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# Global-local deformation measurement using multi digital image correlation system

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## 1. Introduction

The digital image correlation (DIC) technique is a method of measuring the displacement and strain of the entire structure area by comparing images before and after deformation of the structure taken with digital cameras by a facet. DIC technique which is currently receiving much spotlight is a useful technique for measuring deformation. While studies on single DIC system which is used as a simple measure of structure have been conducted a lot [1,2]. However, many structures exist in complex forms and in order to measure complex structure deformation, not only the overall deformation of the structure, but also the deformation of the specific point where stress and strain concentration occurs at the same time is needed to accurately measure. So now it is necessary to study multiple DIC techniques[3, 4].

In this study, we designed and validated multiple DIC system. The two sets of cameras were connected to two different DIC system. To verify the accuracy of the multi DIC system, we compared between tensile test result and ABAQUS simulation result. Finally, we used multi DIC system to predict the area where the crack occurred in global measurement system and measure the length of the crack in local measurement system.

## 2. Multi DIC system

In this study, we designed two kinds of multi DIC system. One for is a tensile specimen with hole and the other system for a tensile speciemen with notch in tensile test.

About first multi DIC system, ATOS CORE 500 and CCD-4M cameras were used to implement multiple DIC systems. The two sets of cameras were connected to different systems and the synchronization between the two systems was implemented through the coding of the ARMIS program. The ATOS CORE 500 camera is designed to measure the global area of specimen, while the CCD-4M camera is designed to measure the local area of interest. Fig.1 is the installation diagram of multiple DIC systems.


Fig. 1. The multi DIC system for specimen with hole in tensile test

About multi DIC system for measurement specimen with notch, 2 sets of CCD-4M cameras were used to implement. 1 set of DIC system for global measurement and the other for local measurement on the other hand.

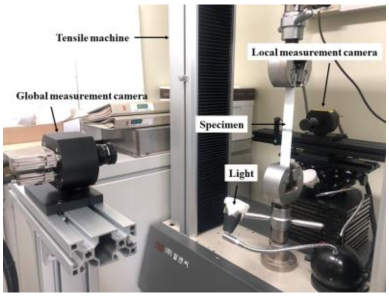


Fig. 2. The multi DIC system for specimen with notch in tensile test

## 3. Specimen preparation

Tensile experimental specimen is selected with aluminum 5052-H32. The tensile tester is RB 301 model.

(a) (b)

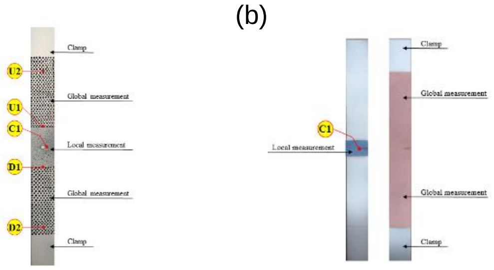


Fig. 3. Tensile test specimen (a) Specimen with hole (b) specimen with notch

Fig. 3. Shows that global and local measurement

area by multi DIC system.

For specimen with hole tensile test, five points were chosen in order to compare the experiment and Abaqus simulation data as shown in Fig. 3. (a). Local representative point of the measurement area is C1, U1 and D1 are representative points on the boundary between global and local measurement, U2 and D2 are representative points on global measurement.

For specimen with notch tensile test, we predicted the area where the crack occurred using global measurement and the length of the crack was measured on the local measurement. We can calculate J-integral value [5] with length of the crack and get $J_{IC}$ [6]. Finally, we can get stress which applied in $J_{IC}$ according to comparation with abaqus simulation

## 4. Results and discussion

Fig. 4. shows the Abaqus simulation and experiment results of specimen with hole tensile test.

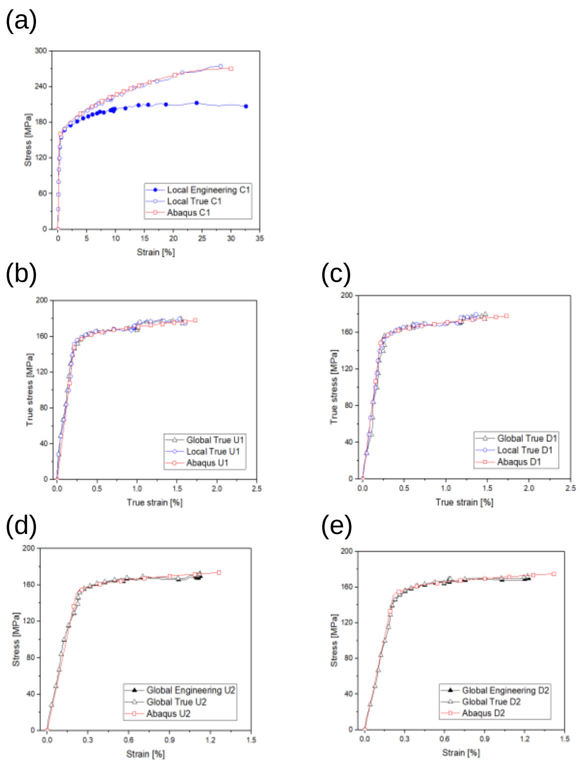


Fig. 4. Specimen with hole Abaqus simulation and experiment results (a) C1 point stress-strain curve (b) U1 point stress-strain curve (c) D1 point stress-strain curve (d) U2 point stress-strain curve (e) D2 point stress-strain curve

Comparing experimental and simulation values of C1, U1, D1, U2, and D2 points, the stress-strain curves were matched well. The maximum stress difference was up to 2% different.

Fig. 5. shows the Abaqus simulation and experiment results of specimen with notch tensile test.

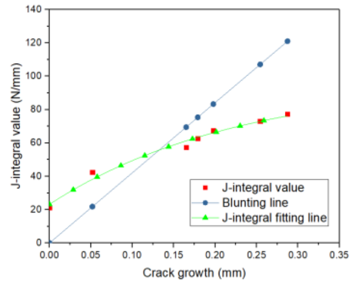


Fig. 5. J-integral-crack growth curve of C1

According to ASTM method [6], we can get $J_{IC}$ and stress 154MPa of $J_{IC}$ by comparison between Abaqus simulation and experiment results.

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