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Application of the Method of Polynomial Approximation for the Determining the "Optimal" Coefficient of the Mathematical Model of Corrosive Destruction. Algorithm 2

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Abstract **− In this paper is adduced the method of polynomial approximation for the determination of the "optimal" coefficient of influence of stress-strain state (SSS) of the design on the rate of corrosion at its optimal designing. Is offered to approximate dependence, in which the coefficient of influence of SSS of structure on the rate of corrosion is the function of the stiffness of parameters of optimized design.**

Keywords **— Corrosive destruction, Evolutionary Theory, Identification, Mathematical Models, Optimal Designing, Polynomial Approximation.**

I. Introduction

In the previous article [5] was considered the algorithm of polynomial approximation, in which the geometric parameters of the optimized design, in particular, its stiffness, depend on the value of the coefficient of influence of the stress-strain state (SSS) of the structure on the rate of corrosion. This algorithm has been designated as "Algorithm 1". It was noted that this method for a large number of control variables is very cumbersome, as for each optimized parameter it will necessary to perform an own approximation.

In this paper, we propose an algorithm that will avoid the difficulties mentioned above and solve the problem set out above.

As in previous article [5] we illustrate the using of second algorithm of polynomial approximation for the determining of the "optimal" coefficient of influence of the SSS on the rate of corrosion process by the example of optimal designing of thin-walled circular cylindrical shell of radius R and wall thickness Δ (Fig. 1). The shell is filled with gas, whose pressure is equal q. The shell experiences the action of aggressive environment in form of hydrogen embrittlement and corrosion on the inside surface of the wall (Fig.1). The process of corrosion damage is described by using of several mathematical models of corrosion destruction: the mathematical model of Ovchinnikov I.G. MMSS [5], the description of which is given in [1], and the mathematical model of Verhulst [5]. The description of combined use of these models is adduced in the paper [4]. In paper [4] is adduced the formulation of the task of optimal designing of shell considering of hydrogen embrittlement of material.

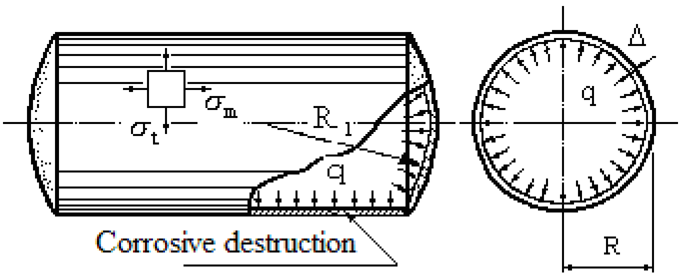

Fig.1 The thin-walled shell

II. The Illustration Of Application Second Algorithm Of Method Of Polynomial Approximation

Algorithm 2. The polynomial approximation of the coefficient of the influence of SSS on the rate of corrosion as the function of stiffness of optimized structure.

We introduce the approximating polynomial:

$$\beta(A) = d_0 + d_1 A_i + d_2 A_i^2 + ... + d_m A_m^n, \quad (1)$$

Let us take as a deviation $\beta(A)$ from $\beta^{\exp}$ on the multitude of points $A_1, A_2, ..., A_m$ the next square approximation:

$$S = \sum_{i=1}^{n} \left[\beta(A_i) - \beta_i^{\exp}\right]^2 , \quad (2)$$

Where $\beta_i^{\exp}$ − the value of the influence of SSS on the rate of corrosion determined by identification of the mathematical model at the process of optimization conditionally labeled as experimental.

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The coefficients in expression (1) are selected in such a way that the value of S was the lowest.

Assume that the approximating polynomial for the determining of coefficient is by the test identification from different starting points becomes:

$$\beta(A) = d_0 + d_1 A_i + d_2 A_i^2 \quad (3)$$

The search of the roots approximating polynomial (3) performed using the method of random search SGEF [7]. To do this, we introduce the notation: $x_1 = d_0; x_2 = d_1; x_3 = d_2$ and we formulate a mathematical programming problem: find a vector $\mathbf{X}(x_1, x_2, x_3)$, that delivers a minimum for the functional:

$$S(\mathbf{X}) = \min \sum_{i=1}^{n} \left[x_1 + x_2 A_i + x_3 A_i^2 - \beta(A_i)\right]^2 \quad (4)$$

at the performance of restrictions:

$$g_j(x) = x_i^- \le x_i \le x_i^+; (i = 1,2,3; j = 1,2,...,6) \quad (5)$$

In the Table 1 shows the results of the solution of mathematical programming problem (4)-(5).

