



Transition Zone Awareness

To address road construction transition zone-related incidents on the Coast over several years, with some resulting in injury or near fatalities it is time for a refresher in road construction To-Do's and Not-to-Do's and just being AWARE of potential hazards and consequences of those hazards.

What is a Transition Zone? A transition zone is where a road heading breaks out of one main construction category into another. Where we commonly see problems is where the terrain is grading from steep, bedrock-controlled onto gentle or moderate benched slopes with thicker sediments. (Road Preworks Map – SLIDE 3)

In wet coastal regions, we have that potentially hazardous combination of lots of water (SLIDE 5), organic soils (SLIDE 6) and smooth (glacially-polished) bedrock surfaces (SLIDE 7).

Many of the slides have been in areas, where the road stripping and subgrade construction is coming out of a full bench and end haul section with lots of rock...

SLIDE 9: heavy rock end haul section

SLIDE 10: ...and the terrain begins to flatten out to what may look like "easy going".

Well, it just so happens that the danger increases in these locations for several reasons:

SLIDE 11: *excavator mishap off transition zone bench*

1. **The operator becomes more relaxed and sees that he can likely make some better time through this stretch of "easy-going".** ALWAYS BE AWARE OF SURROUNDINGS; SLIDE 13: transition zone slide; SLIDE 14: toe of transition zone slide; MAKE SURE MACHINE IS ON STABLE FOOTING; SLIDES 15; KNOW THE SURROUNDING TOPOGRAPHY; SLIDE 17: what are you sitting on?; SLIDE 18: are there steep slopes below?; SLIDE 19: is there loose rock above?
2. **Water tends to concentrate in draw features between steeper bedrock sections (Transition Zones).** Ensure that *drainage works* (ditches, culverts, cross-ditches and waterbars) are *fully functional* at all times during subgrade construction. This prevents ponding of water (SLIDE 22), redirection of water courses (SLIDE 23) and creation of muddy slurries (SLIDE 24).
3. **Sediment layers and organic accumulations are commonly greater in draw features and may store significant amounts of water.** Once the roadway prism has been cleared of stumps and debris it must be stripped of material that is unsuitable for use in subgrade. These materials include organic silts, soft clays and peats. When they are exposed to moisture and physical disturbance, they tend to liquefy and act as lubricants in any granular (sand, gravel) material

they are mixed with. If they are not kept separate from subgrade material, the roadbed may never stabilize even after heavy application of layers of ballast.

SLIDE 28: *transition zone materials exposed to moisture and physical disturbance resulting in slide?* Remember:

1 bucket of mud mixed with 5 buckets of gravel or sand = 6 buckets of mud

4. **The operator may run into unforeseen ground conditions.** Make conservative adjustments or adaptations and if need be consult with the supervisor or other road crew. SLIDE 31: *In this case the operator had moved approx 10m in from the centreline as ground was wet and soupy.* SLIDE 32: *Remove overhanging stumps, boulders, loose or overhanging rock on top or in cut slopes.* SLIDE 33: *Do not overload fill slopes with sidecast material.* SLIDES 34 & 35: *Place riprap (blocky material) at the base of cut slopes to stabilize and for drainage (French drain).* SLIDE 36: *Key in rock on fill slopes to stabilize.*
5. **If you sense a potential DANGER or HAZARD or are unsure about any situation: move to a safe area, stop work and consult a supervisor.** SLIDE 38: *especially during rainfall periods when subgrade soils are saturated*
6. **Always be AWARE of the rainfall situation.** SLIDE 40: *Rainfall shutdown guidelines must be followed.* SLIDE 41: *There may be reason to shutdown operations prior to reaching rainfall criteria. Is water moving sediments?*

Other Factors to be Aware of: SLIDE 42: Wet site indicators, such as swept or pistol-butted trees, salmonberry, skunk cabbage etc.; Piping of water from road cutbanks; Decking of Right-of-Way Logs; Working at Night – Decreased visuals; Adverse end haul grades

SLIDE 43: Let's avoid situations ...SLIDE 44: which none of us want to witness.

All these factors can lead to road prism failure, if construction is carried out in a "Let's Giver" fashion. So a review on road construction awareness safety is never a waste of time.

Subgrade Construction

Subgrade construction sets the pattern on the ground that all subsequent stages must follow and it is the stage that carries the greatest exposure to environmental damage (i.e. landslides, mud into streams, flyrock etc.)

