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# Characteristics of Accordion Reed Oscillation

*Cha Jae Ryong*[*], *Kim Yon*

School of Mechanical Science and Technology, Kim Chaek University of Technology, Pyongyang, DPRK
[*]Corresponding author: Email: cjr7548@star–co. net. kp

Free reed instruments consist of two main families, one of which is oriented in Europe about 200 years ago. The family instruments employ reed mounted asymmetrically on support plate, at which sounding is possible for only one direction of airflow without the aid of resonator. These reeds behave produce sounding frequency a bit below the natural vibration frequency of reed tongue. The other family is oriented in Asia, which employs free reed cut from sheet and mounted symmetrically with respect to airflow direction. Here, the reed can vibrate in both direction of airflow and result in the sounding frequency of reed–pipe combination a bit above both the natural vibration of reed tongue and resonance frequency of the pipe. The reed vibration is a physical phenomenon producing the interaction between the fields of solid and fluid and its analysis is significantly difficult to conduct. Because of a boundary condition varying in terms of time, the accordion reed faces a periodic load. To overcome these problems in earlier study, the reed system could be simplified by a mass–spring–damping single oscillator system or analyzed by Boltzmann lattice method.

This paper illustrates the origin and characteristics of self–excited oscillation of 3D finite elements reed model in line with the numerical and experimental results. In order to obtain results for extensive airflow rates, the experimental arrangement provides the stepping motor driving system to maintain a constant pulling speed for assuring constancy of pressure in the bellow. To identify and investigate the results from the experiment, the simulation of solid − fluid coupling analysis is conducted with the aid of Finite Element software, Abaqus, which has been proposed for the definition of contact areas between fluid and solid field so that the load and boundary conditions varying with time could be introduced reasonably. The fluid area, with wall condition and inlet boundary condition for I area and free boundary condition for II area, is analyzed in Flow step equipped with k– ε turbulence model. Next, the solid area indicating the reed model is divided into solid 1 220 finite elements(C3D8R), which is clamped at riveted end like cantilever beam. From the simulation results, the amplitude growth under self–excited oscillation is exponential and so does the modelling analysis result reveals similar tendency. The results shows that although vibration amplitude rate increases with the increase of blowing pressure, the fundamental pitch tends to decrease as to the blowing pressure increase, just like the experimental results. Because of absence of torsional mode, it may be thought that there is no contribution to the sounding and the transient. It is found that the first natural frequency of reed tongue is in agreement with the first spectrum frequency of torsional vibration, which means that the coincidence in natural frequency of reed and formation frequency of Kalman turbulence could result in self–excited oscillation. The results of the model are in good agreement with the experimental one; such as the transient properties of reed vibration, the impact on the amplitude growth rate, sound pitch and the fundamental frequencies as to the blowing pressures, in particular, conform to the results in earlier literatures. However, the dynamic simulation result of the first natural mode which plays significant roles in the sounding is somewhat different from those suggested in some literatures. It is discovered that the Kalman turbulence immediate behind the reed tongue has the serious impact on the characteristics of oscillation. The result of this simulation could be crucial for determination of sound timber appropriate for culture area which requires considerable efforts.