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A STUDY: Validation of Creep Damage Constitutive Equations of Bar 257 Steels at 650°: A Study

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Abstract

Validation of creep damage constitutive equations under the future loads, the left over lifetime is predicted to be quite limited. The main objective is to make prediction about the lifetime left because a growing stage of damage is encouraged by the previous history of loading. The ultimate goal is to render a loading spectrum that is complete in nature and predict about the time of keeping the material in the loading sequence, prior to facing any complexities related to catastrophic failure. All these damages and lifetime conditions are considered as responsible factors under a specific condition that is termed as 'creep failure condition'. This kind of creep failure condition matches with the enveloped polymers, as well as, with other high temperature conditions.

Keywords: *Creep, future loads, bar 257, constitutive equation*

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INTRODUCTION

The research has discussed the validation of creep damage of the constitutive equations for forecasting and has also identified the lifetime of occurrence of rupture in the Bar 257 steels material. The research has discussed the importance of accumulating the Bar 257 steels value at 650℃). The main prediction of the research is about the lifetime left because the growing stage of damage is encouraged by the loading. Matlab program has been used to find out the solution validation of a set of creep damage constitutive equation after used the formulation for (Xu, 2004) in this project [1]. The research also includes the models and theories for discussing the creep damage mechanisms. General theory and accurate models are used in the research. The research has included two methods of research, which are primary and secondary methods.

LITERATURE REVIEW

Literature review has been conducted in the research, and in the primary methods, different equations are used for analysis. The results are derived by two sets of uni-axial and multi-axial through the creep damage equation. From the result which is created in this project, the constitutive equation (Xu, 2004) can be used for describing creep damage under the limited stress level for each material used [1]. The study has clearly defined the general theory and software that defines the methods and validates the multi-axial creep damage constitutive equations. The research has also clearly evaluated and determined the lifetime along with the stress of failure that occurs through the range of stress conditions. The creep damage that occurs depends upon the nature of the stresses to which the material is subjected (Penny & Marriot). Creep damage studies attempted to accomplish this objective by introducing models that will predict the changes in strain and stress states of structures right until the point of rupture [2].

AIM OF RESEARCH

This project aims to validate the new proposal of "multi-axial" creep damage constitutive equations for Bar 257 steels at 650^{o}C. The research has been undertaken in order to attain the objective of determining the set of constitutive equations for forecasting and identifying the lifetime of occurrence of rupture in the material. The reason behind the assessment of these equations is that the advanced creep damage constitutive equations are found capable enough to cooperate with

problems that result due to the creep damage. The project has also clearly evaluated and determined the lifetime along with the stress of failure that occurs through the range of stress conditions.

OBJECTIVE OF RESEARCH

This research serves the purpose of assessing the new proposal of "multi-axial" creep damage constitutive equations. The objective of the project has been categorized in various steps:

1. Study the validation of creep damage constitutive equations of Bar 257 steels at 650°C.
2. Use Matlab software to provide results.
3. To understand the general theory and software that constitutes the method used for validation of multi-axial creep damage constitutive equations [3].
4. To evaluate and validate the newly defined set of multi-axial creep damage equation in order to determine the lifetime as well as stress of failure resulted due to the limited range of stress conditions.

METHODOLOGY

The purpose underlying technical specifications states that an improvement has to be done in order to develop design codes for current high level temperatures as well as procedures for assessment of life. Through this assessment and evaluation, more security as well as improvement will be made in the plants of high temperatures. Continuum damage mechanisms and cavity growth mechanisms have been used, as they provide a knowledge base, which supports the dealing of newly generated constitutive equations used as the base for knowledge [4].

This helps in a precise definition and explanation of physical mechanisms, which occur in the deformation of materials. Prior to this application, these sets of constitutive equations have been used for the industries to analyze and examine the potential of new sets of formulations with the use of validation methods. The study has clearly defined the general theory and software that defines the methods and validates the multi-axial creep damage constitutive equations. The research has also clearly evaluated and determined the lifetime along with the stress of failure that occurs through the range of stress conditions. The research plan is developed on the basis of the Gantt chart.

Creep damage constitutive equations for the materials of A-369 FP91 steels value at 625℃) at 90 stress and Bar 257 at 650℃) steels at 55 stress, have been used in this project as essential substantiation circumstance for consideration. The three parts should be considered in detail and also be subjected to an analysis in order to discover essential features by using this formalized methodology with the influential software Matlab.

