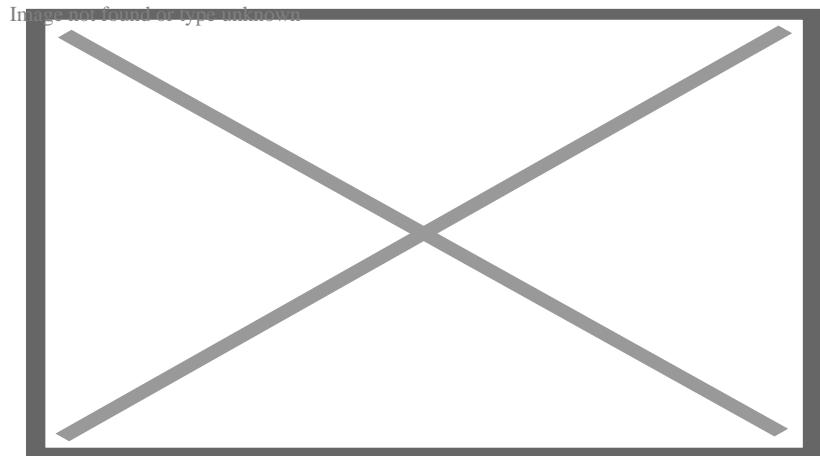
????????????? ?????????? ?????????????? ??? ?????????????? ?????????????? ?????????????? ?????????????? ? ?????????????????  
????? ?????????? ??????

???? ??????? ?????????????? ????????, ?????????????????? ?????????? ?????? ??????? ?????????? ?????????????? [15],  
 ?????????? ??? ?????????????? ?????????? ??????? ?, ??? ??????????, ?????? ?????????? ?? ??????????????  
 ??????????????, ??? ????? ?????????? ??????? ??????? ?????????? ???????????, ? ?????????? ??????? ???????, ?? ?????  
 ?????????????? ??????? ?????????? ?????????? ?????????????? ?????????????? ?????????????? [2]:

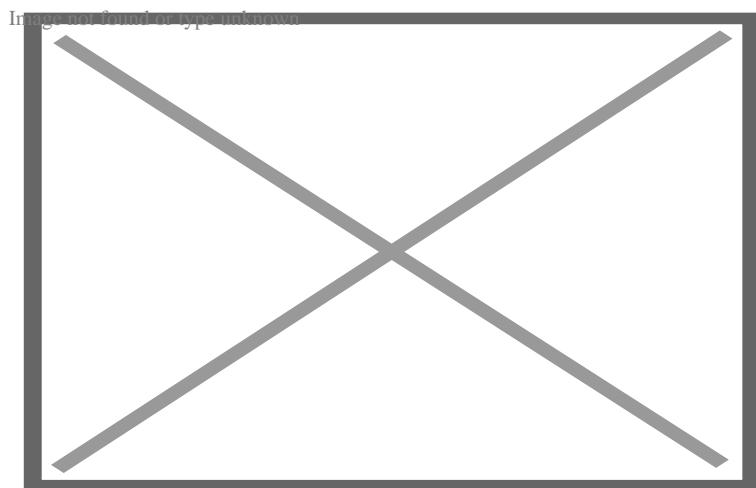
 ,

???????????? ? ?? ??????;  $q\sigma - \text{????????????? ?????????????? ?????? ? ?????????????? ??????????}$ .

????????? ??????????????  $\gamma$  ??? ?????? ?????? ?????????????? ?? ?????????????? [3], ?????? ?????? ?????? ?????? ?????? ?????????? ??????????????, ?????????????? ?? ?????? ??????, ?????????????? ? ?????? ??????, ? ?????????????????? ?????? ?????????? ??????????, ?????????????????? ?? ??? 1 ? 2, ?? ?????? ?????? ?????? ?????????? ?????????? ??????: , ???  $Sm - \text{???????$  ??? ?????????? ?? ?????? ??????;  $Rz - \text{???????$  ?????????? ?? ???????????. ?????????? ?????????? x ? ?????????? ?????? y ? ?????? ?? ?????????? ?????????? ?????????? Sm/Rz ?????????? ? ????. 1.



