Development of Crack Propagation Remaining Life Assessment Procedure and Analysis System

Background

It is an important subject in utilities to reduce maintenance costs by conducting radical operation and maintenance based on appropriate remaining life assessments of aged thermal power plants. Currently, if a visible crack, which measures about a few mm, is detected in a component, the crack must be removed or the component must be replaced. In most of the cases, components have crack propagation life in which reliable operation can be maintained. Therefore further life extension of the components is expected to predict crack propagation remaining life precisely. However the crack propagation remaining life assessment procedure has not yet been fully established and an analysis system of the life assessment has not yet been developed.

Objectives

To establish crack propagation database of long term used high temperature component materials, and to develop a crack propagation remaining life assessment procedure and an analysis system.

Principal Results

1. Establishment of crack propagation database of long term used materials

Microstructure observation and crack propagation tests on materials taken from around 200,000 hours operated components such as turbine rotor and casing were performed. As a result, it was found that creep damage accumulated during operation was not significant and effect of material degradation due to long term operation on crack propagation property was not observed. 3000 data points were obtained through the crack propagation tests, and the crack propagation database was established.

2. Development of crack propagation remaining life assessment procedure

Based on crack propagation tests using thin plate specimens and actual component model specimens of the long term used components, a crack propagation remaining life assessment procedure was proposed considering accuracy, simplicity and realistic application of the procedure. Feature of the proposed procedure is to adopt the Neuber rule as a simplified method *1 to assess the crack propagation under thermal stress condition occurring in high temperature components in fossil fuel power plants.

3. Case study of crack propagation assessment for an actual casing

In order to conduct crack propagation remaining life assessment of the high temperature components by using the proposed procedure, a crack propagation analysis system based finite element method, which is easy to use by conversation style, was developed. By using the developed system, a case study of crack propagation analysis of an assumed initial crack at R portion of an actual casing with sever temperature and stress yields was performed. As a result, the crack propagation remaining life assessment procedure was demonstrated and crack propagation behavior under thermal stress condition in the casing was predicted (Fig.2).

Future Developments

The developed crack propagation remaining life assessment procedure and analysis system will be applied to the remaining life assessment for actual turbine casings and boiler thickness parts.

Main Researchers:

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Reference

Takashi Ogata, et al., 2002, “Development of Crack Tolerant Remaining Life Assessment Procedure of High-temperature Components in Aged Thermal Power Plants”, EPRI workshop, International Conference on Advances in Life Assessment and Optimization of Fossil Power Plants, Florida

*1 : Simplified method to assess J integration under deformation controlled condition using stress and strain obtained from ratio of applied load to limit load.

