TEAM 506: CORNING PLUGGER PALLET SHORT PART STABILIZATION

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ABSTRACT

Our Corning sponsors, Jeffery Roche and Jeffery Stott, experience unstable conditions in their ceramics manufacturing plant. They are part of a company that makes ceramics to filter harmful emissions. While shorter ceramics are on the conveyor pallets, they risk falling off because of quick stops and vibrations, resulting in damage. The way that Corning corrects this issue lowers the risk of pieces falling but needs extra labor. Ceramic cylinders moving down the conveyor need to keep their faces bare for quality testing. The plant has various constraints that our design can't interfere with. The team created a mechanical lifting design that will combat the unstable conditions in the plant while lowering the need for extra labor. Inspiration for the design's look came from the shape of a T, our team has named the design the "Self-nesting T's." These Self-nesting T's raise and lower on both sides of the ceramic faces. The design uses no grease and relies on shoulder bolts to move. Considering the dust present in the plant environment, standard grease won't work. To engage, the design uses overhangs placed along the conveyor to lift and drop the T's when needed. Our T's go low enough so the ceramic faces will uncover during testing. The light materials selected allow the design to move with less forces needed. The motion of the design allows it to fully integrate with factory conditions. This range of motion protects the ceramic and brings down the labor cost. Adding thin foam padding prevents further ceramic damage. Various tests confirmed the design's ability to perform its goals. After senior design day, Corning can adjust the design and apply it in their factory to reduce their labor costs while protecting the ceramics from damage.

Keywords: Ceramics, Stabilization, Manufacturing

1. INTRODUCTION

1.1 Project Objective

This project aims to produce a stabilization system to protect ceramics on Corning's conveyor line while reducing the required manual labor.

1.2 Key Goals

After developing the project description, the team was able to come up with a list of key goals that the design must achieve. The first key goal of this project is to design a method to prevent damage to ceramic filters and substrates while on the production line in Corning's manufacturing plant. Their current design utilizes a "T" shaped piece of Plexiglas that is placed upside down and inside the slots on their chuck system. This method adequately prevents short part ceramics from falling and obtaining damage. Another goal of the team's design is to limit human interaction compared to the current system. The system currently in place requires two plant workers to place the T's on the chuck at the beginning of the line and remove them before the imaging process. The design used for this project should also be able to seamlessly integrate with the current conveyor system. There are several overhangs and space limitations on their current conveyor and the team's design needs to fit within these parameters.

1.3 Assumptions

In order to complete the project in the required timeframe, the team needs to make some vital assumptions. The team is assuming that the pallets and conveyor itself remain level during the transporting process. Additionally, the team expects the data and measurements received from our sponsor to be accurate and precise. This means that the pallets are uniform across the plant. Lastly, the team assumes that the manufacturing plant conditions will remain the same throughout the project duration.

2. TARGETS AND METRICS

Target and metrics were created in order to allow the team to evaluate the success of the device created. These targets and metrics were created with the assistance of the Corning sponsors. They provide exact numbers that would allow them to be able to validate that our device is a good fit for their manufacturing plant.

2.1 Prevent Damage

The current device that Corning is using is a Plexiglas T that does not allow for any ceramics to fall from the conveyor and become damaged. To validate that our design would be successful, a target to achieve 0% damage to ceramics being manufactured was created. This target was created so that our device matches what Corning currently uses.

2.2 Fits Return System

The device should be able to fit within the return system that runs underneath the conveyor, allowing pallets to return to the beginning. This system has a maximum allowable height of 6 inches (15.24 cm), meaning the device must be able to retract below that value, or it will interfere with the underside of the conveyor.

2.3 Limit Manual Labor

The Plexiglas T's that are currently used are not able to fit within the conveyor's return system. This requires them to place on a pallet at the start of the conveyor and removed near the end. To do this, our sponsor has 2 workers dedicated to adding and removing the Plexiglas T's. For our key goal of limiting interaction, our device should require no more than 1 worker to operate.

2.4 Withstanding Load

The device needs to withstand a load of 8 lb (0.454 kg) in the direction of the face of the ceramic. This is the maximum load the device needs to withstand to make sure the design will successfully support a ceramic if it were to lean against it.

2.5 Reveal Ceramic Face

The design should reveal the face of the ceramic within 48 seconds. This is the amount of time allowed to stop a pallet before it would cause a backup of the other pallets on the conveyor. The device must be able to reveal the face of the ceramic completely to allow for proper imaging of the face.

3. RESULTS AND DISCUSSION

The device created by the team was named the Self-Nesting T. Figure 1, shows the prototype created by the team that will be referenced throughout the remainder of this section.

FIGURE 1: SELF-NESTING T PROTOTYPE

3.1 Prevent Damage

The device can protect the ceramics based on the testing done for vibration, impact force, and expansion height. The device created can withstand the maximum available vibrations during testing which was 3600 vpm (vibrations per minute). This level of vibration was applied for 15 minutes to validate that the device would not show signs of failure during the time it is traveling on the conveyor.

Along the conveyor line, the pallet experiences multiple sudden stops. Our sponsors recorded the acceleration of the pallet on their conveyor line with an accelerometer. The acceleration from their data peaked when the pallet hit these sudden stops. To test our device's ability to withstand these stops, several impact tests were carried out. During these tests, the pallet was traveling at a medium velocity and then suddenly brought to a halt. An accelerometer was placed on the pallet to record the acceleration that the pallet experienced. *Figure 2* shows the section from Corning's data that shows the peak of about 4 G's.

