Structural winterization upgrade for snow loads

Mobile Modular 120m² Unit (MMU120)

Roel Gijsbers Phd Msc
1. Development progress
2. System specifications
3. Stuctural safety
4. Winterization: Snow load
Mobile Modular 120m² Unit

MMU120 = Mobile Modular 120m² Unit

From Warehouse to Shelter structure for multifunctional and extended use

MMU120 is setting a new standard for structural safety in humanitarian sheltering
Cooperation with WRG relief goods
- Based on existing 6m span structure as used by MSF
- System adaptations, focusing on structural performance and assembly method

Setting a new structural safety standard
- Event tents: EN 13782 3 months
- MMU120: EN 1990/1991 3 – 10 years!!!
  Increase in lifespan and load conditions will lead to more safety and less risk

Exploration of manual assembly method without climbing

Kit approach
- BASIC KIT 3 year lifespan, low wind, no snow
- PLUS KITS Structural upgrades for 10 year lifespan, extra wind & snow loads
- ADD-ON KITS for extended functionality and connectivity (T1, T2, T3, container)
Mobile Modular 120m² Unit (MMU120)

Final steps:

- Technical fine-tuning of prototype
- Improvement of manual based on findings during assembly and disassembly
- Integrate manual in the packaging solution
- Demonstration sept 2015 (Chad – Red Cross)
- Market implementation strategy
Mobile Modular 120m² Unit

System specs

- **Size**
  - 8x 15 x 2.8m side wall height
  - 120m² – 8 m span - filling a current gap in needs

- **Benefits**
  - Safe, durable and reliable solution.
  - Modular lay-out, quick assembly and multiple configurations possible, competitive pricing

- **Lifespan**
  - 3 years / 10 years

- **Safety**
  - 2 Wind classes: W1 - 20 m/s; W2 - 31 m/s;
    (= basic wind speed, 10m h, 10 min av., 50y, EN 1991-1-4)
  - 2 Snow classes: S1 – 50 kg/m²; S2 – 100 kg/m²;
    (= snow load on ground, EN 1991-1-3)

- **Acceptation**
  - Positive –> Upgrade and modification of a proven system
  - (MSF used WRG system in Sudan & in Ebola campaign)
Kit approach: Versatility

- ADD-ON KITS extended functionality and connectivity

Extension:
- a) Extension per module length: 8x3m
- b) MMU120 side wall connection

Acclimatization:
- a) Shade net
- b) Awning
- c) Covered corridor / protected waiting space
- d) Multi-layered roof / Insulation liner
- e) Box in box insulation (lower heated volume)
- f) Roof zone ventilation

Functionality:
- a) Inner partition/ room divider
- b) Side wall tables
- c) Racks
- d) Flooring
- e) PV panels
- f) Hard shell side wall panels
- g) Intrusion and impact proofness (side walls) / locks
Warehouse 68 Euro pallets

Warehouse 60 Euro pallets

Warehouse 28 shelves (0.6x3x2.4m)
Ward: 20 beds, 2 consult. rooms

Mess 144 places

School 80 students (3 classes)
Connectivity

- **Outside storage**
  - Connection with Clever roof for outside dry storage of low value goods (e.g., wood) or hazardous substances (chlorine, fuel)

- **Container connection**

- **System extension**
Showcase Versatility in Prototype
Structural Safety

- Standards comparison
  - EN 13783 Temporary tent structures
  - EN 1990 Actions on buildings

- Structural Upgrade kits

- Snow load

- Snow kit solution
# Structural Safety

## Structural standards comparison

<table>
<thead>
<tr>
<th></th>
<th>Temporary tent structures</th>
<th>(semi) permanent structures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>Not specified</td>
<td>(not) specified</td>
</tr>
<tr>
<td><strong>Lifespan</strong></td>
<td>&lt; 3 months</td>
<td>Dependent on function</td>
</tr>
<tr>
<td><strong>Basic wind speed</strong></td>
<td>&lt;28 m/s, if &gt;28 m/s, special calculation needed</td>
<td>Location dependent</td>
</tr>
<tr>
<td><strong>Wind load</strong></td>
<td>0,3 kN/m² (&lt;10m span; &lt;5m high)</td>
<td>Location dependent (building height, terrain, lifespan)</td>
</tr>
<tr>
<td><strong>Aerodynamic factors</strong></td>
<td>Simplistic, roof factors underestimated, sidewalls overestimated</td>
<td>Full (pressure+suction on roof, 4 combinations, internal over- and underpressure)</td>
</tr>
<tr>
<td><strong>Snow</strong></td>
<td>EN 1991-1-3</td>
<td>EN 1991-1-3</td>
</tr>
<tr>
<td><strong>other</strong></td>
<td>Special section on stability: overturning, sliding and lifting</td>
<td></td>
</tr>
</tbody>
</table>

Also used in case of extended lifespans!!

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R. Gijsbers – IFRC-SRU Conference 2015
Mobile Modular 120m² Unit

20 | 05 | 2015
Kit approach: system upgrades
Criteria: cost effectiveness & simplicity

- BASIC KIT currently used profile too weak
- PLUS KITS structural addition to BASIC KIT
Kit approach

- BASIC KIT  3 year lifespan, low wind, no snow
- PLUS KITS
  a) 10 y lifespan
  b) Heavy wind kit  (3y & 10y)
  c) Medium snow kit  (3y & 10y)
  d) Heavy snow kit  (3y & 10y)
Snow loading zones

- Not a hazardous load, but a largely predictable and static load
- Influences: Wind / roof form & material / internal heating / surrounding buildings & vegetation

Based on values in Eurocodes & international standards
Applicable up to 1500m above sea level

Example: The Netherlands: 70 kg/m² = S2

<table>
<thead>
<tr>
<th>Snow zone</th>
<th>Snow load (kN/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0</td>
<td>0</td>
</tr>
<tr>
<td>S1</td>
<td>0 - 0.5</td>
</tr>
<tr>
<td>S2</td>
<td>0.5 - 1.0</td>
</tr>
<tr>
<td>S3</td>
<td>1.0 - 1.5</td>
</tr>
</tbody>
</table>
Snow loads

- Resulting in large horizontal forces in structure
- Vertical downwards forces (pressure) on foundation
Snow loads
Snow load

Heavy wind KIT

- Tensioning cable
- Force in cable:
  - S1 (50kg/m²): 19 kN
  - S2 (100kg/m²): 33 kN
- >50% reduction of bending moment!
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