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THE LINEAR SCHEMATISATION IN WHICH THE DIAGRAM OF RESISTENCE AT WEARINESS IS DEPICTED, FOR ASYMETRICAL CYCLES HAVING VARIABLE LOADING -A GENERALISED POINT OF VIEW-

WEBER Francisc, MAKSAY Ştefan

UNIVERSITY POLITEHNICA - TIMIŞOARA
FACULTY OF ENGINEERING – HUNEDOARA, ROMANIA

ABSTRACT:
The paper displays the improved expressions of the safety coefficient, in ratio with variable stress, attained through asymmetric cycles.

KEY WORDS:
variable stress, schematizations, safety coefficients

The subsequent paper aims at improving the relation for the calculus of the safety coefficient at variable loadings, through asymmetrical cycles.

Thus, in paper [1], the Soderberg schematisation borders on the Haigh type diagram in terms of the AC straight line segment. On the other hand, Serensen [2] develops this estimate by considering the ABC broken line.

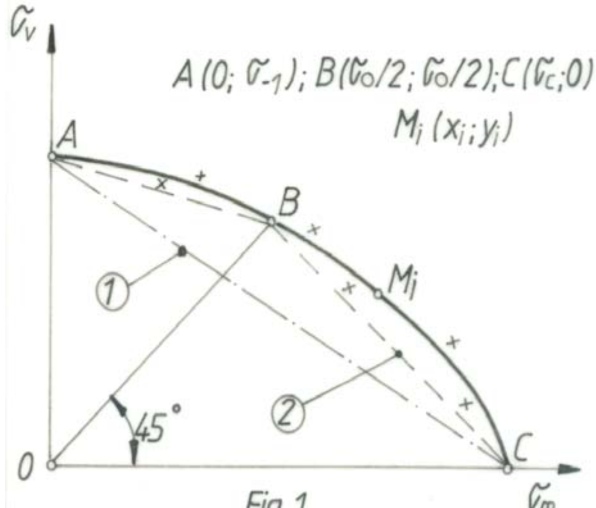

Fig.1

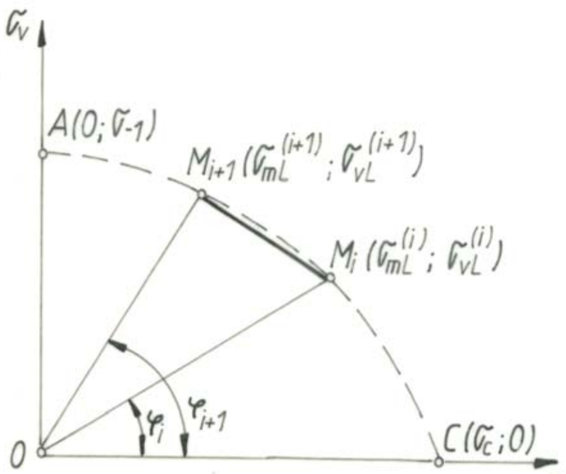

Fig. 2

Therefore, the experimental determination of points on the Haigh type diagram and the approximation of this diagram through a polygonal line, will nonetheless contribute to the perfecting process entailed by the value of the safety coefficient.

Taking points

$$M_i\left(\sigma_{mL}^{(i)},\sigma_{vL}^{(i)}\right), i = 1,\dots,n \quad (1)$$

Situated on the Haigh diagram, so that:

$$\begin{cases}\sigma_{mL}^{(1)} = \sigma_c \\ \sigma_{vL}^{(1)} = 0\end{cases} \qquad \begin{cases}\sigma_{mL}^{(n)} = 0 \\ \sigma_{vL}^{(n)} = \sigma_{-1}\end{cases} \tag{2}$$

and

$$\varphi_i < \varphi_{i+1}, \tag{3}$$

$i = 1, \ldots, n-1$,

where

$$\theta_i = \frac{\sigma_{vL}^{(i)}}{\sigma_{mL}^{(i)}} \tag{4}$$

and

$$\varphi_i = \mathrm{arctg}\,\theta_i, \tag{5}$$

noting,

$$\varphi = \mathrm{arctg}\frac{\sigma_{vL}}{\sigma_{mL}} \tag{6}$$

for

$$\varphi_i \le \varphi \le \varphi_{i+1}, \tag{7}$$

the equation of the straight line undergoing the points M_i , $M_{i=1}$ is

$$\sigma_{vL} = \frac{\sigma_{vL}^{(i)} - \sigma_{vL}^{(i+1)}}{\sigma_{mL}^{(i)} - \sigma_{mL}^{(i+1)}}\left(\sigma_{mL} - \sigma_{mL}^{(i+1)}\right) + \sigma_{vL}^{(i+1)}, \tag{8}$$