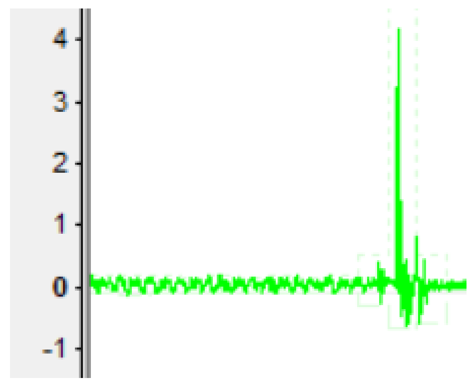

FIGURE 2: CORNING ACCELEROMETER DATA IN G'S

Due to our testing limitations, a max acceleration of 28.5 meters per second, or 2.9 G's was reached. *Figure 3* shows a table of the accelerometer data recorded. During this test, the Self-Nesting T was in the expanded position and was able to withstand this sudden spike in acceleration without collapsing. The ability for our device to withstand this test multiple times provides confidence that our device will successfully endure the travel on Corning's conveyor line.

	1 X	2 Y	3 Z
77	-0.4217	-0.7764	9.0541
78	3.1066	-0.3199	10.1990
79	-28.5064	-16.8925	14.7240
80	6.6272	5.8783	12.3423
81	-0.6685	-4.0420	20.2792

FIGURE 3: ACCELEROMETER TEST DATA SEPARATED BY AXIS IN METERS PER SECOND

The device was also validated to be able to prevent damage to the ceramics due to its ability to prevent them from falling off the pallet, much like the Plexiglas T does. This was tested by ensuring that the height of the device was, at minimum, the same height as the device Corning currently uses. Corning's Plexiglas T has a height of 11 inches (27.94 cm) and can keep the ceramics from falling off the pallet. The device created has a total extended height of 12 inches (30.48 cm) and when tested, does not allow for the ceramics to fall off the pallet. This data is listed in *Table 1* as expansion height, along with other important measured heights that are further discussed in the following subsections.

Testing	Target	Measured
Retraction Height	< 6 in	4.3 in
Middle Joint Height	< 4 in	3.6 in
Expansion Height	11 in	12 in

TABLE 1: VALIDATION OF DEVICE HEIGHTS

3.2 Fits Return System

The device had to be lower than 6 inches (15.24 cm) to fit into the return system. When the device was fully retracted, the highest point was measured to be no more than 4.3 inches (10.92 cm) tall. This meant that the device was fully capable of fitting in the feedback system without causing any issues. This data is recorded in *Table 1* and demonstrated in *Figure 1*.

3.3 Limit Manual Labor

The device needed to be able to actuate with the assistance of at most 1 person. The design was made in a manner that requires very little force on the lever arm to enable it to fall with the assistance of gravity. Through testing with a stepper motor, it was determined that the device was able to lower without human assistance.

It was further evaluated and tested to determine the need for a person to lift the device as well. Also using the stepper motor, it was found that, with an applied force greater than 4 lb (1.81 kg), the stepper motor was able to use the lever arm to actuate the device to the up-right position. These then validated that there was zero manual labor needed to actuate the device.

3.4 Withstanding Load

The testing of the load withstood by the device was completed by applying a load to the side of the device the ceramics would hit. This applied force was measured to determine how much load could be applied before the device bends or flexes. From this testing, it was determined that over 10 lb (0.454 kg) of load could be applied before significant bending occurred. This amount of load did not cause permanent damage to the device. The device is believed to be able to withstand more than this 10 lb (0.454 kg) of load before showing signs of permanent damage.

3.5 Reveal Ceramic Face

The device was given a maximum time of 48 seconds to raise or lower itself. This is the amount of time that is allowed before causing a major backup on the conveyor line. From the testing of manual powering and motor powering, it was determined that the maximum time the device should take to raise is no more than 20 seconds. While the maximum time for the device to lower was under 10 seconds. This time difference was affected by the speed of the testing motors as well as the force required to raise the device being higher than that needed to lower the device.

To reveal the face of the ceramic the device must also go below the chucks that the ceramics sits on. These chucks have a maximum height of 6 inches (15.24 cm) and a middle notch height of 4 inches (10.16 cm). The device was able to be validated by measuring that the outside height is no more than 4.3 inches (10.92 cm). Similarly, the middle notch height is no more than 3.6 inches (9.14 cm) (*Fig 1*). Both heights fit the required height to reveal the face. This data is shown in *Table 1*.

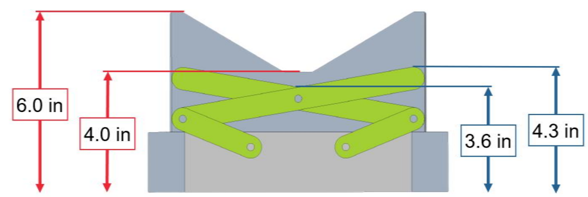

FIGURE 3: RETRACTION HEIGHTS OF DEVICE

4. CONCLUSION

Overall, the device was able to hit all the critical targets. It was determined that this device will be able to provide the needed protection to Corning's ceramics. The device was also determined to be able to achieve all the critical targets that would allow Corning to automate their protection method of these ceramics.

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