Table 1
The values of the coefficients of approximating polynomial, the calculated value and the coefficient of influence of SSS on the rate of corrosion rate on the rate of corrosion

№	Starting points		The coefficients of approximating polynomial			$\beta(A)$	Δ_i (%)
	A (sm^2)	β_i	d_0	d_1	d_2		
1	2309,34	0,1667274	0,04631835	0,0000052504	0,00000009443	0,162	2,75
2	1976,50	0,1061461				0,116	-9,54
3	1646,78	0,0844576				0,081	4,60
4	1307,56	0,0588444				0,054	8,48
5	1134,58	0,0423870				0,044	-4,22
6	1065,51	0,0396290				0,041	–3,57

To determine the coefficients of the polynomial (3) let us select the values of objective function out of the search trajectory (Table 2 [4]).

These values of objective function are listed in Table 1.

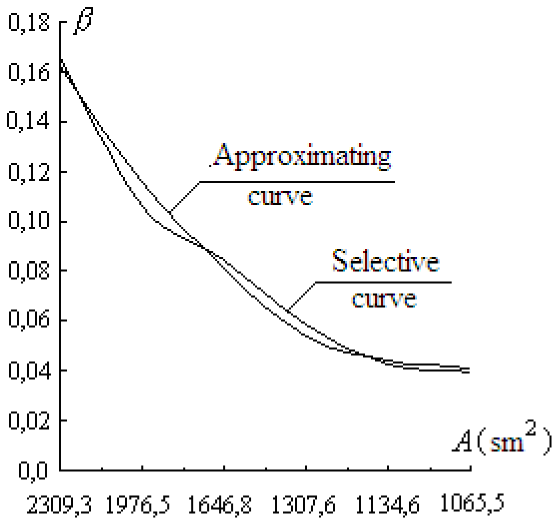

Fig.2. The approximation of selective curve with the help of second-degree polynomial

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Because of the proximity of selective ("experimental") and approximating curves in subsequent calculations we shall use an approximating curve. Take the derivative of the function (3) and equate to zero by:

$$\frac{d\beta}{dA} = d_1 + 2d_2 A = 0. \qquad (6)$$

Deciding the equation (6) with respect to A, we obtain:

$$A = -\frac{d_1}{2 \cdot d_2} = -\frac{-0{,}0000521504}{2 \cdot 0{,}0000000443} = 588{,}605 \text{ sm}^2$$

Substituting this value of the cross section of the shell stiffness in the expression (1), we determine the extreme value of coefficient of influence of SSS on rate of corrosion:

$$\beta(A) = d_0 + d_1 A + d_2 A^2 = 0{,}04631835 - 0{,}0000521504 \cdot 588{,}605 +$$

$$+ 0{,}0000000443 \cdot 588{,}605^2 = 0{,}03097.$$

Let us perform the optimization of the shell with this coefficient ratio and some specifying identifications.

The results are given in Table 2.

Table 2
The results of specifying identifications and optimal parameters of shell

№ п/п	Starting stiffness			The model's coefficients				The optimal parameters of shell, the depth of destruction		
	A (sm^2)	Δ (sm)	R (sm)	δ_0	η	ϑ	β	$A_{опт}$ (sm^2)	Δ (sm)	δ (sm)
1	1065,51	1,696	100,00	0,3222	18,621	10,621	0,03097000	943,50	1,502	0,3745
2	943,50	1,502	100,00	0,3225	18,603	10,511	0,03076057	943,37	1,501	0, 3743
3	943,37	1,501	100,00	0,3224	18,607	10,509	0,03072270	943,11	1,501	0,3742

The result that is shown in Table 2 in the last line, is almost identical with the results obtained previously by multiple identification and have adduced in Table 3 [5].

The considered method of polynomial approximation is useful in the event that construction has a large number of parameters to be optimized, since it does not require their preliminary approximation. However, when it is used is required the careful approximation of dependence of the function of influence of SSS on the rate of corrosion from the stiffness of structure.

Let us apply the method of successive approximations that has been described at using the algorithm 1.