A decent reference for subgrade construction, which all road crew should have access to is (This handbook can be purchased for a small fee from the BCIT Bookstore):

Forest Road Construction, Handbook 1, Forest Engineering Technology, BCIT, Nov2001

Here are some good excerpts right out of the book:

- ⇒ During subgrade construction the excavator operator digs out the exposed mineral material and spreads it out where it will do the most good. At the same time he should have the centreline where it belongs to achieve horizontal alignment of the road, while taking safe advantage of the topography (i.e. keeping the road near the slope contour).
- ⇒ Slope and ditch at the same time, placing coarser material on the outside edge; finer material on the inside. This keeps the grader operator happy and most importantly, stabilizes the running surface. Compact the outer edge with the bucket and tracks. Walk materials in to firm up the surface.
- ⇒ Plan the workload to minimize moves. Make every move short from start to finish and plan where to put materials so they won't have to be moved twice.
- ⇒ The working area should be kept level to keep both machine and operator running smoothly. If the operator is bouncing around in the cab, unplanned motion and fatigue could result in mistakes. The best breakout force on any hydraulic excavator is realized from $\frac{3}{4}$ of its maximum reach, to a vertical stick position. This is the range of maximum advantage of the machine's hydraulic power, combined with its geometry. The result is maximum stick and bucket breakout.
- ⇒ Combined with the $\frac{3}{4}$ factor, the bucket face and stick should always be in line. This way, no matter where the bucket is placed, the teeth are always at the right angle for action. This gives you the best angle on your bucket linkage to get proper breakout from your bucket cylinder. An inexperienced or poor operator will constantly correct his bucket after it is in the ground, resulting in longer breakout times. Instead, when he dumps his bucket, he should combine bucket and stick functions so when the material clears, his bucket face and stick are in line at $\frac{3}{4}$ reach. When he swings back, no additional motions are required.
- ⇒ Lifting the bucket wastes time and is less safe. Keep the bucket low to the ground and follow the profile as you swing (also the safe mode). The excavation bucket is the tool of choice for pioneering. The cleanup bucket is best suited to sloping, ditching and whenever large volumes of material must be moved forward or backward on grade.
- ⇒ A great deal of time can be needlessly wasted when an operator is just plain bailing and digging. He should know where his next bucketful is coming from and if he plans ahead, his productivity and safety improves. Proper planning eliminates the possibility of covering the same area twice and enhances operator awareness and safety.

3-Pass Technique (see diagrams)

All standard road construction should involve a 3-pass technique. The concept is to minimize the amount of excavation and disturbance thereby reducing overall effects on stability and increasing safety.

1. In the first pass, the logs and stumps are removed over a pioneered track. Logs can either be hauled away or stacked crosswise behind the hoe.
2. The second pass involves the stripping of the topsoil from above and below the pioneer track and placing it downslope of the road prism. The waste logs are then picked up and placed on top of and below the wasted topsoil so as to not be buried in fill.
3. The third pass consists of using the uncovered mineral soil to construct the bearing surface of the road with the toe of the fill keyed into the hill on the pioneer track. In all cases, sidecast sliver fills should be avoided.

Wet Soil Conditions

If excessively wet mineral soil is encountered during the third pass, two construction techniques can be used depending on how quickly the subgrade might drain.

1. In areas where soils are particularly silty and drain slowly, end-hauling of excavated material will be required followed by the import of coarse ballast subgrade and granular surfacing.
2. If soils are medium to coarse grained and will drain over a period of a few days, a back-casting technique can be used. This method minimizes the amount of sidecasting and eliminates the need for end hauling. It involves cutting a bench approximately 1m below the finished grade at centreline and piling the material on the subgrade behind the hoe. Water is then allowed to drain from the pile over several hours or days until the soil is near the optimum moisture content for compaction. Finally the material is spread and compacted in lifts of less than 0.6m thickness until final grade is achieved.

Review of Road Construction Prescriptions

Key in Rock Construction: This method utilizes shot rock, angular boulders or rubble that is placed together to construct an interlocking matrix. The toe of the fill is to be 'keyed in' to the existing bank, providing a stable subgrade with over steepened slopes. Fine soil material and organics are not to be incorporated with the rock material during construction, though a sliver fill of fines over the completed fill is acceptable. Excess spoil is to be endhauled to designated spoil areas.

$\frac{3}{4}$ Bench Constructed Fill Construction: This method utilizes shot rock, angular boulders or rubble to construct an interlocking matrix, with the toe of the fill 'keyed in' to the existing bank, providing a stable subgrade with oversteepened slopes. Sidecasting of fine soil material and organics or use of puncheon in subgrade construction is **not** permitted (remnants are acceptable). This material should be endhauled to designated spoil areas.

Full Bench Construction: This method of **approximate** full bench cut requires no side casting of cut material. Any material used for subgrade construction should be keyed into the slope, and be supported by benches within the road prism. Appropriate material such as gravel and rubble size shot rock should be used for subgrade construction, or backcasted for use elsewhere. Use of fine textured, silty soil material or use of puncheon in subgrade construction is **not** permitted (remnants are acceptable). This material should be endhauled to designated spoil areas.

Spoil Sites for end hauled material should be established on wider benches, away from stream drainages and areas of imperfect drainage.

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