????????? 1 – ?????????????? ??????????????  $\gamma$  ?? ?????????? ?????????? ??? ??????????????  
? ?? ?????? ( $Sm/Rz$  ?? 4)



????????? 2 – ?????????????? ??????????????  $\gamma$  ?? ?????????? ?????????? ??? ??????????????  
? ?? ?????? ( $Sm/Rz$  ?? 4 ? ??????)

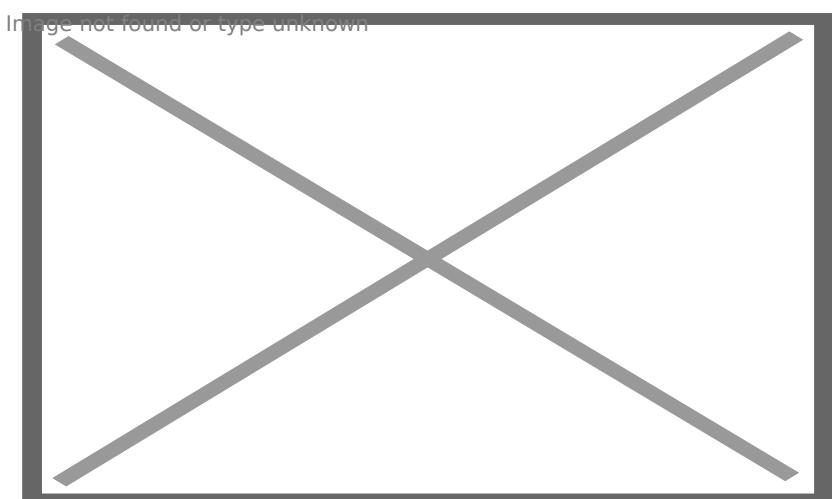
?????? 1 – ??????? x ? y ? ?????? ??? ?????????? γ

???????? Sm/Rz	x	y	??? R2
? 4	0,25	0,944	0,9859
? 4 ? ???	0,76	0,134	0,8155

?????? q? ?????????? ?? ?????? , ?? a – ??????? ?????? [4]. ??????? ?? ??????? ?????? ? ?????????? ?? ?????????? ? [3]. ?????? ?????? ?????? ?????????????? ??????????????, ?????????????? ? ?????????????????? ?????????????? ? [3].

300            600            900    1200  1500 σ?, ???

a, ??



?????? 3 – ??????? ?????????? a ? ?????????? ?? ??????  
 ?????????? ?????????? ?? ?????? σ?

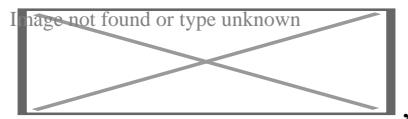
?? ?????? ?????? (???. 3) ???  $R2 = 0,9729$  ??????? ? ?????????? ?? ??????, ???:

$$? = 4610\sigma^{-1,573},$$

??? σ? – ?????? ??????? ??????? ?? ??????, ???.

?????????  $t = Rz$ , ??? ??? ?????? ?????????????????? ?? ?????????????? ??? ?????????? **?** ?????????????? ??????????????  
 ??????  $Rz = R_{max}$ , ???  $Rz - ???$  ?????? ?????????????? ?? ?????????????? ??????????????,  $R_{max} - ???$  ?????????????? ??????  
 ??????????????.

? ?????? ?????????????????? ? ????, ???  $Ra = 0,2Rz$  [17], ????? ?????????????????? ?????? ??? ?????????????? ασ ???  
 ?????? ? ?????? ?????????? ???

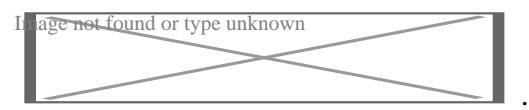


???  $Ra - ???$  ?????? ?????????????? ?????????? ??????.

