Engineering Guidance Note 1

Tracked Plant On Slopes

Summary

We sometimes operate tracked plant on slopes without a full understanding of the risks and factors of safety involved. As a result, a number of incidents have occurred on JNB sites involving tracked plant operating on slopes. These incidents were caused by failure due to sliding, overturning or inadequate ground bearing capacity.

Wherever possible, we should avoid operating plant on slopes. However the nature of the sites we work on means this is often unavoidable. This guidance has been compiled to aid the understanding of these risks and to help conscious decision making.

Operating safely on different slope gradients

Design

(S) Slope Gradient

S > 1:3	*1:3 > S > 1:6*	*1:6 > S*
AVOID!	**CONSIDER**	**OVERTURNING AND SLIDING GENERALLY OK**
Design out the need to put tracked plant on the slope ↓ If can't avoid putting tracked plant on the slope, carry out calculations to consider bearing*, overturning^ and sliding ↓ If bearing, overturning or sliding are not satisfactory, then develop TW solutions to allow safe working on the slope		Carry out calculations to consider bearing* ↓ If bearing not satisfactory, develop TW solution to allow safe working

*Actual bearing pressures are greater on slopes than on the flat, for example a slope of 1:7 can increase bearing pressures by 5 times - it is easy to underestimate the increase in bearing pressure from moderate slopes.

^ Overturning calculation for tracked excavators may need to consider different boom positions and loads to account for different activities (e.g. digging, tracking with load, lifting) being carried out on the slope

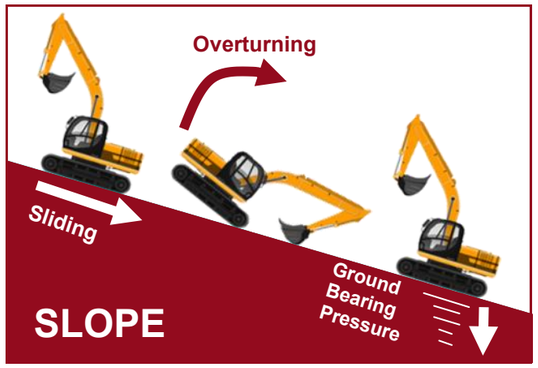
Construction

- In order to get sliding, overturning and bearing checks carried out, list "plant on slope stability checks" on the TW schedule and write a design brief for the specific machine/load/slope being considered.
- Ensure RAMS reflect actual conditions and temporary works requirements
- Ensure instruments in machine cab are working correctly
- Ensure the plant will actually operate (e.g hydraulically) on the slope (generally ok up to 1:3) - speak to the supplier or JNB Plant. Guidance on slopes in manufacturers' literature only usually refers to whether the plant will operate on the slope, and will not consider whether the plant is stable in terms of sliding, overturning and bearing.
- Avoid slippery, wet, muddy and icy slopes (unless these have been specifically designed for)
- If site conditions change (e.g. weather, debris, spillage), STOP work and re-assess.
- Ensure the slope and temporary works are inspected regularly
- Always face the machine up or down the slope, never work side to side along the slope and never work diagonally to the slope
- Working and tracking on slopes should only be undertaken by experienced and competent operators (see Tool Box Talk 58 for how to assess competence).
- When tracking with a load, always keep the load as low as possible and close to the machine
- Use the machine blade (if present) as a "second brake"

Operations this guidance note applies to...

Tracked Excavators	
✓	Excavating
✓	Lifting
✓	Tracking with load (pick, carry and drop)
✓	Tracking without a load (i.e. travelling to/from work area)
Tracked Dumpers	
✓	Tracking with payload
✓	Tracking without payload

Failure Modes



Information for sliding calculations...

Coefficient of Friction on a slope	
0.6	Representative of 'good' conditions
0.4	Representative of wet/polished conditions. Should generally be used in sliding calculations
0.2	Very conservative for exceptionally poor
Suggested Factors of Safety Against Sliding	
1.2	Factor of safety against sliding for plant with
1.5	Factor of safety against sliding for plant without blade

Excavator Variants

Tracks	**Rubber Tracks**	Use on hard ground, concrete and tarmac surfaces.	Tail Swing	**Conventional Tail Swing**	The rear counterweight extends beyond the tracks
	Metal Tracks	Use on softer ground, muddy or rocky terrain		**Zero Tail Swing**	More compact and better where space is restricted. However the counterweight has to be heavier to compensate for the compact nature of the machine body, so the machine is heavier. Zero tail swing machines generally will lift less than a conventional machine of the same weight at the same radius.
	Rubber vs. Metal Tracks	For design purposes, using rubber tracks versus metal tracks WILL make a difference to the coefficient of friction. BUT the difference is small and difficult to quantify, so for simplicity we can ignore the difference.		**Conventional vs Zero Tail Swing**	This means that, on the flat, zero tail swing machines generally exert a higher bearing pressure under the tracks. However, on slopes conventional machines generally exert a higher bearing pressure due to the more eccentric counterweight.

"If I cannot do it safely, I will not do it."

Please ensure your teams are briefed on the above information.

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Published By:	JNB Communications	Title:	n/a	Date:	August 16