Creep Damage Constitutive Equations

Uni-Axial Formulation

$$\dot{\varepsilon} = A\sinh\left(\frac{\beta\sigma(1-H)}{(1-\emptyset)(1-\omega)}\right)$$

$$\dot{H} = \frac{h}{\sigma}\left(1-\frac{H}{H^*}\right)\dot{\varepsilon}$$

$$\dot{\emptyset} = \frac{K_c}{3}(1-\emptyset)^4$$

$$\dot{\omega} = C\dot{\varepsilon}$$

Multi-Axial Form: New Formulation *(Xu,2000a,b)*:

$$\dot{\varepsilon}_e = A\sinh\left(\frac{\beta\sigma(1-H)}{(1-\emptyset)(1-\omega)}\right)$$

$$\dot{H} = \frac{h}{\sigma_e}\left(1-\frac{H}{H^*}\right)\dot{\varepsilon}_e$$

$$\dot{\emptyset} = \frac{K_c}{3}(1-\emptyset)^4$$

$$\dot{\omega} = CN\dot{\varepsilon}_e . f_2$$

$$\dot{\omega}_d = \dot{\omega} . f_1$$

TECHNIQUE OF RESEARCH PROGRAM

- In this project, the v=0, 1, 2, 3, 4 have been used as the equations variables.
- The time increment of 10 h has been used for integration from virgin state to failure state.
- Dr. Xu's constitutive equations have been considered in the Matlab software, which was proposed with the stress sensitive index v.
- The critical value of failure condition 1/3 is used the material is deemed failed.
- The stress of 90 and 55 Mpa are used for A-369 FP91 at 625℃ steel and Bar 257 at 650℃, respectively.

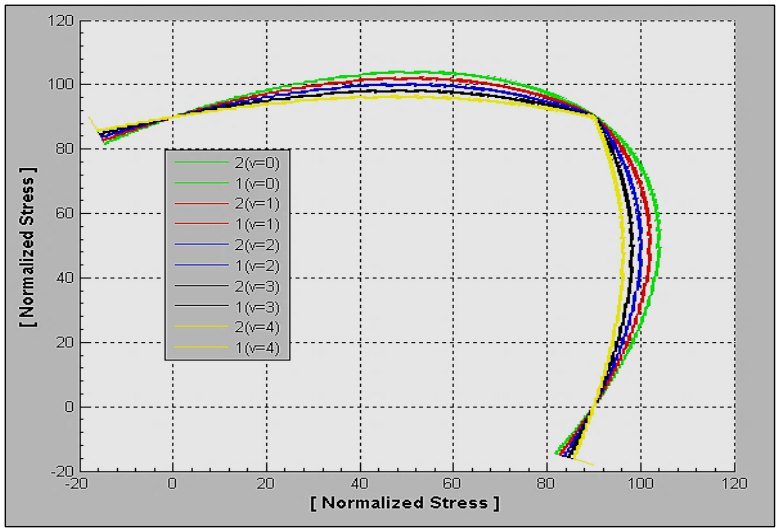

Fig. 1: *A-369 FP91 Plane Stress Isochronous Rupture Loci, (v=0:4) at Range (–0.2 to 1).*

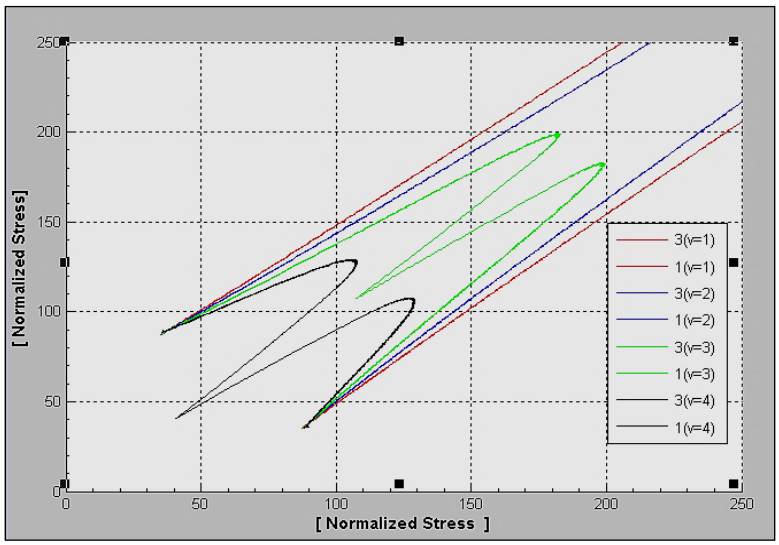

Fig. 2: *A-369 FP91 Plane Strain Isochronous Rupture Loci, (v=0:4) at Range (–0.2 to 1).*