?????????  $\rho = r? = 0,03(Sm/Ra)$  [17], ???  $r? - ???$  ?????? ?????????? ?????? ?????????? ??????????????, ???  
 ?????????????? ?????????????? ?????????????? ?????????????? ?????????????? ?????? ??? ?????????? ?? ??????????:  
 – ??? ?????????? ? ??????



– ??? ?????????? ? ??????



### 3 ?????????? ????????????

???? ?????????? ??????? ???? ???? ???? 30????, ??????? ?????? ?????????? ?????. 2.

?????? 2 – ??????? ??????? ?????????? ?????????? ?σ ??? ??????? ?? ??? 30????, ??????? ?????? ?????????? ?????.

???????	S, ??/??	Sm, ???	Rz???, ??????? ????? ???????? (?????????????), ???	, ??? ?????- ???????	Rz, ??????? ????? ?????????-???, ???	? <sub>1</sub> , ??????? ? ??????	? <sub>2</sub> , ???????????
0,1	141	2,5 ? <sub>1</sub> = 1,049 ? <sub>2</sub> = 1,097'	1	4,298	1,077	1,153	
			2	4,76	1,083	1,167	
			3	5,081	1,088	1,176	
			4	5,335	1,091	1,183	
			5	5,549	1,094	1,188	
0,15	183	4,2 ? <sub>1</sub> = 1,062 ? <sub>2</sub> = 1,124'	1	6,435	1,089	1,177	
			2	7,01	1,095	1,19	
V = 150 ??/??;			3	7,412	1,1	1,199	
r = 1??;			4	7,731	1,103	1,206	
? = 45°;			5	7,799	1,104	1,208	
? <sub>1</sub> = 15°;							
? = 10°;							
? = 15°;	0,2	247 ? <sub>1</sub> = 1,082 ? <sub>2</sub> = 1,164'	1	10,579	1,108	1,216	
t = 0,5 ??;			2	11,323	1,114	1,228	
?1 = 20 ???			3	11,843	1,118	1,237	
			4	12,256	1,122	1,244	
			5	12,604	1,125	1,249	
0,25	302	11,5 ? <sub>1</sub> = 1,099 ? <sub>2</sub> = 1,198'	1	14,904	1,124	1,247	
			2	15,785	1,13	1,26	
			3	16,401	1,134	1,268	
			4	16,891	1,137	1,275	

5

17,303 1,14

1,28

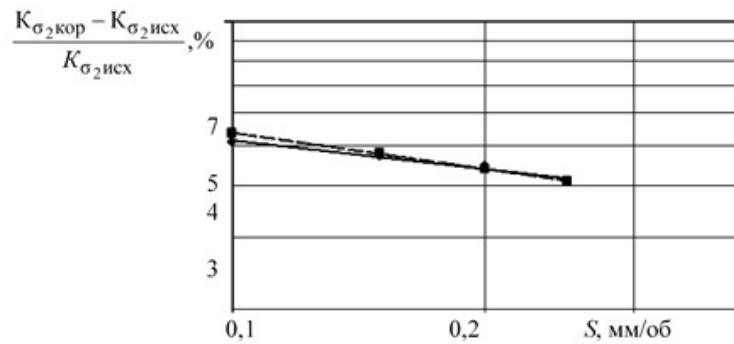
6,84

?????????, ??? ?????????????? ?????????????? ?????????? ? ?????????? ??????? ?? ?????? S, ?????? ???  
 ?????? ??? ???? r ? ?????? ?????????? ?????? ?????? ?????? ?<sub>1</sub>, ??? ?????? ?????? ?????? ???  
 ?????? ?????? ?????? ?????? ?? ?????? ?????????? ?????????? ?????????? ?σ.

????????? ?????? ?? ?????? ?????????? ?????????? ?????????? ?????????? ? ?????????? ??????????????  
 ??? ?????? ?????????? ?????? V ? ?????? S ??? ?????? 30????? ?????????? ?? ????. 4.

