I. Introduction

Corrugated paper boxes are a primary means of packaging for logistical transportation worldwide. They are lightweight, fully recyclable, low-cost to manufacture, and highly customizable to meet various size, material, and structural specifications. However, these boxes are still prone to collapsing (box buckling) during storage and shipment, causing product damage, lost revenue, wasted resources, and customer complaints. Dr. Box Calculator Pro is a cloud computing platform designed to predict the buckling strength of corrugated paper box under diverse environmental conditions. Although the original Dr. Box provides comprehensive functionalities for box modeling and finite element analysis simulation, it takes time to run each analysis. The integration of AI tools with finite element analysis could provide instant results for box buckling.

II. Variation in Corrugated Paper Box Analysis

The corrugated box analysis would vary depending on the type of box, board combinations, fluting type, paper properties, humidity level, insert types, staples and cutouts to mention a few. Dr. Box Calculator Pro is capable of predicting buckling strength of corrugated paper box within 90% with the aforementioned variations using finite element analysis.

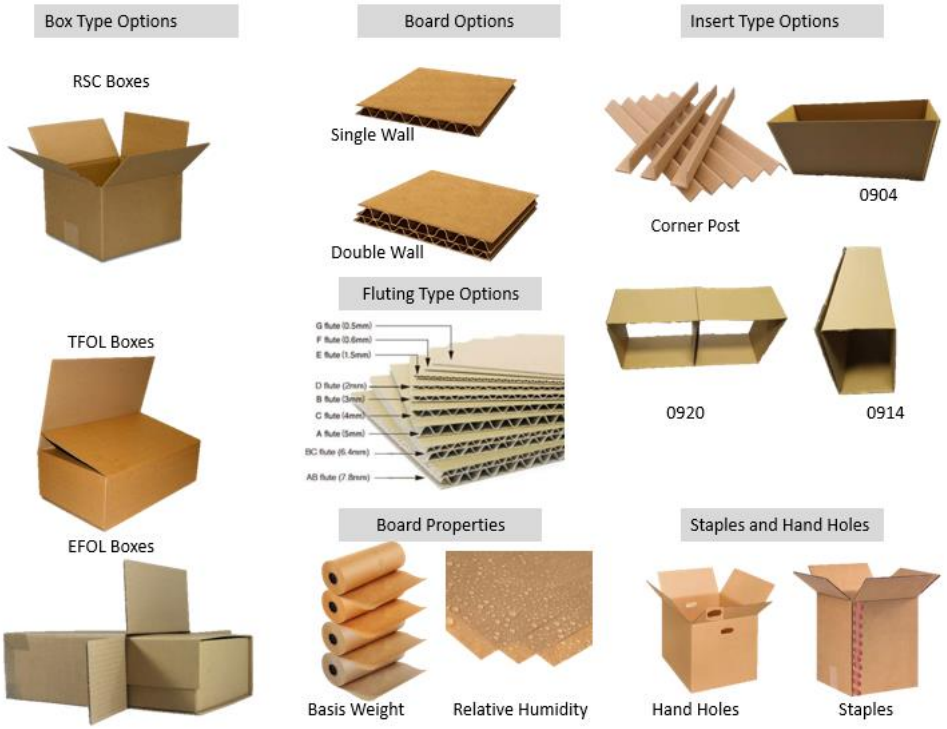

Figure 1 Corrugated Paper Box Variation

III. Website

The website drboxonline.com provides the user with an interface to provide the specifications that include box type, dimensions, insert, paper type, fluting type, board combination and insert type to our tool. A finite element model is built and analyzed based on these specifications and user is provided with an output file that includes the buckling

load, force displacement and deformed shape of the box with failure contours. The following images show the input and output to the website.