Fig. 3: *A-369 FP91 Creep Strain Curve under Plane Stress at 625°C.*

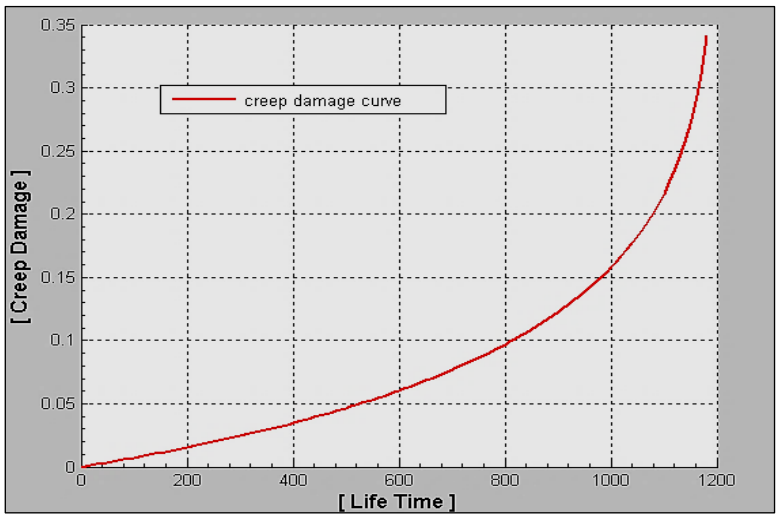

Fig. 4: *A-369 FP91 Creep Damage Curve under Plane Stress at 625°C.*

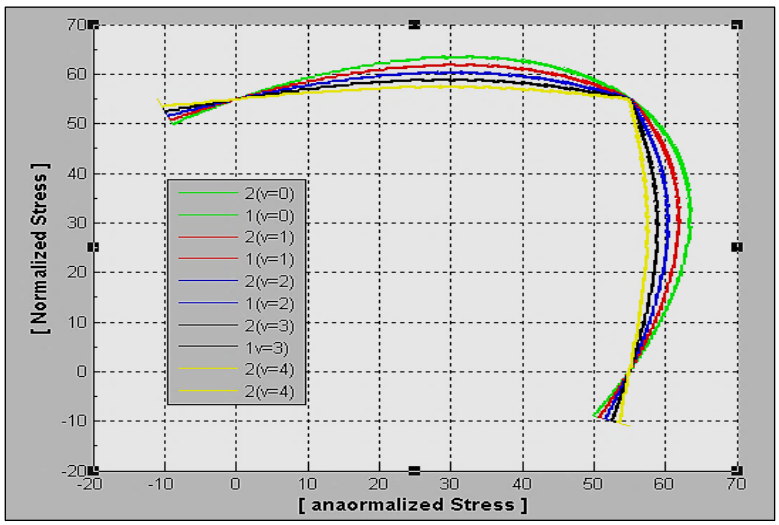

Fig. 5: *Bar 257 Plane Stress Isochronous Rupture Loci, (v=0:4) at Range (–0.2 to 1).*

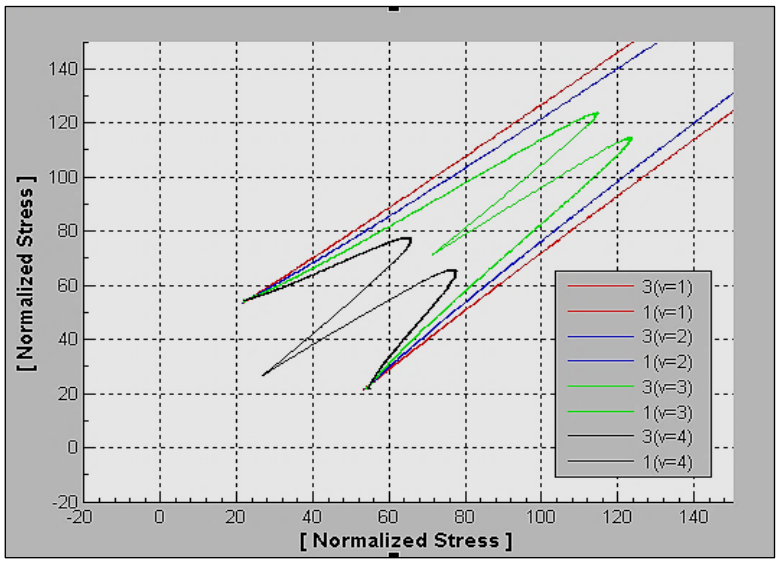

Fig. 6: *Bar 257 Plane Strain Isochronous Rupture Loci, (v=0:4) at Range (–0.2 to 1).*

