Application of Matlab to Data Processing of Buckling Experiments

Jiahui Zhou, Peng Yang, Jie Sun, Chenyu Shi and Jianghong Xue*
School of Mechanics and Construction Engineering, Jinan University, Key Lab of Disaster Forecast and Control in Engineering Ministry of Education, Guangzhou 510632, Guangdong, China
Email: txuej@jnu.edu.cn

Abstract. In this paper, matlab programs were written to efficiently process the experiment data for buckling and post-buckling of delaminated composite beams. In the experiments, data collected from 810 Material Test System (MTS) and from dial indicator were sampled at different frequencies, thus were not matched with each other in time. To solve this problem matlab programs were developed. It shows that using the developed program, the experiment data from the two testing systems are corresponding and truly reflect the changes of mechanical parameters in the buckling and post-buckling process of specimens in the experiments.

1. Introduction
In mechanical experiments, the sampling frequencies of several machines working at the same time may be different due to mechanical failure or operational errors. As a result, the different quantities collected by different machines are not corresponding. Under the circumstances, data processing is undoubtedly required. However, it is very troublesome and time-wasting for us to pick the useful data from such vast amounts of that. Computer programs can be used to solve the problem above very quickly and conveniently.

As we know, Matlab is a matrix-oriented high-level programming environment which gives access to fast algorithms for a large number of numerical tasks on many common computer platforms [1]. Matlab has been used to realize multi-channel synchronous data acquisition [2], to process many kinds of data such as compaction test data, NMR data, ocean chemistry data [1, 3, 4] and so on. But there is few application to non-corresponding buckling experiments data.

This paper introduces a matlab program to realize data processing mentioned above, and shows how to apply it to the data processing of some buckling experiments to study the nonlinear failure of damaged composite laminate. Applying the Matlab program, we can save time and simplify data processing.

2. Problem Solving and Programing Ideas
When we experiment on delaminated composite beams, there are three quantities need measuring: lateral deflection, longitudinal displacement and axial compressive force. Among them, longitudinal displacement and axial compressive force are measured by Material Test System, while axial compressive force is measured by the dial indicator. Normally, these three quantities should correspond with each other. Because of a problem with the dial indicator, its sampling frequency is not consistent with the set frequency and is mutative, which leads to different acquisition frequencies of these three quantities.
As both the 810 Material Test System and the dial indicator record the time when they collect each sample, to make the three quantities matched, we let the number of samples of all the three quantities in a given second depends on the minimum number of samples in this second. For example, in a certain second, the MTS samples 5 times, while the dial indicator samples 3 times, so the number of samples of each quantity in this second is three (the first two extra samples from MTS will be discarded). The program flow chart of the main part is shown in figure 1. To take advantage of fast matrix operations in matlab most processing commands have been vectorized. The program code of the main part is shown in the appendix.
3. Results and Discussion

This section is going to compare the data before and after processing. Plots of force against deflection before and after data processing for two typical specimens are shown in the figure 2, which indicates the data processing is very effective. It can be found that the deflection of the specimen at yield is much smaller after data processing than before, and certainly the data processed can reflect the real situation more accurately.

![Plots of force against deflection before and after data processing for two typical specimens](image)

Figure 2. Plots of force against deflection before and after data processing for two typical specimens

If the original data is used to analyse the buckling and post-buckling of the delaminated composite beams, we are going to get wrong results. The program proposed in this paper can help to analysis experiment data correctly and distribute to follow-up work.

Although these quantities will not correspond very strictly after being processed, the errors are very small and are not large enough to affect the observation of the failure mode of the specimens because the samples were screened within every second.

Since the data of force and displacement are measured by the same testing system and there is little difference between the data before and after processing, no comparison is made here.

4. Conclusion

By using the matlab program provided in this paper, we can process experiment data much more conveniently and efficiently to deal with the data obtained from the buckling experiments so as to avoid manual and repeated processing of similar data. After applying the program, different quantities are matched with each other in time, so that the properties of the materials or structures can be analysed correctly and accurately. With this program, we lay a solid foundation for the subsequent research and offer a reference for similar experiment data processing.
5. Acknowledgements
The work presented herein was conducted with the financial support of Guangdong Natural Science Foundation (2017A030313013).

6. Appendices
i=0; j=0;
s=0;
%Create a new matrix. Pre-allocate memory for efficiency.
C=zeros(length(A),3);
while (i<length(A)) && (j<length(B))
    %A refers to the matrix consists of the data collected by the dial indicator.
    %B refers to the matrix consists of data collected by 810 Material Test System (MTS).
    q1=i; q2=j;
    i=i+1; j=j+1;
    while (i<length(A)) && (A(i,1)==A(i+1,1))
        i=i+1;
    end
    while (j<length(B)) && (B(j,1)==B(j+1,1))
        j=j+1;
    end
    if i-q1<j-q2
        k=i-q1;
    else
        k=j-q2;
    end
    s=s+k;
    for p=1:k
        C(s-p+1,1) = A(i-p+1,2);
        C(s-p+1,2) = B(j-p+1,2);
        C(s-p+1,3) = B(j-p+1,3);
    end
    end

7. References
[1] Gunther U L, Ludwig C and Ruterjans H 2000 J. Magn. Reson. 145 201-208.
[2] Yang Y, Tan Y, Huang J and Yuan N 2009 Realization of multi-channel synchronous data acquisition using matlab Microcomputer Information 25 4-5, 84.
[3] Yu Z and Cheng S 2012 Applied Mechanics and Materials vol 170-173, et al (Yantai: China) p 611.
[4] Chen X, Lu C, Liu Z and Yang Y 2005 Computers and Applied Chemistry 22 59-61.