Lightweight Composite Rail Driver’s Cab.

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De-Light Project

- EU FP6 funded project
- Spacium Train: Bombardier.
- Suburban networks.
- Materials:
  - Steel substructure
  - Composite shell
- Designed to meet crashworthiness requirements of:
  - Bombardier.
  - EN 15227 “Railway Applications – Crashworthiness Requirements for Railway Vehicle Bodies”.
Current design philosophy

- Main cab structure:
  - Steel box construction.
  - Welded plates.

ISSUES

- Weight.
- Complex to assemble.
- Cost.
Current design philosophy

- Cab shell
  - Thin composite sheet.
  - Attached to steel sub-frame.

ISSUES

- Poor energy absorption.
- Substantial sub-structure adds weight.
- Ineffective use of space.
Standard Crashworthiness design

- Two sets of energy absorbers:
  - Lower at buffer level
  - Upper to react LDO crash scenario

- Loads reacted by substantial steel pillars.
Cab Design Zones

- **Reaction Zone**
  - Non deformable structure
  - Load paths

- **Secondary Crush Zone**

- **Primary Crush Zone**

Diagram showing:
- Rear Bulkhead
- Support Pillar
- Upper Energy Absorber
- Anti-Climber Energy Absorber
Cab Design Zones

- **Reaction Zone**
- **Secondary Crush Zone**
  - Houses the main energy absorbers
  - React majority of energy
- **Primary Crush Zone**
Cab Design Zones

- **Reaction Zone**
- **Secondary Crush Zone**
- **Primary Crush Zone**
  - Reacts small impacts
  - Reduces size of main energy absorbers
  - Aligned with secondary crush zone
Primary Crush Zone

- Detachable nosecone
  - Located in primary crush zone.
  - React energies \( \leq 0.2 \text{MJ} \).
  - Replaceable, interchangeable.
  - Composite sandwich structure.
  - Lightweight.
Secondary Crush Zone

- Main energy absorption module:
  - Upper absorber for Large Deformable Obstacle crash.
  - Lower absorbers for buffer-level impacts.
Upper Absorber Concept

- Aluminium honeycomb beam
- Fit within existing design.
- Designed to absorb LDO crash energies
Dynamic Modelling of Upper Absorber

Total energy absorbed: 801 kJ
(Target = 700 kJ)
Lower Absorber Concept

- Large aluminium tube
- Blocks of aluminium honeycomb of varying density
  - Begin crushing at rear of absorber rather than the front
  - Honeycomb will self align when fully crushed.
Lower Absorber Concept

Lower Density  Higher Density  Higher Density  Lower Density
Reaction Zone

- React the energies from impact:
  - Provide support to absorbers.
  - Distribute load rearward.
  - Non-deformable.

- Blended composite pillars into structural cab shell.
Reaction Zone:

- **Composite Pillars:**
  - React loads from upper absorbers.

- **Composite reactors:**
  - Withstand loads from lower absorbers.
  - Integrated with pillars
Reaction Zone Testing

- Test specimens manufactured.
- Each specimen consists of 4 tubes and designed to withstand 200 kN.
- Tested under compression at Newcastle University.
- Loading rate of 1000 kN/min
- Average failure load = 542 kN
Complete Design

- Full scale prototype:
  - Showcased at INNOTRANS, Berlin.
  - Mass saving: 60%
  - Part-count saving: 40%
  - Cost saving: 50%
Thank You!

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