

Addressing Ladder Safety and Supporting Injury Prevention

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Ladder Falls – Prevalence



- 66 Emergency Room Visits/ 100,000 Workers
- Leading Cause of Fatal Falls
- $63\% \rightarrow$ fracture, sprain or fatality

Groff and Farmer, 2009 BLS, 2017 Partridge et al., 1998



Construction Industry

- > 300 Lost-time Injuries
- Critical Injury or Fatalities
- Largest Occurrence



Ladder Falls – Prevalence in Construction

Year	Critical injuries		Fatalities		
	Ladders	All Hazards	Ladders	All Hazards	
2011	22	181	1	22	
2012	23	187	0	13	
2013	26	197	0	21	
2014	27	191	1	22	
2015	21	151	3	18	
2016	18	159	0	14	
2017 (May 1)	13 (May 1)	92 (May 1)	0 (May 1)	7 (May 1)	
Total Incidents	150	1,158	5	117	
Percent of Total Incidents	13%		4%		



LADDER USE IN CONSTRUCTION GUIDELINE Revised 10/30/2018 PROVINCIAL LABOUR-MANAGEMENT HEALTH & SAFETY COMMITTEE

Ladders – Fall Prevention System

1 m

4x

1x

Ladder-Structure Tie-Off

 \circ $\,$ Rails secured to a structure $\,$



Fall-Arrest System

- Many different types
- Depend on use and ladder type used
- MUST be anchored to a structure not the ladder itself



Establish safety criteria to determine failure tolerance of a ladder with a falling 113kg (250 lbs) tethered operator



Identify parameters that lead to **ladder failure** through tipping, deformation or destruction that could **cause an operator to contact the ground** despite fall arrest system use.

Test Parameters



Test Parameters:

- Ladder Material (2)
- Operator Tether Method (2)
- Leaning Surface (1)
- Ground Surface (3)
- Force Direction (7)



Would a worker avoid impact with the ground?

Methods – Ladder Setup



Methods – Ladder Types Tested



Aluminum

- 24 ft. (7.3 m)
- Type I / Grade 1
- 250 lb. (113.4 kg) capacity

Load Capacity	Description	CSA Code	ANSI Code
200 lbs/91 kg	Household – Light Duty	Grade 3	Type III
225 lbs/102 kg	Tradesman and Farm – Medium Duty	Grade 2	Type II
250 lbs/113 kg	Construction & Industrial – Heavy Duty	Grade 1	Туре І
300 lbs/136 kg	Construction & Industrial – Heavy Duty	Grade 1A	Type IA
375 lbs/170 kg	Construction & Industrial – Heavy Duty	Grade 1AA	Type IAA

Methods – Tether Method



Methods – Tether Method



Tether Used:

- 6ft Adjustable
 Lanyard Adjusted
 to 4 ft slack length
- Non-shock absorbing
- Polyester Webbing

RAIL - Wrapped around the outside of both vertical siderails and over the adjacent rung



RUNG - Wrapped twice around a single rung



Methods – Leaning Surface



1 Leaning Surface – to replicate a building surface

- Aluminum Siding/Metal Eavestrough
 - \circ Chosen as a worst-case scenario
 - Lower Friction:
 - o Brick
 - \circ Wood
 - Vinyl Siding

Anchor Point – Attached to the leaning surface.



Methods – Ground to Ladder Condition



Wood (Decking)



Loose Earth





Methods – Force Direction



Methods – Load Drop System



Methods – Load Drop System



Methods – Load Drop System



Methods – Drop Testing



Upper Portion of Ladder

• Wear, uniformity, or damage?

Pass/Fail "a worker could theoretically safely descend from the ladder and the ladder remained structurally intact"

Lower Portion of Ladder
 Adequate base of support?



Methods – Drop Testing (0-0 Condition)





Methods – Total Conditions



Test Parameters:

- Ladder Material (2)
- Operator Tether Method (2)
- Leaning Surface (1)
- Ground Surface (3)
- Force Direction (7)



84 Total Conditions

Would a worker avoid impact with the ground?

Methods – Total Conditions



84 Total Conditions (42 – Fiberglass; 42 Aluminum)

If condition failed \rightarrow Re-test (with new ladder)

Cumulative Failure (testing of multiple conditions) OR Acute Failure (specific test condition)

Results – Fiberglass

Force Direction	Wood		Cement		Dirt	
Horizontal- Vertical	RUNG	RAIL	RUNG	RAIL	RUNG	RAIL
0-45	Pass	Pass	Pass	Pass	Pass	Pass
0-90	Pass	Pass	Pass	Pass	Pass	Pass
90-0	Pass	Pass	Pass	Pass	Pass	Pass
90-45	Pass	Pass	Pass	Pass	Pass	Pass
45-90	Pass	Pass	Pass	Pass	Pass	Pass
45-45	Pass	Pass	Pass	Pass	Pass	Pass
0-0	Pass	Pass	Fail/Pass	Pass	Pass	Pass







Force Direction	Wood		Cement		Dirt	
Horizontal- Vertical	RUNG	RAIL	RUNG	RAIL	RUNG	RAIL
0-45	Pass	Pass	Pass	Pass	Pass	Pass
0-90	Pass	Pass	Pass	Pass	Pass	Pass
90-0	Pass	Pass	Pass	Pass	Pass	Pass
90-45	Pass	Pass	Pass	Pass	Pass	Fail/Pass
45-90	Pass	Pass	Fail/Pass	Pass	Pass	Pass
45-45	Pass	Pass	Pass	Pass	Pass	Pass
0-0	Pass	Pass	Pass	Pass	Pass	Pass



Discussion



Type I / Grade 1 would sustain onetime fall

Inclusive to tested conditions

Structural tie-off and proper footing

Ladder Integrity \rightarrow Important!

Ladder destruction and deformation

• Ladder material matters (fibreglass vs. aluminum)

Discussion



Following health and safety best practices from the MLTSD under the Occupational Health and Safety Act (OHSA)

→ Defective ladders should be taken out of service and discarded.

The lowest number of drop tests prior to a failure was 7

→ Critical Importance – Ladder has not been exposed to high loading previously

Discussion: Ladder Material



- Fibreglass → Minimal Wear/Deformation
- Aluminum → Significant Wear, Uniformity Change/Deformation and Damage
 - \circ Permanent Deformation
 - Stress Hardening?

Discussion – Representation of Real World?



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Ministry of Labour, Training and Skills Development



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