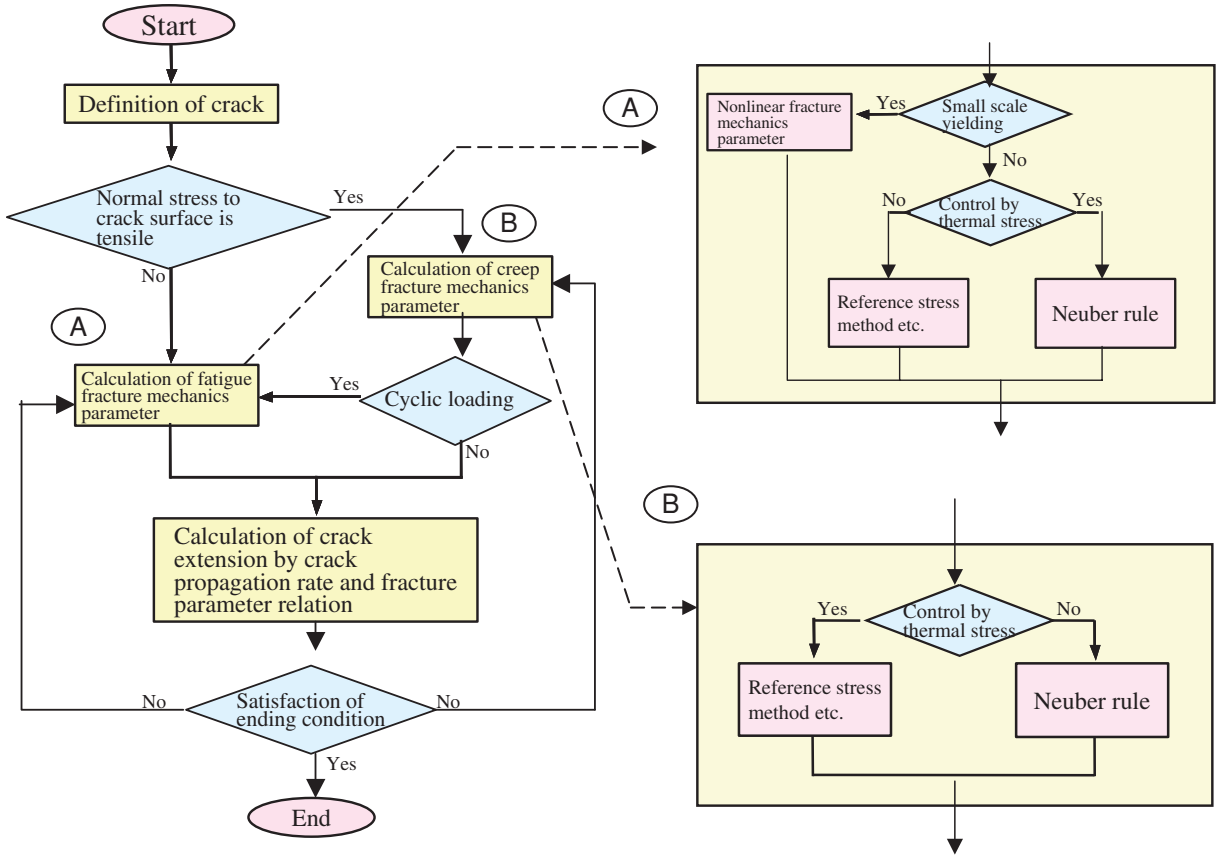
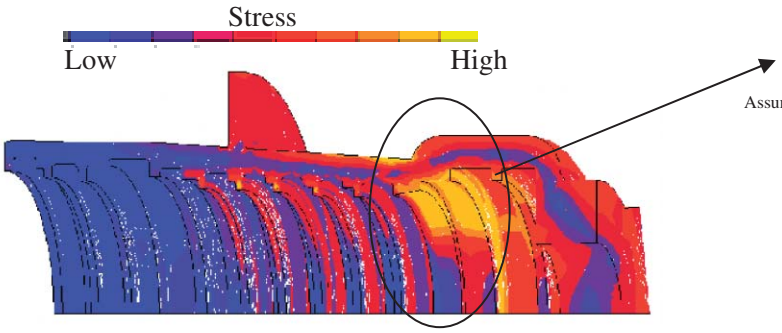
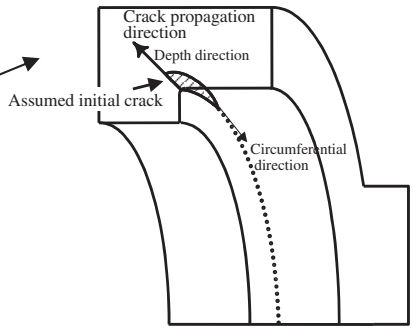


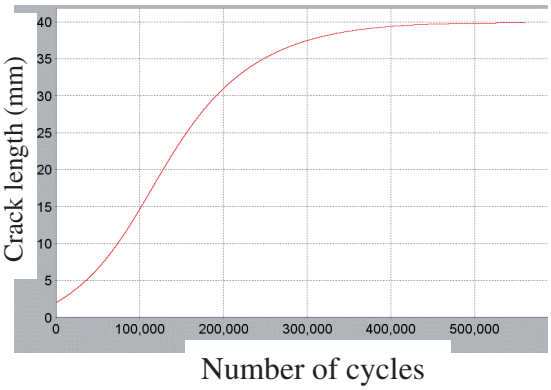
Fig.1 Crack propagation assessment flow proposed in this sturdy



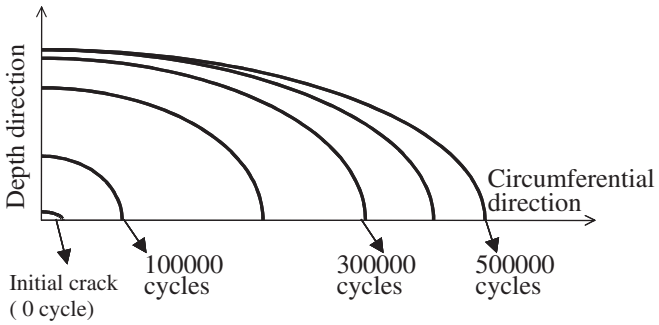
(a) Stress distribution in a casing



(b) Assumed initial crack in a casing



(c) An example of crack propagation calculation



(d) Crack propagation profile

Fig.2 An example of crack propagation analysis result of an assumed crack in a casing by the developed system