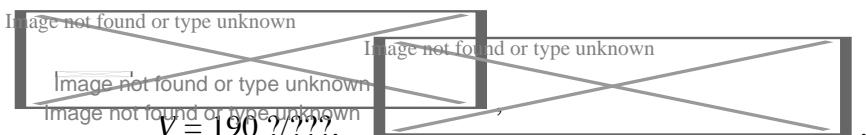
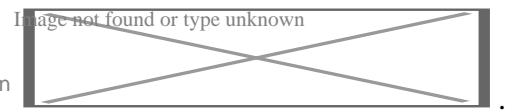
????????? ?????? ??2??  ?? ?????? ?????????? ?????? r ??? ?????? ?????????? ?? ????. 5.

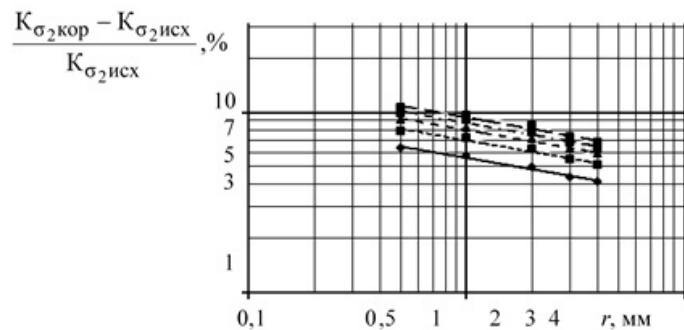
????????? σ2 ??? ?? ?????? ?????????? ?????? ?????? ?????? ρ1 ??????????  
 ?? ????. 6.



????? 4 – ?????????? ?????????? ?2??? ?? ?????? ?????? ? ?????? ? ??????  
 ??? ?????????? ?????? ?????????? ????

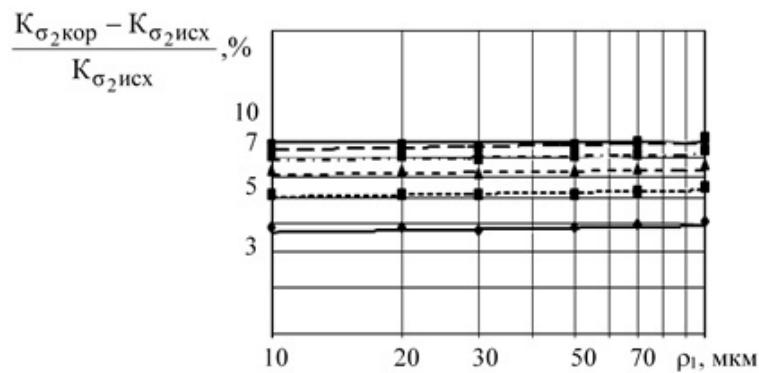
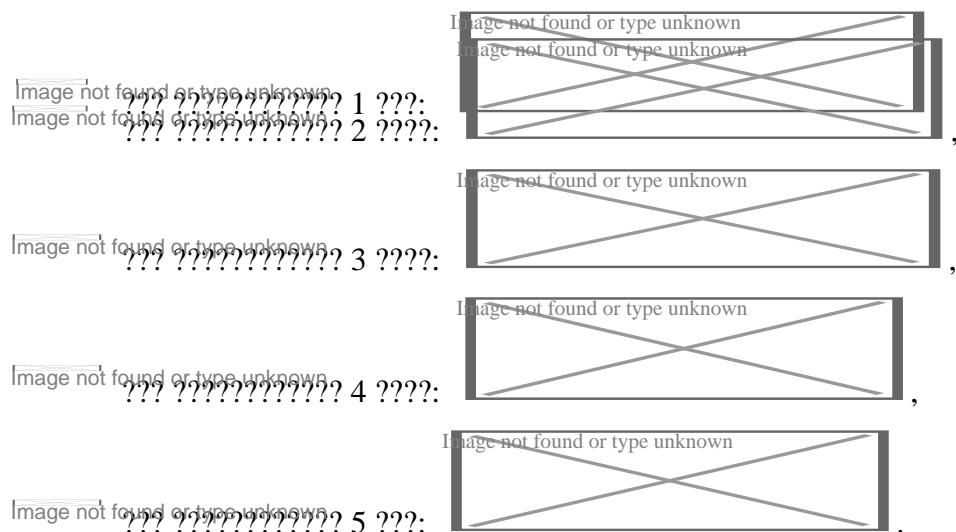
????????? ?? ????. 4:

$V = 150$  ???,   
 $V = 190$  ???, 



????????? 5 – ?????????????? ?????????? ?σ2??? ?? ??????? ?????????????? ???????  
??? ??????? ?????? ?????

