Queensland University of Technology

Assessment of Grip Performance of Klein Handrail Sample

Client:

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Abstract

The Client (Klein Architectural Pty Ltd) manufactures handrail, formed from stainless tubing, designed to provide increased levels of grip to the user relative to plain tube handrails. This improvement would benefit users of the handrail by assisting safe passage in slippery environments, such as stairways, ramps and bathrooms.

The Client wishes to quantify the level of improvement offered by the formed design over plain tube handrails. The Consultant (Dennis De Pellegrin, Queensland University of Technology) has conducted a theoretical study to estimate this improvement, based on the geometry and surface roughness of the handrail sample provided, and published friction coefficients between skin and metal surfaces under various contamination conditions. This report includes the theory used and corresponding results and conclusions, and represents the deliverable for the consultancy project as per the Service Agreement between the Consultant and Client.

In summary, based on coefficients of friction ranging between 0.1 for oil-contaminated skin, 0.25 for dry skin and 0.5 for wet skin, and an average contact slope of 8°, it has been shown that the grip in the axial direction improves by between 1.8 and 4 times. Greatest improvement occurs when the handrail is contaminated with oil, however, it must be remembered that the absolute grip for this case is still lower than in both dry and wet conditions.

3. Results

From the theoretical analysis, the grip improvement factor, β, can now be calculated using Equation (2). The values of β for various angles and coefficients of friction are also shown for comparison in Table 2. It can be seen that the improvement in grip varies from 1.8 to 4 times at 8° angle. Greatest improvement occurs when the handrail is contaminated with oil, however, it must be remembered that the absolute grip force for this case is still lower than in both dry and wet conditions.

Table 2: Estimated grip improvement factors (β) for contact between human skin and various metals and plastics

		Friction coefficient μ					
		0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
Angle α [degrees]	**2**	1.7	1.4	1.3	1.2	1.2	1.2
	4	2.4	1.8	1.5	1.4	1.4	1.3
	8	4.0	2.6	2.1	1.9	1.8	1.8
	16	7.7	4.7	3.8	3.4	3.3	3.3
		Oily		**Dry**		**Wet**	

4. Conclusion

A theoretical analysis has been conducted to estimate the enhancement of grip offered by the Klein Architectural handrail sample relative to comparable plain stainless-steel tube. In conclusion:

- The analysis reveals that at least 1.8 times improvement in grip capability is obtained for the same gripping force
- This improvement is attributed to the slope of the surface which contributes to the mechanical interlocking between the rail and the hand
- This study is limited to the effect of sliding along the length (axial direction) of the rail, where improvement offers the greatest utility to users
- Some improvement in grip is also anticipated for pulling in the radial direction; however this was not quantified in the present investigation

References

[1] SE Tomlinson, R. Lewis, MJ Carre, The effect of normal force and roughness on friction in human finger contact, Wear 267 (2009) 1311-1318

[2] R Lewis, C Menardi, A Yoxall, J Langley, finger friction: Grip and opening packaging, Wear 263 (2007) 1124-1132