At the beginning, let us describe the behavior of the function of influence of SSS on the rate of corrosion from the stiffness of the cross section of the shell with the help of a polynomial of the third degree:

$$\beta(A) = d_0 + d_1 A + d_2 A^2 + d_3 A^3 \qquad (7)$$

Introducing the notation: $x_1 = d_0$; $x_2 = d_1$; $x_3 = d_2$ and $x_4 = d_3$ deciding the problem of mathematical programming:

$$S(\mathbf{X}) = \min \sum_{i=1}^{n} \left[x_1 + x_2 A_i + x_3 A_i^2 + x_4 A_i^3 - \beta(A_i)\right]^2 \qquad (8)$$

at the execution of restrictions:

$$g_j(x) = x_i^- \le x_i \le x_i^+; (i = 1,2,...,4; j = 1,2,...,8) \qquad (9)$$

We are get the coefficients of the polynomial (7) (Table 3).

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Table 3
The values of the coefficients of the approximating polynomial and the calculated value of the coefficient of the influence of SSS on the rate of corrosion

№	Starting points		The coefficients of polynomial	$\beta(A)$	Δ_i (%)
	A (sm^2)	β_i			
1	2309,34	0,1667274	d_0 = 0,02052301 d_1 = 0,0000076611118 d_2 =0,0000000009456436 d_3 =0,000000000009776864	0,164	1,84
2	1976,50	0,1061461		0,115	–8,18
3	1646,78	0,0844576		0,079	6,03
4	1307,56	0,0588444		0,054	8,23
5	1134,58	0,0423870		0,045	–5,48
6	1065,51	0,0396290		0,042	–4,94

Now, solving the problem of optimal design, instead of execution at each step of the procedure of identification of the mathematical model we will calculate the value of coefficient of influence of SSS on the rate of corrosive process with the help of expression (7).

For the coefficients of a mathematical model, we take the average value calculated on a sample of the values of these coefficients.

Extrapolating the approximating curve shown in Fig. 3. We determine the cross sectional area of the shell A=1000 sm^2 and compute the coefficient of the influence of SSS on the rate of corrosion:

$$\beta(A) = d_0 + d_1 A + d_2 A^2 + d_3 A^3 = 2{,}052301 \cdot 10^{-2} + 7{,}6611118 \cdot 10^{-6} \cdot 1000 + $$
$$+ 9{,}456436 \cdot 10^{-10} \cdot 1000^2 + 9{,}7767864 \cdot 10^{-12} \cdot 1000^3 = 0{,}03889841$$

The optimization results are recorded in Table 4.

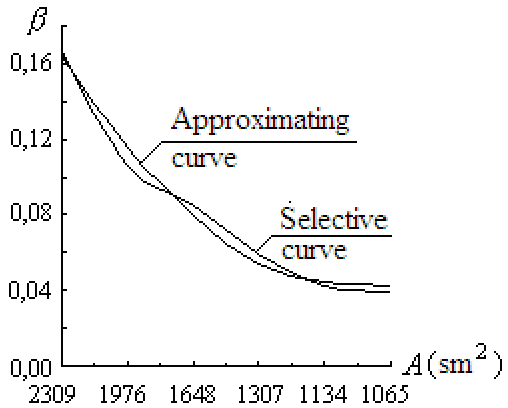

Fig.3. The approximation of selective curve with the help of third-degree polynomial

Substituting in expression (7) the value of cross-sectional area of shell listed in the second column of Table 4, we calculate the value of coefficient of influence of SSS on the rate of corrosion β and then with this coefficient we execute the optimization of shell and carry out the check the shell strength under the plastic and brittle fracture.

As seen from the Table 4 at $A = 600$ sm^2 the shell strength under brittle fracture is not satisfied ($P_r > 1$). Therefore we accept $A = 650$ см^2 and carry out the appropriate calculations. The results are recorded in Table 4. The strength of the shell under the brittle fracture is not broken. We accept $A = 630$ см^2 and determine the coefficient β. The results are recorded in Table 4.

