CRITICAL REVIEW

COMMENTS

to the Publication by V. P. Naumenko and I. V. Limanskii, “Fracture Resistance of Sheet Metals and Thin-Wall Structures. Part 1. Critical Review” (Strength of Materials, 2014, Vol. 46, No. 1, 18–37)

The authors made an attempt to subjectively evaluate modern approaches to structural strength analysis of cracked thin-walled structures, but in fact any structures whatever are not examined and only test results for some types of specimens are discussed [1].

Ungrounded criticism of our several studies [2, 3] impelled us to write this note. Thus, in p. 31 [1] the three assertions are imputed to us, however, we have nothing to do with them. For the reader's convenience, we would remind that the matter is practical risk evaluation for the fracture of structures based on the combined use of brittle and ductile fracture criteria within the so-called two-criterion approach. Considering certain difficulties in the access to the preprint [2] of 25 years' standing, we quote the definition cited there: “The diagram of fracture estimation is the method of interpolation of the two extreme cases of fracture (brittle and ductile) with the generalized equation

$$K_r = f(S_r),$$

where K_r is determined as the ratio of the current value of the fracture mechanics parameter to its critical value and S_r is usually equated to the ratio of the applied stress value in the net section, normalized to the ultimate strength.” This is the basic premise of the two-criterion approach.

Unfortunately, the authors [1] have chosen the unacceptable way of polemics when we are first imputed nonexistent assertions, then they refute them themselves. As an example, we quote the following initial premises they ascribe to “the majority of oversimple approaches” (according to the far-fetched authors' terminology [1], first of all, to the studies [2, 3].

1. The value K_{Ic} is a preferred, i.e., a general-purpose, measure of fracture resistance for both extremely brittle and high-ductility metallic materials [80].

2. The characteristic K_{Ic} of a metallic material that is fractured in the elastoplastic region, can be determined from the results of uniaxial tensile testing of smooth specimens [83].

3. The value K_{Ic} for the material of any thin-wall structure, including that of a main pipeline, has the meaning of the constant of its condition, which is independent of the deformation constraint. (Here and further Refs. [80] and [83] in [1] correspond to [2] and [4] of the present publication).

It is easy to verify that the above three “premises” do not appear in any one of the so-called “oversimple” approaches, they invented by the authors [1] and are in full contradiction to the above premise [2]. Show this in the same sequence.

1. In fact, the value K_{Ic} is “preferable, i.e., universal, measure of fracture toughness” only for brittle materials but in no way for those of high-plasticity, while fracture toughness on the diagram controls the ductile fracture criterion $S_r = 1$. This is the meaning of the two-criterion approach, remaining beyond the authors' comprehension [1].

Translated from Problemy Prochnosti, No. 3, pp. 179 – 181, May – June, 2014. Original article submitted May 14, 2014.

2. In a study [4] (Ref. [83] of the authors [1]) even mentioning of the two-criterion approach is absent and, thus, there are no recommendations for estimating K_{Ic} by the test results for the smooth specimens in uniaxial tension.

In a standard [3], a simpler estimation of the value K_{Ic} is proposed by its correlation with impact strength. Therefore, it is improper to attribute to the K_{Ic} estimation within the two-criterion approach by the test results of the smooth specimens in uniaxial tension. As regards the correlation itself between K_{Ic} and yield stress, in many publications (e.g., [5]) as well as in our study [4], there is a sufficient number of convincing experimental data, corroborating its existence under certain conditions.

3. The value K_{Ic} , determined by the standard, is necessarily having the meaning of the constant, independent of the deformation constraint. It turns out that the authors [1] are unfamiliar to the true fact of estimating K_{Ic} at temperatures below the critical one of the ductile-brittle transition on the specimens of full-scale (or smaller) thickness, cut out, e.g., from a thin-walled pipeline.

Discussions, cited in pp. 32 and 33 [1] and concerning reference stresses, are not correct. The reference stresses do not depend on the choice of yield stress or ultimate strength as the normalizing value. This concept was introduced already in 1968 as a certain equivalent measure of the load level within the model of an ideally plastic body. As was noted in our study [6], σ_{ref} can be determined very easily as the imaginary ultimate strength whereby the body is transferred to the limiting state at a given system of loads.

Since all subsequent considerations and manipulations of the authors [1] are based on the above misconceptions, their further analysis makes no sense. However, in this case, the natural question arises: what confidence of the reader in the area of more complicated fracture criteria can the authors [1] expect if for their understanding, as the above analysis demonstrates, even “oversimple” approaches are of insuperable complexity?

In our opinion, many principles of [1], which can be judged by the reader independently, do not feature sufficient depth and validity. It is explained by the two circumstances. First, to all appearances, its authors have no experience in calculating cracked structures subject to the danger of the ductile-brittle transition. Second, the authors’ ambitions are obviously directed to getting back fracture mechanics to its initial state, which went away very far from Griffith’s times, such an object is stated in p. 21 [1]: “Results of realization of the extensive program of experimental studies have allowed authors to eliminate in due time search of so-called fracture toughness constants and to begin development of transformation laws.” The essence of those laws is not discussed in the review. In return, it is noted in the Section “Conclusions” (pp. 33 and 34) that the results “made it possible to set to the solution of the next problem of fracture mechanics, which is key in its significance: to derive the data transferability law for a rectangular plate with a central mode I propagating crack (Fig. 1a) under conditions of uniaxial and/or biaxial loading [1].” (Here the reference to Griffith is given.) As if there was no 100 years of development of fracture mechanics science!

REFERENCES

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