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Subject: Undercarriage Failure and New-Growth Plywood Substrates Analysis.

Lately, there has been an overwhelming number of off-hire containers presenting with undercarriage failure, which is currently classified as "overload damage." The most noticeable pattern is lengthwise floor compression along typical forklift wheel paths, accompanied by plywood panel failure between crossmembers with or without underside finger-joint cracking. This progressive failure results in downward-bowed crossmembers and contact deflections between the chassis main rails and container crossmember flanges.
These visual conditions can be explained with minimal research, basic mechanical and structural analysis, and reverse engineering.
It is my contention that current IICL damage criteria rely solely on face-value inspection, failing to account for the structural limitations of "new-growth" plywood substrates.
Based on my years of experience inspecting thousands of containers, this failure mode was evident early on. Most, if not all, of the undercarriage failures seen across thousands of post-1990 containers originate in new-growth ply flooring.

Credentials & Field Experience
The following findings are based on 48 years of hands-on field experience in the intermodal container industry. My background spans leasing company operations, equipment control and maintenance, repair facility management, and my current role operating **Independent Marine Surveyors LLC**.

Structural Mechanics: The Composite Undercarriage

To better understand how this series of events culminates in floor failure or complete undercarriage failure, key components and their functions must be clarified:

- **Composite Structure Design.** The undercarriage of a shipping container is a "composite structure"—an engineered assembly combining two or more distinct, separate materials. In this case, 1-1/8" 21-ply marine-grade plywood and supporting steel crossmembers work together to produce a stronger, more durable structure with superior load-bearing properties.
- **Mutual Dependency.** Both components bound together provide enhanced strength and weight distribution that neither material could achieve alone. The failure of either component compromises the other and devalues the entire composite structure.
- **Rolling Shear Failure.** Dishing or sagging of plywood floor panels between crossmembers (rolling shear)—regardless of how minimal—is a structural failure of the plywood, leaving the crossmembers vulnerable and the integrity of the composite structure compromised.

Container Floorboard History

This history is critical as it lays out the original floor products used across manufacturing eras and demonstrates the absence of substrate-driven undercarriage failures prior to the transition to new-growth timber:

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- **Pre-1970 Manufacturing.** Dry containers built prior to 1980 used:
- 6" x 1-1/8" solid Oak or Apitong floorboards,
- 12" x 1-1/8" laminated Oak planks,
- 48" x 92-3/4" sheets or 1-1/8" 21-ply marine-grade plywood,
- segmented floor designs incorporating narrow ply sheets or Apitong floorboards mixed with 6” wide metal hat sections.
- All species were milled from dense, old slow-growth lumber. Floor and undercarriage failures caused by substrate breakdown were unheard of; undercarriage failures were directly linked to inadequate Z-type and C-type crossmembers or improper repairs. (Open-top containers during this era used 12" x 1-1/8" laminated Oak boards, which delaminated only due to excessive environmental exposure.)
- **1970–1980 Manufacturing.** 21-ply marine-grade plywood began replacing plank flooring more frequently, though panels were still produced from old slow-growth timber. Outside of upper-ply delamination and **finger cracking from direct point-load impacts**, there were few rolling shear issues, and complete undercarriage failure was virtually unheard of.
- **1980–1990 Manufacturing.** Dry and open-top containers incorporated 1-1/8" 21-ply marine-grade plywood almost exclusively in place of Apitong, Oak, and laminated Oak planks due to favorable weight and cost

considerations. Because these panels still utilized remaining stocks of old slow-growth lumber, load-contributing ply floor and undercarriage failures remained rare.

- **1990–2000 Manufacturing.** Floor failure (rolling shear), ply cracking, and undercarriage failure began increasing at unprecedented rates due to the shift toward new-growth sustainable lumber.
- **2000–2015 Manufacturing.** Nearly all dry cargo and open-top containers used some form of 1-1/8" 19- or 21-ply new-growth plywood or bamboo-combination flooring, resulting in a drastic drop in product consistency and reliability. The most noticeable issues were dishing or sagging (rolling shear) between crossmembers (supported on 11-3/4" centers) and underside finger cracking completely void of impact. Furthermore, delamination markers changed: prior to 2000, whole laminates separated in sheets when lower-grade adhesives failed. With modern phenolic adhesives, the glue bond held while the weaker new-growth wood fibers tore loose under stress.

Material Comparison: Pre-2000s vs. Post-2000s Plywood

Feature	Pre-2000s (Common / Old-Growth)	Post-2000s (Standard / New-Growth)
Timber Source	Dense, slow-growth natural forests	Fast-growth, sustainably farmed plantation trees
Growth Ring Density	Roughly 60 growth rings per inch	Roughly 14 to 16 growth rings per inch
Wood Composition	High proportion of dense latewood and heartwood	High proportion of softer sapwood and juvenile wood
Glue Type	Mixed or lower-grade resins	Phenolic WBP (Water & Boil Proof)
Veneer Quality	More internal voids/knots, but denser fiber	Void-free hardwood cores, lower fiber density
Chemical Treatment	Basic fungicides	Heavy impregnation for AQIS compliance
Primary Failure Mode	Adhesive bond separation (sheet delamination)	Wood fiber failure and rolling shear under load

(Note: Material specification comparisons originate from technical product guides provided by specialized timber importers and marine plywood manufacturers supplying the container industry.)