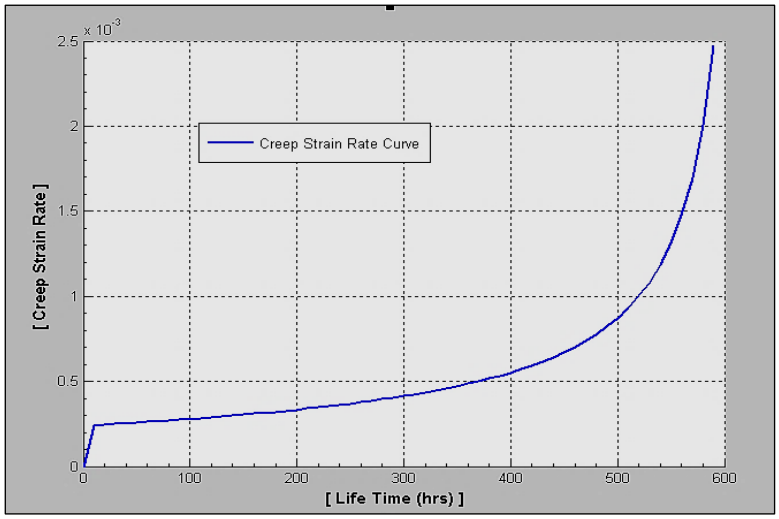

Fig. 7: *Bar 257 Creep Strain Curve Under Plane Stress at 650°C.*

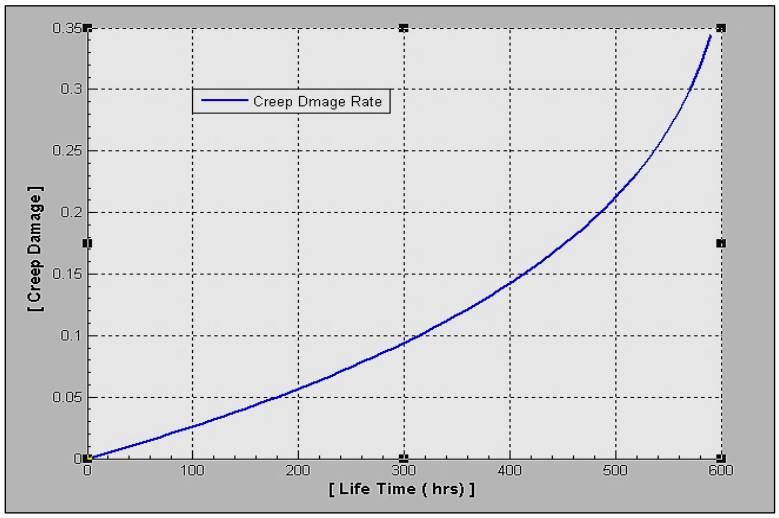

Fig. 8: *Bar 257 Creep Damage Curve under Plane Stress at 650°C.*

DISCUSSION

The aim of project has been successfully achieved by using the validation methodology which was proposed by Dr. Xu. It can be said that the stress level of materials is independent of the creep lifetime of the material. In terms of engineering application concept, it is not possible to consider an extremely high level of stress and very short creep lifetime [5]. The previous of KRH formulation did not take the strain failure and because of that we did not have enough time to produce this strain failure.

In the stress sensitive index, it is difficult to obtain varieties of stress condition. This difference has been overcome by using new set of constitutive equations, also this new formulation could produce better figures to match the observation and it could describe the creep deformation and evaluation more accurately as shown in Figures [1-8].

CONCLUSIONS

The study has fulfilled the purpose through providing the technical specifications that are undertaken for bringing the improvements for developing the design codes in the context of the current high temperatures. The aim of the research fulfills the purpose through assessing the multi-axial creep damage constitutive equations. For meeting the purpose of the research, two mechanisms are used, which are: cavity growth mechanism and continuum damage mechanism that support the constitutive equations that are base of knowledge [6]. The research has included the literature review as the secondary method for

data collection. Through the support of various articles, the damage caused by the creep has been discussed.

In conclusion; the aim and objectives have been achieved, e.g.

1. First of all, general knowledge of computational creep damage mechanicals has been learned as the basic background.
2. Secondly, the general theory and practical for validation methodology of multi-axial damage constitutive equation has been done.
3. Finally, the new set of multi-axial creep damage constitutive equations in terms of lifetime and strain at failure under range of stress state has been assessed through the validation method [7].
4. It is found that the popular constitutive equations are not really accurate and the new formulation proposed by XU is better and it should be used in future FEA analysis.

The research has also discussed the various theories, such as non-destructive testing methods and metallographic replication technique that detects the creep. The study has also included the sputtering process that covers the layers of a heavy metal and microscope; this process is described through standard E 1351, and ASTM.

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