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Table 4
The results of successive approximations to the "optimal" value of coefficient of the influence of SSS on the rate of corrosion

№	A (sm^2)	β	Starting points		A (sm^2)	Δ (sm)	δ (sm)	σ (MPa)	P_r
			Δ (sm)	R (sm)					
1	1000	0,03889841	1,696	100,00	951,67	1,515	0,3875	1536,7	0,9999
2	950	0,03702989	1,515	100,00	949,75	1,512	0,3845	1536,8	0,9999
3	900	0,03530532	1,512	100,00	948,06	1,509	0,3817	1536,8	0,9999
4	850	0,03371734	1,509	100,00	946,51	1,506	0,3791	1536,0	0,9999
5	800	0,03225865	1,506	100,01	945,06	1,504	0,3768	1536,6	0,9998
6	700	0,02969979	1,504	100,00	942,44	1,500	0,3726	1536,5	0,9998
7	600	0,02757013	1,500	100,00	940,06	1,496	0,3691	1536,5	1,0002
8	650	0,02858738	1,500	100,00	941,23	1,498	0,3708	1536,6	0,9999
9	630	0,02816951	1,498	100,00	940,71	1,497	0,3701	1536,8	1,0000

The resulting solution of the problem is not optimal, but it defines the area that is close to the point of extreme.

Let us carry out from found points the specifying identifications and the search of optimal solutions. The results are listed in Table 5.

Table 5
The optimal parameters of shell and a corresponding "best" set of coefficients of mathematical models of corrosive destruction.

The optimal parameters of shell			The model's coefficients				The depth of corrosive destruction		
A (sm^2)	h (sm)	R (см)	δ_0	η	ϑ	β	δ_t (sm)	δ_σ (sm)	δ_Σ (sm)
940,71	1,497	100,00	0,3227	18,603	10,496	0,0303989	0,3225	0,0519	0,3744

Consider the optimal designing of statically determinate welded I-beam, which is interact with an aggressive media (Fig.1 [4]). As a mathematical model of corrosion damage we accept Ovchinnikov's model (1) [4].

The welded I-beam is subjected by corrosion caused by the environment and by the SSS influence on the corrosion rate. For a description of the corrosion process will take two models: Verhulst's model [5] and Ovchinnikov's model in the form of:

$$\delta(t_j)=\frac{\delta_0}{1+\eta\exp(-\vartheta\delta_0 t_j)}+\beta\sum_{k=1}^{j}\left[\frac{1}{E}\left\{\frac{M_p}{J_z}y_{\max}\right\}^2(t_k-t_{k-1})\right],(k=1,2,...,j), \qquad (10)$$

Where the first term describes corrosion of unstrained metal (3) [5], the second term takes into account the impact of SSS on the rate of corrosive process (3) [4].

The description of coefficients and the terms in equation (10) are given in paper [5].

For identification of the mathematical model (10) we take the functional:

$$J=\left\{\delta_j^e-\frac{\delta_0}{1-\eta\exp(-\vartheta\delta_0 t_j)}-\beta\sum_{k=1}^{j}\left[\frac{1}{E}\left\{\frac{M_p}{J_z}y_{\max}\right\}^2(t_k-t_{k-1})\right]\right\}^2,(j=1,2,...,n;k=1,2,...,j), \quad (11),$$

Where δ_j^e – the experimental depth of corrosion damage (Table 6).

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Table 6
The data of experimental studies of wellded I-beam is influenced by an aggressive environment

Observing time (years)								
0,0000	0,1643	0,5753	1,0219	1,4410	2,0191	2,4602	2,957	3,2000
The depth of corrosive damage (sm)								
0,0062	0,03186	0,0890	0,2571	0,3030	0,3254	0,5596	0,3813	0,3940

The task of identifying the model (10) we solve as the mathematical programming problem. For this purpose, we introduce a vector of control variables, where: $\mathbf{X}(x_1, x_2, x_3, x_4)$, где: $x_1 = \delta_0$, $x_2 = \eta$, $x_3 = \vartheta$ and $x_4 = \beta$.

The problem of mathematical programming is formulated as follows: find a minimum of the functional:

$$J(\mathbf{X}) = \left\{ \delta^{э} - \frac{x_1}{1 - x_2 \exp\left(-x_3 \delta_0 t_j\right)} - x_4 \sum_{k=1}^{j} \left[\frac{1}{E} \left\{ \frac{M_p}{J_z} y_{\max} \right\}^2 (t_k - t_{k-1}) \right] \right\}^2, (j = 1,2,...,n; k = 1,2,..., j) \qquad (12)$$

at the execution of restrictions:

$$g_1(\mathbf{X}) = x_1 - x_1^- \geq 0; \qquad g_2(\mathbf{X}) = x_1^+ - x_1 \geq 0; \qquad (13)$$

For solve the problem of mathematical programming (12)-(13) we use the method of random search SGEF at the following initial data: $M_p = 561{,}79$ кНм; $E = 2{,}1 \cdot 10^5$ МПа; $n = 9$; $x_1^+ = \{1{,}0\}$, $x_1^- = \{0{,}0\}$.