The Three-Step Sequence of Undercarriage Failure

When undercarriage failure occurs as a result of an inadequate new-growth substrate, the progressive breakdown follows three distinct stages:

1. **Substrate Yielding.** 21-ply flooring fails during loading due to the inadequate structural composition of the new-growth substrate.
2. **Loss of Composite Integrity.** The understructure (crossmembers) loses its structural load-sharing value once the key supporting component (structural ply substrate) fails.
3. **Crossmember Deflection.** Undercarriage crossmembers fail and bow downward due to the structurally compromised substrate, causing contact deflections between chassis main rails and crossmember flanges.

Supporting Research & Wood Density Science
Significant reference material—including industry articles, government documents, and engineering studies—documents the mechanical differences resulting from the shift from old-growth to fast-growth wood sources starting around the 1980s and early 1990s:

- **Density and Growth Ring Differences.** Old-growth wood harvested from slow-growing, competitive natural forests possesses roughly **60 growth rings per inch** and a high proportion of dense latewood and rot-resistant heartwood. Modern plantation-grown wood grows rapidly, resulting in as few as **14 to 16 growth rings per inch** and a higher proportion of softer sapwood and juvenile wood. Modern marine-grade plywood typically ranges in density from 430 kg/m³ to 750 kg/m³ depending on species (e.g., Okoume at 450–500 kg/m³, or Meranti and Birch at 600–750+ kg/m³). Overall, **modern new-growth wood is typically 15% to 30% less dense than pre-1980s old-growth wood—a structural disparity some timber experts compare to the gap between "paper and marble."**
- **USDA Forest Products Laboratory Research.** Technical reports from the U.S. Department of Agriculture—including its 1985 report *Weak Wood: Fast-Grown Trees Make Problem Lumber* and its *Mechanical Properties of Wood* reference chapters—scientifically confirm that rapid plantation growth increases juvenile wood and lowers density, directly reducing compressive strength and stiffness.
- **Industry Building Codes vs. Container Specifications.** In the U.S. construction sector, the **American Lumber Standard Committee** and Department of Commerce product standards (**PS 1** for Structural Plywood and **PS 2** for Wood-Based Structural-Use Panels) periodically update official design values to reflect changes in the timber supply. Modern

building designs compensate for weaker new-growth wood by specifying denser species, larger dimensions, or thicker panels.

- **The Uncompensated Deficit in Containers.** To match the structural performance of a vintage 1-1/8" 21-ply old-growth sheet, a modern equivalent requires a significant increase in raw density or structural reinforcement (such as thicker panels or closer crossmember spacing) to compensate for wider growth rings and higher sapwood content. **No structural compensation has been applied to container ply substrates since the timber shift occurred.**

Addressing Common Industry Questions
Question: Why don't we see all container floors showing signs of floor failure or undercarriage failure?

Answer: If a unit experiences early substrate yielding and lives out its remaining service life carrying light, voluminous cargo (such as cereal or garments), the likelihood of progressing to full undercarriage collapse is low.

Question: Why are we seeing significantly more floor panel and undercarriage failures on 20-foot dry containers as opposed to 40-foot containers?

Answer: A 20-foot container carries nearly the same maximum payload weight within half the structural footprint. Operating and maneuverability restrictions concentrate heavier, denser cargo over a smaller floor area, subjecting 20-foot units to substantially higher structural stress and up to twice the racking forces—accelerating mechanical and structural deterioration.

Feature	20-Foot Dry Container	40-Foot Dry Container
Cargo Density	High (Heavy, concentrated loads)	Low/Moderate (Voluminous loads)
Common Cargo	Heavy, dense industrial goods	Light, bulky consumer goods
Primary Damage	Floor rolling shear and structural undercarriage failure	External scratches and minor dents
Typical Usage	Harsh, high-stress industrial environments	General cargo transport

Conclusion
The amount of established engineering and forestry data on this subject outside the shipping industry—which has failed to filter into our own learned publications—is both astonishing and worrisome. To argue against this issue in the face of physical evidence is illogical.

The Undeniable Facts:

- The industry is currently utilizing new-growth lumber.
- This failure pattern did not exist when utilizing old-growth lumber.
- Pound for pound, new-growth lumber does not mechanically or structurally meet the standards of tested old-growth lumber.
- No structural compensation has been made for the new-growth strength deficit.
- Current structural panels in their existing 1-1/8" form do not meet the long-term design requirements associated with original ISO structural standards.
- Visible and physical signs of ply panel failure appear prior to undercarriage failure, backed by decades of long-term in-service results.
- There is zero failed structural tolerance allowance for a container floor panel.
- Ply panel failure directly compromises the composite undercarriage structure.
- Composite structure failure can only progress once panel failure begins; it is not self-healing.
- A compromised composite structure utilized to its rated design potential—or simply kept in service over time—creates the exact conditions for catastrophic failure.
- All observed undercarriage failures are accompanied by active floor failure or panel replacements from prior floor failure.

Lessors have chosen to overlook the fact that the most vulnerable component of a container—the floor, which is currently inherently structurally inadequate—is subject to normal and age-related wear and deterioration, and that its compromised condition directly leads to progressive undercarriage failure and eventual catastrophic failure.
By relying on a face-value diagnosis, lessors have formulated an uncontested hypothesis that blames every failure on lessee "overload." Further, they impose the notion that a recognized structural failure (rolling shear) will progress no further, treating a container—regardless of age—as if it operates within a vacuum where the laws of physics and materials science do not apply.

Closing Recommendation

I trust these field findings will reach the appropriate technical decision-makers within the IICL who can conduct an objective, engineering-based review. Updating repair criteria to recognize new-growth substrate failure will mitigate undercarriage safety risks and ensure fair financial liability between lessors and lessees.

If there are any questions I could resolve regarding this matter, please do not hesitate to ask.

Pictures representing floor failures are attached.

Regards,
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