Considering curve (8) as a limit cycle (safety coefficient equal to the unit) is consequently taken into acount, alongside with its homothetic curve to the origin, the points of which represent loading cycles having an identical safety coefficient c >1, for the same type of effort concentrator. Based on the latter considerations, the following equation is to be established,

$$\sigma_v = \frac{\sigma_{vL}^{(i)} - \sigma_{vL}^{(i+1)}}{\sigma_{mL}^{(i)} - \sigma_{mL}^{(i+1)}}\left(\sigma_m - \frac{\sigma_{mL}^{(i+1)}}{c}\right) + \frac{\sigma_{vL}^{(i+1)}}{c}, \tag{9}$$

where

$$\sigma_{mL} = c\sigma_m,$$

$$\sigma_{vL} = c\sigma_v, \tag{10}$$

The succeeding expression of the safety coefficient is inferred from relation (9):

$$c = \frac{\sigma_{mL}^{(i+1)}\left[\sigma_{vL}^{(i)} - \sigma_{vL}^{(i+1)}\right] - \sigma_{vL}^{(i+1)}\left[\sigma_{mL}^{(i)} - \sigma_{mL}^{(i+1)}\right]}{\sigma_m\left[\sigma_{vL}^{(i)} - \sigma_{vL}^{(i+1)}\right] - \sigma_v\left[\sigma_{mL}^{(i)} - \sigma_{mL}^{(i+1)}\right]}, \tag{11}$$

for the limitation of φ given by (7).

In the particular case when n = 2, the formula of the safety coefficient given by (11) in the whole fields, emerges as

$$c = \frac{\sigma_{-1}\sigma_c}{\sigma_m\sigma_{-1} + \sigma_v\sigma_c}, \tag{12}$$

which, introducing the notations

$$\frac{\sigma_v}{\sigma_{-1}} = \psi, \qquad \frac{\sigma_m}{\sigma_c} = \theta, \tag{13}$$

becomes

$$c = \frac{1}{\psi + \theta}, \tag{14}$$

relation coincidental with Soderberg's formula.

However, when n = 3, we shall consider point M_2 corresponding to the pulsatory cycle, that is

$$\sigma_{mL}^{(2)} = \sigma_{vL}^{(2)} = \sigma_0/2 \qquad \text{for } 0 \le \varphi \le \pi/4 \tag{15}$$

$$c = \frac{1}{\theta + \left(\frac{2}{\sigma_0} - \frac{1}{\sigma_{-1}}\right)\sigma_v} \tag{16}$$

is obtained, and for

$$c = \frac{1}{\psi + \left(\frac{2}{\sigma_0} - \frac{1}{\sigma_{-1}}\right)\sigma_m} \tag{17}$$

Using the calculation method, it is illustratively easy to verify whether those values provided by (16) and (17) are connected to $\varphi = \pi/4$ (case in which $\sigma_m = \sigma_v$).

Relation (16) and (17) coincide with Serensen's formula. In certain cases [3], the value of the safety coefficient for $0 \le \varphi < \pi/4$, given by (16 is replaced by value (14), which is a covering one).

It is additonally noticeable that if point $M_2(\sigma_0/2,\ \sigma_0/2)$ exists on the $M_1,\ M_3$ segment, that is

$$\frac{\sigma_0}{2} = \frac{\sigma_{-1}\sigma_c}{\sigma_{-1} + \sigma_c} \tag{18}$$

both determinations (16) and (17) lead to the value of the safety coefficient (14) given by the Soderberg schematisation.

Introducing, for i = 1,2, ... ,n-2, the notations

$$\psi^{(i)} = \frac{\sigma_v}{\sigma_{vL}^{(i+1)}}, \qquad \theta^{(i)} = \frac{\sigma_m}{\sigma_{mL}^{(i+1)}}, \tag{19}$$

and

$$v^{(i)} = \frac{1}{\sigma_{vL}^{(i+1)}}\left[\sigma_{vL}^{(i)} - \sigma_{vL}^{(i+1)}\right]$$

$$M^{(i)} = \frac{1}{\sigma_{mL}^{(i+1)}}\left[\sigma_{mL}^{(i)} - \sigma_{mL}^{(i+1)}\right], \tag{20}$$

the safety coefficient (11) receives the shape

$$c = \frac{v^{(i)} - M^{(i)}}{\theta^{(i)}v^{(i)} - \psi^{(i)}M^{(i)}}, \tag{21}$$

for $$\varphi_i \le \varphi < \varphi_{i+1}, \tag{22}$$

where $$\varphi = \operatorname{arctg}\frac{\sigma_v}{\sigma_m}, \tag{23}$$

φ_i being given as an expression (5).

$$\varphi_{n-1} \le \varphi < \pi/2, \tag{24}$$

relation (21) with notation (19) and (20) is not applicable $\sigma_{mL}^{(n)} = 0$. For φ belonging to this interval, the expression of the safety coefficient is deduced from relation (11) in the shape

$$c = \frac{\sigma_{-1}\sigma_{mL}^{(n-1)}}{\sigma_v\sigma_{mL}^{(n-1)} + \sigma_m\left[\sigma_{-1} - \sigma_{vL}^{(n-1)}\right]}, \tag{25}$$

that is

$$c = \frac{\sigma_{mL}^{(n-1)}}{\psi\ \sigma_{mL}^{(n-1)} + \sigma_m\left[1 - \sigma_{vL}^{(n-1)}/\sigma_{-1}\right]} \tag{26}$$

The general relation (11), as well as (21) and (26), function of the intermediate points number, improve the value of the safety coefficient given by the classical relation of Soderberg (14) and Serensen (16), (17).

All in all, the formulae previously obtained can be applied to brittle materials too, replacing σ_c by σ_r.

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