In the first stage of research we choose a point in the space of permitted parameters with coordinates: $d_0 = 0{,}02$ m; $h_0 = 0{,}85$ m; $a_0 = 0{,}03$ m; $b_0 = 0{,}4$ m and for this point we execute the identification of the mathematical model. As a result, we obtain the following coefficients model: $\delta_0 = 0{,}3251$, $\eta = 18{,}635$, $\vartheta = 10{,}399$, $\beta = 0{,}2690313$.

Then, from a point with coordinates adduced above we execute the optimization of I-beam. The statement of the problem of optimal design of welded I-beam as the mathematical programming problem, is formulated in paper [3] equations (15)-(22). Also in paper [4] are shown the initial data, under which performs the optimization, the geometric constraints on variables and time of corrosion.

In the search process of optimal solution on the search trajectory were chosen 6 intermediate points in order of descending of objective function and the results of selection were listed in Table 7. For each of the intermediate points was performed the identification of the mathematical model (10) and the model coefficients were entered in Table 7.

Table 7
Selected results of optimal design of the I-beam

№	The intermediate values of parameters of welded I-beam and the coefficients of a mathematical model									
	A (sm^2)	J_z (sm^4)	d (sm	h (sm)	a (sm	b (sm	δ_0	η	ϑ	β
1	410,00	567160,8	2,000	85,00	3,00	40,000	0,3251	18,635	10,399	0,269031
2	307,41	314907,9	1,879	74,19	2,52	33,314	0,3236	18,632	10,458	0,137784
3	260,94	228218,7	1,768	70,53	2,36	28,871	0,3239	18,631	10,443	0,085722
4	203,91	210458,1	1,284	75,67	2,32	22,980	0,3239	18,637	10,484	0,082149
5	167,10	227315,2	0,810	83,34	2,88	17,316	0,3308	18,644	10,179	0,084565
6	156,87	269184,2	0,683	85,00	3,00	16,479	0,3278	18,639	10,295	0,096783

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In Fig. 4 is a plot of the dependence of sample values of the function of SSS influence on the rate of corrosive process from the moments of inertia of the cross section of the I-beam.

The graph shows that the influence of SSS on the first search step decreases, following in accordance with Theorem 1 [2]. behind the change in the stiffness of the cross section of I-beam, and then begin to increase in proportion to an increase of the stiffness of the cross section.

The minimum value of the function of SSS influence on the corrosion rate is within the range of changes in the stiffness of the cross-section.

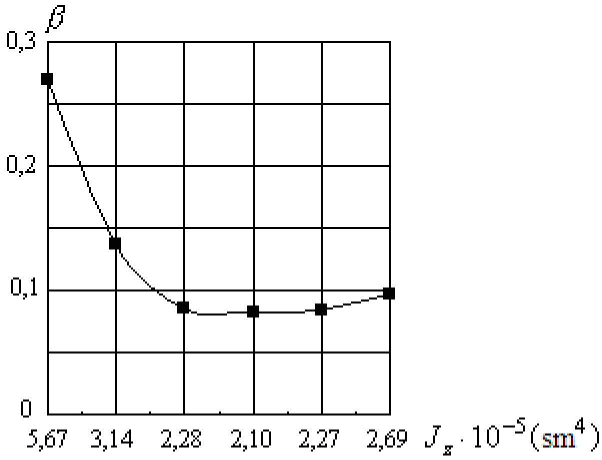

Fig. 4. The graph of the dependence of influence function of SSS on the rate of corrosion process from the values of moments of inertia of I-beam cross-section

The graph shows that the mathematical minimum of SSS influence on the rate of corrosion is between the third and fourth values of the stiffness of the cross-section of the optimized I-beam (Table 5). We approximate the curve shown in Fig. 4 polynomial and let us determine the value of coefficient of influence of SSS on the rate of corrosion and the corresponding value of the stiffness of the cross-section of I-beam. As an approximating polynomial we choose a third-degree polynomial:

$$\varphi(\beta) = a_0 + a_1\beta + a_2\beta^2 + a_3\beta^3 . \quad (14)$$

We investigate the process of finding the "optimal" value coefficient of influence of SSS on the rate of corrosive process in more detail.

Let us carry transfer from the table 4 intermediate states of beams and adduce in Table 5 the corresponding to these states the values of moments of inertia, the sizes of the optimized cross-sections of the I-beam and the corresponding values of coefficients of mathematical model of corrosive destruction (10).

