Failure Analyse Prediction of Bolts Component Using Probality Method

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ABSTRACT

In a chemical factory there are steam pipes, which convey high pressure and high temperature steam, sealed with end flanges by 12 bolts at each end. Several bolts at the end of the flange were broken suddenly during the maintenance work. The investigation was performed to predict the failure of the bolt. Stress, strain and deformation of the bolts were analyzed. From the simulation, the failure happened almost close to the end of the bolt where it had been fixed. The simulation result was validated by the results that were produced by probability method. The failure may be prevented by using the right material with a large diameter or by changing the design of the bolt.

INTRODUCTION

In a chemical factory there are steam pipes, which convey high pressure and high temperature steam, sealed with end flanges by 12 bolts at each end. Anti-leaking molds are used at the ends of the steam pipes to avoid leaking of steam. When the problem occurred, investigation and analysis were performed. One of the problems was that the vapor leaked out at one end of a main steam pipe. During the maintenance task to do the anti-leaking work, several bolts on an end flange were broken suddenly. The end flange sprang about 10 m away. After inspecting the scene, three bolts were broken as shown in Figure 1. The other bolts were bent and their teeth were worn out. The analysis will perform to look on the stress, strain and deformation of the bolt.

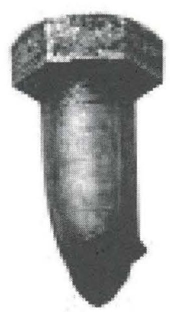

Figure 1: The failure of the bolt

DETERMINISTIC METHOD

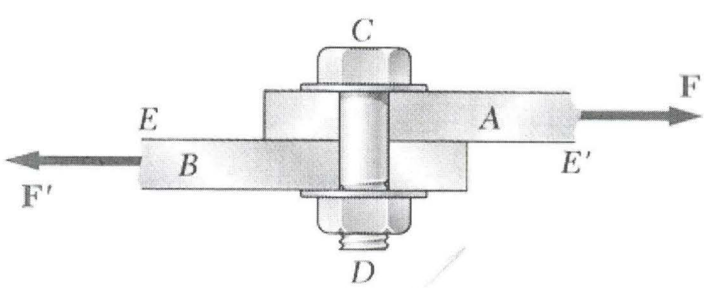

Figure 2: Connection with a bolt in shear

The concept of stress is considering a two-force member under axial loading. The normal stress is that the member was obtained by dividing the magnitude P of the load by a original cross-sectional area, A_0 of the member.

$$\text{Stress of bolt, } \sigma = \frac{P}{A_0} \tag{1}$$

Shearing stresses are founding bolts, pins, or rivets connecting two structural members or machine components. For example, in the case of bolt CD as shown in Figure 2 which in the single shear, the formula is:

$$\tau_{ave} = \frac{P}{A} = \frac{F}{A} \tag{2}$$

Shearing stress is commonly found in bolts, pins, and rivets used to connect various structural members and machine components. The application of shearing stress are when the bolts having the shear between two joints for example when we want to connect different plate or at the bridge. Bolts that tighten the beam at the bridge will have the shear stress when the loads are applied to the beam. Shearing also occur in the clamping process when a product from a piece of sheet metal is designed. The machine that commonly uses this process is turret machine which is to punch the sheet metal into the shape that is designed.

The elongation of the components is derived from the Equation (3) below:

$$\text{Elongation} = \frac{(l_f - l_0)}{l_0} \times 100 \tag{3}$$

where l_0 is the original length and l_f is the final length of the components.

Reduction of the area because of the physical changing is given by the Equation (4) as shown:

$$\text{Reduction of area} = \frac{(A_0 - A_f)}{A_0} \times 100 \tag{4}$$

where A_0 is the original cross-sectional area and A_f is the final cross-sectional area.

PROBALITY APPROACH OF FAILURE DIAGNOSIS

The probability approach that gives the quantitative method is declared as integrated multi-count. If the calculation is not using random number that is over of value N=10^{10}, the result will be a function (valued vector) of:

$$\mathbf{R}(\xi_1, \xi_2 ..., \xi_N) \tag{5}$$

for the following $\xi_1, \xi_2 ..., \xi_N$ random number. This is malfunction estimator for

$$\int_0^1 ... \int_0^1 \mathbf{R}(x_1 ..., x_N) dx_1 ... dx_N \tag{6}$$