????????????? ?? ????. 5:



????????? 6 – ?????????? ?σ2??? ?? ??????? ?????????????? ??????? ?????? ρ1

????????????? ?? ????. 6:

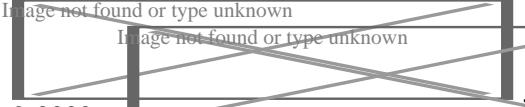
Image not found or type unknown  
????????????????? 1 ????: 

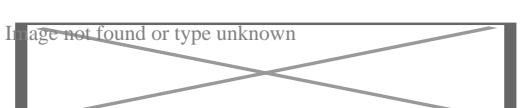
Image not found or type unknown  
????????????????? 2 ????: 

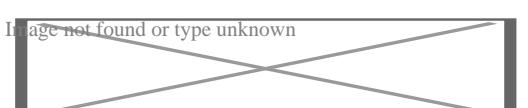
Image not found or type unknown  
????????????????? 3 ????: 

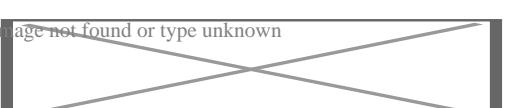
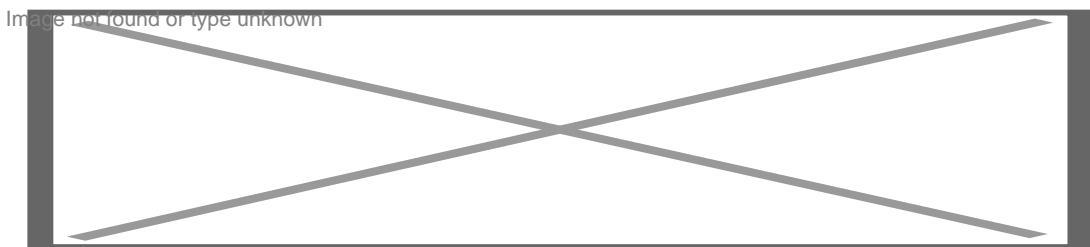
Image not found or type unknown  
????????????????? 4 ????: 

Image not found or type unknown  
????????????????? 5 ????: 

???????????? ? ?????????????????? ??????????????? ??? ?????????????? ?????????????? ?????????????????? ?????????????????? ??????????????????  
????????????? ? ??????????????? ??? ?????????????? ??????, ?????????????????? ?????????????? ?????????????? ?????????? ???  
??????????????, ?????????? ?????????????????? ?????????? ?????????? ?????????????? ?????????? ?????????????? ?????????????? ???  
??????. ??? ?????????? ? ?????????????? ? ???????????, ?????????????????? ?? ????. 7. ?????????? ??????????  
????????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ??????????????  
??? ?????? ? ?????????? ??????????????, ?????? ?????????? ? ??????????:

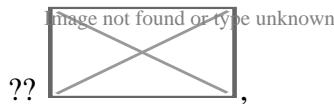
2) ?????????????? ? ?????????????? ?????????????? ?????????????? ?????? ?????????????? ?????? ?????? (????????? ??????? V, ?????? S ? ?????? ?????? t), ?????????????? ?????? ?????? ?????? ?????????????? (?????? ? ? ??????? γ ???? ????, ?????? φ ? ?????????????? φ1 ???? ?????? ? ????, ?????? ??? ?????? ?????? ? ?????? r ? ?????????? ?????? ?????? ??????) ? ??.