The coefficients of the polynomial (14) we will search by solving the following problem: find a minimum of the functional:

$$S = \sum_{i=1}^{n} [\varphi(\beta_i) - J_z(\beta_i)]^2 . \quad (15)$$

Introducing the notations: $x_1 = a_0$; $x_2 = a_1$; $x_3 = a_2$; $x_4 = a_3$, formulate the mathematical programming problem: find a vector $\mathbf{X}(x_1, x_2, x_3, x_4)$, which minimizes the functional:

$$S(\mathbf{X}) = \sum_{i=1}^{n} \left[\left(x_1 + x_2\beta + x_3\beta^2 + x_4\beta^3\right) - J_z(\beta)\right]^2 \quad (16)$$

at the execution of restrictions:

$$g_j(\mathbf{X}) = x_i^- \le x_i \le x_i^+ ; \quad (i = 1,2,...,3;\ j = 1,2,...,6). \quad (17)$$

The search of coefficients of approximating polynomial (14) is performed using the method of random search SGEF. approximation results are given in Table 5.

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Table 5
The values of coefficients of approximating polynomial and the values of estimated coefficients of indluence of SSS on the rate of corrosive process

№	Starting points		The coefficients of polynomial	β	Δ_i (%)
	$J_z\,(\text{sm}^4)$	β_i			
1	567160,8	0,2690313		0,269084	0,02
2	314907,9	0,1377836	a_0 = 160830,2	0,135592	–1,59
3	228218,7	0,0857222	a_1 = –18723,49	0,085028	–0,81
4	210458,1	0,0821492	a_2 = 11490850,0	0,076538	–6,83
5	227315,2	0,0845652	a_3 =–21591050,0	0,084176	–0,46
6	269184,2	0,0967832		0,104729	8,21

Fig. 5 shows the sampling and approximating curves.

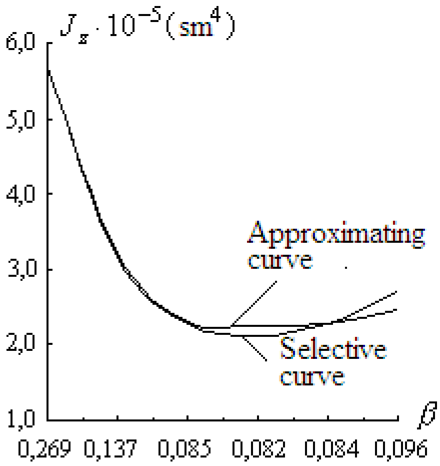

Fig.5. The approximation of selective curve with the help of third-degree polynomial

Introducing the notation $x_1 = \beta$, we are solving the problem of determining the coefficient of influence of SSS on the rate of corrosion β as the problem of mathematical programming: find a minimum of the function

$$\varphi(\beta) = a_0 + a_1 x_1 + a_2 x_1^2 + a_3 x_1^3 \qquad (18)$$

at the execution of restrictions:

$$g_1(\mathbf{X}) = x_1^- \le x_1 \le x_1^+ . \qquad (19)$$

Solving the problem (18)-(19) relatively to the coefficient β we determine extreme value $\beta = 0{,}081659605$. Substituting this value of coefficient β to formula (14), we find the value of the moment of inertia corresponding to the value of this coefficient β: $J_z = 224168{,}6\ \text{sm}^4$.

Taking this coefficient β as "optimal", we perform the optimization of the I-beam from an arbitrary point of the parameter space. Optimization results are listed in Table 6.

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Table 6
The optimal parameters of I-beam

A (sm^2)	d (sm)	h (sm)	a (sm)	b (sm)	β	A_{opt} (sm^2)	d (sm)	h (sm)	a (sm)	b (sm)
410,0	2,000	85,00	3,000	40,00	0,081660	142,94	0,6807	84,999	2,939	14,474

Let's approximate the function $\varphi(\beta)$ by a polynomial of fourth degree:

$$\varphi(\beta)=a_0+a_1\beta+a_2\beta^2+a_3\beta^3+a_4\beta^4. \quad (20)$$

Introducing the notations $x_1=a_0;\ x_2=a_1;\ x_3=a_2;\ x_4=a_3;\ x_5=a_4$, formulate mathematical programming problem: find a vector $\mathbf{X}(x_1,x_2,x_3,x_4)$, which minimizes the functional:

$$S(\mathbf{X})=\sum_{i=1}^{n}\left[\left(x_1+x_2\beta+x_3\beta^2+x_4\beta^3+x_5\beta^4\right)-J_z(\beta)\right]^2 \quad (21)$$

at the execution of restrictions:

$$g_j(\mathbf{X})=x_i^-\le x_i\le x_i^+;\quad (i=1,2,\ldots,5;\ j=1,2,\ldots,10). \quad (22)$$

The problem (21), (22) is solved by random search. approximation results are recorded in Table 7.

