

ANALIZA PRSLINA NA NANO NIVOU

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Rezime

Prikazano je nekoliko primera otkaza konstrukcija u eksploataciji i diskutovan značaj prslina na bazi mehanike loma. Zahvaljujući razvijenom pristupu moguće je predvideti ponašanje prslina pri lomu, tj. oceniti pouzdanost konstrukcije. Za tu ocenu potrebno je primeniti konzervativni model, pogodan da pokrije moguće neizvesnosti različite prirode. Prikazani su primeri ocene pouzdanosti. U prvom slučaju je cilj bio da se utvrdi kritična veličina prslina u datom polju napona u razmatranoj konstrukciji, radi pripremljenosti u slučaju pojave prslina. U drugom slučaju ocenjena je pouzdanost konstrukcije sa otkrivenom prslinom radi produženja eksploatacije razmatrane posude pod pritiskom. U ovom razmatranju treba uzeti u obzir i neprekidni razvoj industrije, posebno mašinske i građevinske, koji ima dva bitna obeležja. Prvo je da se neprestalno pojavljuju nova projektantska i konstrukcijska rešenja, a drugo je da broj jedinica proizvedenih objekata stalno raste. Zbog je udeo otkaza i lomova često statistički zanemarljiv, ali pojedini su, zbog značaja konstrukcije katastrofalni, i sa aspekta projekatata, pa i uopšte, spektakularni.

Prikazani primeri pokazuju koliko je problem složen, sa jedne strane, ali sa druge strane se može videti da je suština problema još nedovoljno jasna. Razlog je što je mehanika loma u matematičkom delu materijal posmatrala kao kontinuum, što je daleko od stvarne mikrostrukture materijala. Zbog toga se već u ranoj fazi razvoja mehanike razmatra pitanje trenutka nastanka loma i njegovog oblika interdisciplinarnim pristupom. Prekid međuatomske veze je prihvaćen kao pojava prslina, koja daljem procesom može da se razvije do loma. Pri tom je pojam „otkaz“ doveden u pitanje, odnosno da li je to prva pojava prekida atomske veze ili vidljivo razdvajanje sve do neopotrebljivosti konstrukcije.

Razvoj mikro i nano konstrukcija pitanje otkaza stavlja u prvi plan, jer posledice mogu biti katastrofalne. Kako su mikro i nano dimenzije dovoljno bliske dimenzijama klasičnog opisa loma neophodna su dalja istraživanja suštine loma i nivoa na kome do prekida veze u materijalu dolazi. Posebna pažnja će biti posvećena upravo tom problemu.

CRACK ANALYSIS AT NANO LEVEL

Summary

Several failure examples of structure in service are presented and significance of crack discussed, based on fracture mechanics. Based on developed approach it is possible to predict behaviour of crack in a fracture, e.g. to evaluate the reliability of structure. It is necessary for this evaluation to apply conservative model, capable to cover possible uncertainty of different nature. The cases of reliability evaluation are presented. The first one was performed with the aim to assess the critical size of crack in given stress field of considered structure, to be prepared for eventual crack occurrence. In the second case the reliability of a structure with detected cracks was assessed for the prolongation of service life of considered pressure vessel. It is necessary in this consideration to have in mind continuous industrial development, especially in machine and equipment production and in civil engineering structures, characterized by two substantial phenomena.

For that the amount of failures and fractures is often statistically negligible, but some of them, due to significance of a construction are catastrophic, from designer point of view, and in general sense, spectacular. Presented examples have shown the complexity of the problem, on one side, but on the other side one can recognize that the problem essentially is not quite clear. The reason is that fracture mechanics in its mathematical part assumed material as a continuum, what far from real material microstructure. Therefore, even in very early stage of fracture mechanics the question of fracture instant and its mode was opened. The separation of atoms is accepted as crack occurrence, which in next process can be developed in fracture. By this the notion "failure" became questionable, that is whether it is the interatomic break or visible separation up to the unavailability of a structure.

The development of micro and nano structures the question of failure puts in first line, because the consequences can be catastrophic. However, micro and nano dimensions are close to the classical description of fracture and this requires further investigation of fracture essence and of level the link in material is broken. Special attention will be paid just to this question.