3) ?????????????? ?????????? ?????????? ?????????????? ?????????????? ?????????????? Rz???, ???:



??????????, ??/?.?;  $\beta$  ?  $\epsilon$  – ???? ?????????? ? ???? ??? ?????? ?????? ? ?????, ??????;  $r$  ?  $\rho_1$  – ?????? ???  
 ?????? ?????? ? ?????? ? ?????? ?????????? ?????? ?????? ???????????, ?;  $\eta$  – ?????? ?????? ??????  
 ?????????????? ?????????????? ??????????, ??/?.?;  $\theta$  – ?????????? ?????? ?????????? ? ???? ??????, °?;  $\tau$  –  
 ?????????????? ?????????????? ?????????? ?????????? ??????, ???;  
 $b$  – ?????? ?????????? ?????? ?????? ?????????? ? ?????????????? ??????, ?;  
 $m$  – ?????????? ??????, ?????????? ?? ?????????? ?????? ? ?????? ??????, ? ?????? ??????????????  
 ?????????? ?????? ?????? ?????? [17];  $\eta$  ?  $n$  – ?????????? ?? ?????????? ?????????????? ??????????  
 ?????????????? ?????????????? ?????????? [17].

4) ?????????? ?????????? ?????? ?????? ?????????? ?????????? ?????????? ?????????? ?  $\eta$  ?????????? ?????? ?????????? ?????????? ?? ??????:

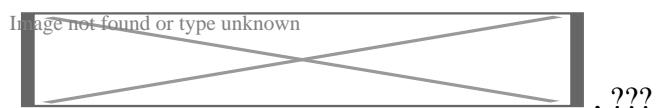


???  $U$ ? – ?????? ?????? ?????? ?????????? ?????????????? ???? ?????? ?????? ??????????, %;  
 $Sm$  – ??? ?????????? ?? ?????? ?????, ???;  $b$ ? ?  $b_1$  – ?????????? ?????, ?????????? ?? ?????? ? ??????????  
 ?????????? (????? ?????????? ?????? ??????????) [19].

5) ?????????? ?????? ?????????? ??????????  $V? = V0$ ? ??

???  $V\eta$ ? – ?????? ?????? ?????? ??????, ?????????? ?? ?????? ? ?????????? ? ?????????? ? ??????????  
 ?????????? ?. ?. [18-21].