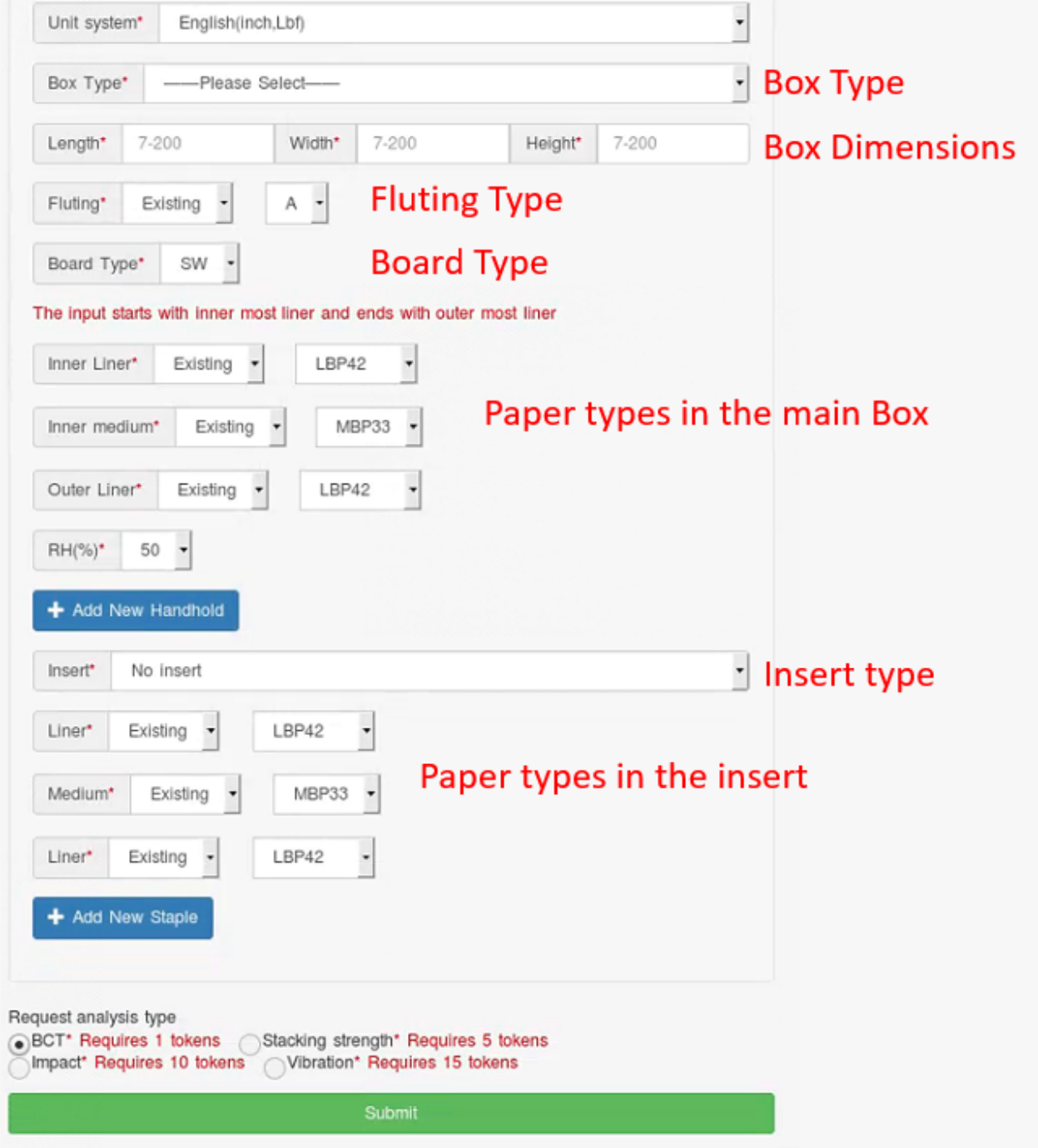

Figure 2 Input Page on the Website

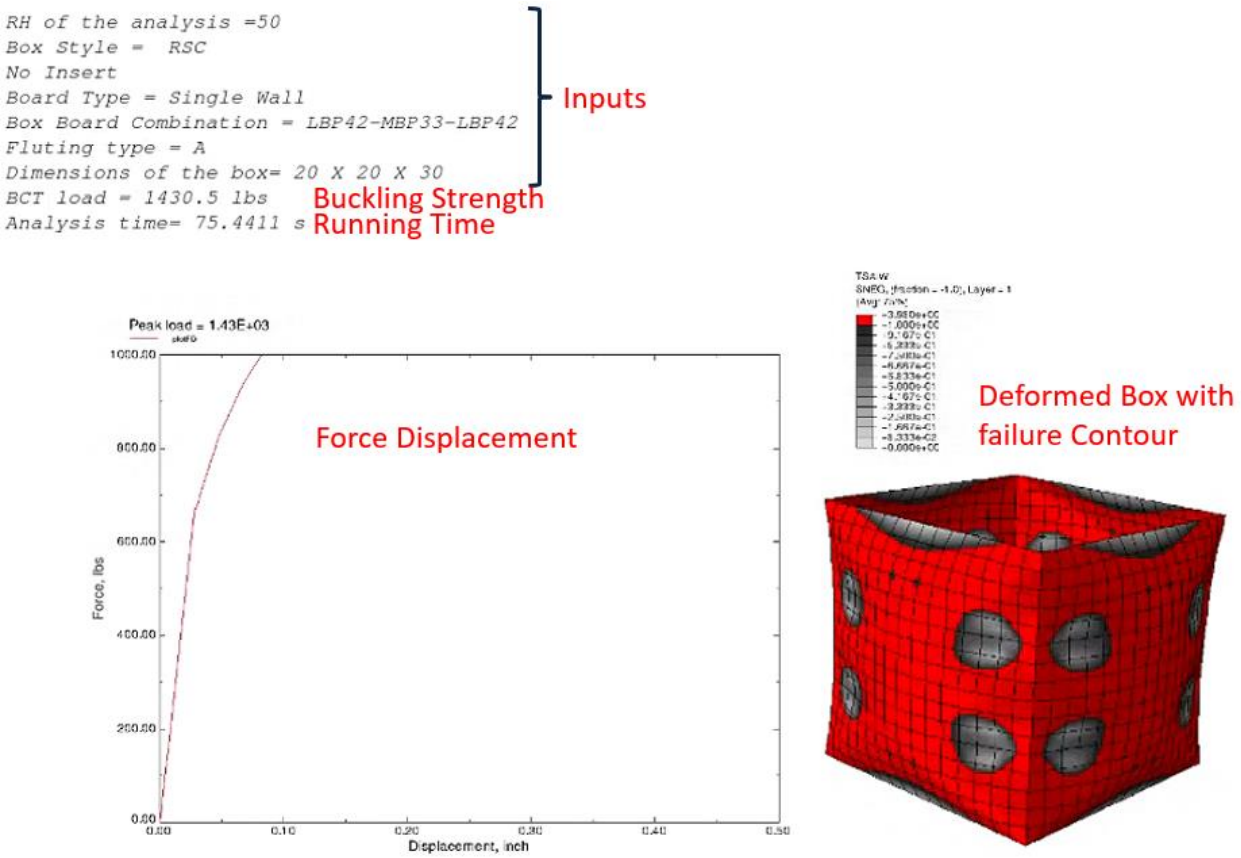

Figure 3 Output of the Analysis

IV. Data Generation

Based on the finite element model data is generated with inputs and outputs of the above tool. For the most basic box the inputs are the dimensions of the box and the outputs are the variation in force displacement, box deformation and failure. The deformation and failure of the box are described at predefined position on the box. The data is generated by varying the dimension of the box along the domain. 8000 data points were generated by varying the length, width and height of the box from 180mm to 5100mm. The inputs for each data points are the length, width and height of the box and the outputs are maximum force, force variation with displacement of the box, deformations in x, y and z at 128 points and failure at 128 points for each box.

V. Target Neural Network

The target is to replace the finite element by a number of neural networks. The first step is to train the neural network for the simplest of box with variation in size of the box only. This is followed by defining rules on preprocessing of the data for training neural network. The steps for basic neural network would be extended to a more complicated box analysis that includes variation in paper properties of the box along with the box size. The task is to define rules on what type of neural network would be best suited, the preprocessing of the data and minimum number of data points required for a neural network for a different type of box given the variation and number of inputs.