Invited Paper

Investigating the Influence of Container Design and a Bulge Reduction Technique in Corrugated Fiberboard Containers under Static Compression

Jay Singh * and Koushik Saha **

Abstract

This study explored the bulge effect in corrugated fiberboard boxes caused by excessive weight, leading to compromised stacking strength and potential product damage. It investigated how container design, specifically the height variations of regular slotted containers (RSCs), affects bulging under compression and its vulnerability to environmental conditions. Testing met ASTM standards, with samples conditioned according to ASTM and TAPPI protocols, revealing that changes in box height influence bulge displacement. Subsequent research examined the impact of top-to-bottom static compression loads on bulging in tape-reinforced RSC designs, evaluating bulge reduction and compression strength across various tape placements and environments. Notably, previous studies had not explored the effect of reinforcement tape on bulging reduction. Using specialized equipment, 120 samples representing five container designs with different tape placements were tested. Statistical analysis affirmed that reinforcement tape notably reduces out-of-plane displacement of container panels under ambient conditions, although its effectiveness diminishes under higher humidity. Evaluation of compression strength did not exhibit a clear pattern concerning tape presence under ambient conditions. These findings provide valuable insights for packaging engineers aiming to optimize corrugated fiberboard containers, stressing the importance of considering both container design and environmental factors to reduce material usage while improving stacking strength and rigidity.

Keywords: Bulge effect, Corrugated fiberboard, Stacking strength, Container design, Regular slotted containers (RSCs), Reinforcement tape, Compression strength

1. Introduction

The transportation of packaged products involves numerous risks, including damage from physical, chemical, microbiological, and climatic sources. Protecting products during transportation requires containers that offer adequate protection, with attention often given to compression and shock performance, but limited research has focused on bulging performance. Bulging occurs when containers experience material fatigue due to prolonged stacking, potentially damaging the product inside. Environmental factors, such as humidity, further complicate this issue by weakening paper-based materials. While increasing product headspace may reduce compressive force damage, it could destabilize pallet loads and decrease shipping efficiency [1]. RSCs made of C-flute single-wall corrugated fiberboard are common in the packaging industry, making their performance optimization crucial. Corrugated fiberboard containers have become the dominant form of transport packaging since their introduction in the late 19th century, with the global industry generating substantial revenue [2].

* Professor, Packaging Program, California Polytechnic State University, San Luis Obispo, CA 93401, (805) 756 2129, jasingh@calpoly.edu

** Professor, Packaging Program, California Polytechnic State University, San Luis Obispo, CA 93401, ksaha@calpoly.edu