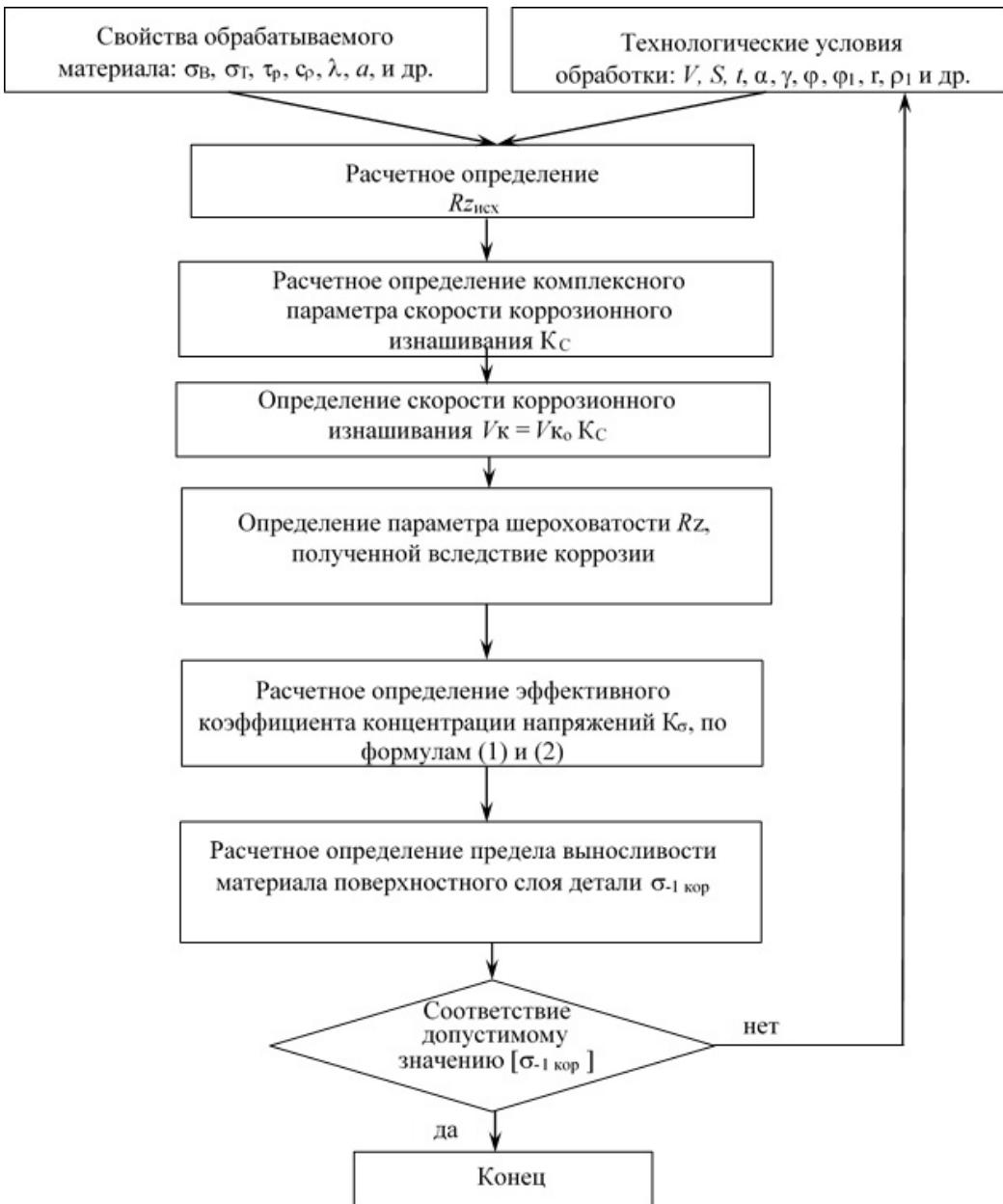
6) ?????????? ?????? ?????????????? ??????????  $Rz$  ???? ?????????? ?????????? ?? ?????????????? ???  
 ?????? ?????? ?? ?????? ??? ??????, ???:



???



???  $\tau$  – ???? ??????????????, ???;  $\eta = 1,28 \dots 2,0$  – ??????????, ?????????? ?????????? ??????????  
 ?????????? ?????????? ?????? ? ?????? ??????????;  $\beta$  – ???? ?????? ?????? ?????????? ??????, ???;  $\phi$  –  
 ?????? ??? ?????? ? ?????.



?????? 7 – ??????? ?????????? ?????????? ?????????????? ?????????????? ?????????????? ?????????????? ?????????????? ?????????????? ??  
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7) ?????????????? ?????????????? ?????????????? ?????????????? ?????????????? ?????????????? ? ?????????? ?????????????? ?????? ??????  
?? ?????????? (1) ? (2).

8) ?????????????? ?????? ?????????????? ?????????? ?????????????? ?????????????? ?????? ?????? ?????? ?????? ?????????? ?-1??? ??  
????????? ?-1?? = ?-1/??, ??? ?-1 – ?????? ?????????????? ?????????? ?????????? ??????. ??? ?-1 ???  
????????????? ?????????????? ???????????, ?? ?????? ?????????? ?????? ???, ?? ?????????? ?????????? ?????????????? ?????????????? ??????????????  
????????????? ?????? ?????????? ? ?????? ?????????? ?????? ?????????? ?????????? σ-1 ??? ??? ?????????? ?????????? ??????????  
????????????? ??????.

???????????, ??? ?????????? ?????????????? ?????????? ? ?????????????? ???? ?????????? ?????? ???  
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?? ??????? ?? 5 ?? 9 ???????, ??? ?????????? ??? ?????? ?????????? ?????????????? ?????????????? ??????.

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????????????? ??????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ??  
????????? ? ?????????????? ??????? ??????? ?????? ?????????? ?????????? ?????? ?????????? ?????????????? ???  
????????? ?????????? ? ?????? ?????????? ?????????? ?????????? ?????????????? ?????????????? ??????????.