Table 7
The values of coefficients of approximating polynomial and the values of estimated coefficients of indluence of SSS on the rate of corrosive process

№	Starting points		The coefficients of polynomial	β	Δ_i (%)
	J_z (sm^4)	β_i			
1	567160,8	0,2690313	a_0 = 88329,01 a_1 = 1573479,0 a_2 = 922593,4 a_3 =–594312,1 a_4 = –3493,871	0,269084	0,06
2	314907,9	0,1377836		0,135592	–1,96
3	228218,7	0,0857222		0,085028	–0,61
4	210458,1	0,0821492		0,076538	6,18
5	227315,2	0,0845652		0,084176	–0,14
6	269184,2	0,0967832		0,104729	7,60

Just as in the previous case, we introduce the notation $x_1=\beta$ and we solve the problem of mathematical programming relative coefficient β: find a minimum of the function:

$$\varphi(\beta)=a_0+a_1x_1+a_2x_1^2+a_3x_1^3+a_4x_1^4 \quad (23)$$

at the execution of restrictions:

$$g_1(\mathbf{X})=x_1^-\le x_1\le x_1^+. \quad (24)$$

The extreme value of the coefficient β by solving the problem (23)-(24), we obtain equal $\beta=0{,}07897616$. From equation (20) we find the moment of inertia of the cross section of the optimized I-beam corresponding to the value of the coefficient β: $J_z=218057{,}76\ sm^4$.

From any point of the parameter space we perform optimization of the I-beam with the coefficient of $\beta=0{,}07897616$. Optimization results are listed in table 8.

Table 8
The optimal parameters of I-beam

A (sm^2)	d (sm)	h (sm)	a (sm)	b (sm)	β	A_{opt} (sm^2)	d (sm)	h (sm)	a (sm)	b (sm)
410,0	2,000	85,00	3,000	40,00	0,078976	142,79	0,6814	84,999	2,932	14,472

As calculations have shown the approximation of selective curve by the polynomial higher degree allows you to get a lower value for the coefficient of influence pof SSS on the rate of corrosion, and, therefore, easier the optimal project.

To summarize, we will formulate a methodology to optimize the parameters of constructions interacting with aggressive media, using mathematical models that take into account the influence of SSS on the rate of corrosive process:

1. For an arbitrary starting point of the region of permitted parameters is performed identification the mathematical model of corrosive damage on the experimental data, for the mathematical model are determined the coefficients, the mathematical programming problem is formulated and is performed the search of optimal solutions.
2. On the next step out search trajectory is performed the selection of several intermediate points in descending order of the objective function. For each of these points is performed the identification. The found design parameters and coefficients of the mathematical models create the base selection. Selective curve constructed according to the basic selection, binds the function of SSS influence on the rate of corrosive process with the parameters of stiffness of design.
3. We describe the basic curve by the polynomial of the second or higher degree, and using the analytical or numerical methods we determine the coefficients of polynomial.
4. We formulate the problem of mathematical programming, in which the criterion of quality is either a function of influence of SSS on the rate of corrosion (Algorithm 1), or the coefficient of the influence of SSS on the rate of corrosion is the function of parameters of optimization in a view of the integral value of the objective function (method 2). The area of permitted parameters is defined by functional and geometric constraints. Solving the problem of mathematical programming, we define the corresponding coefficients of a mathematical model. In some cases, to calculate the value of SSS influence coefficient it is necessary to investigate the dependence obtained with the help of polynomial approximation by analytical methods.
5. Knowing the "optimal" value of coefficients that take into account the influence of SSS on the rate of the corrosive process, we determine the optimum parameters of design.
6. Using the results of optimization as a starting point, we carry out additional identifications of the mathematical model for this point and we set the final values of the coefficients of a mathematical model.
7. From any point of the parameter space is searched for the best solution, which is taken as final.

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