BC hydro ENGINEERING

Civil Technical Tips
Distribution Engineering

By: Tonia Jurbin Loc: EDMB03 Pillar E14 Tel: (604) 528-2045 E-mail: tonia.jurbin@bchydro.com

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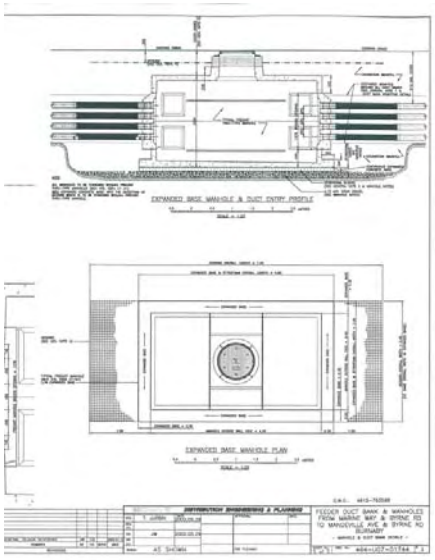
TOPIC: Stuff We Have Done in Funky Soils

Introduction Edward invited me to guest write your monthly newsletter and because I liked the assignment title I agreed. Building on his ideas from the November Newsletter 'unknown soil conditions' I'll offer practical tips on how to recognize and manage soft soils installations. I'm also going to discuss the many distribution requests I've had in the past to review development encroachment on the BCH R/W in soft soils. I'm working on the assumption that the designer knows that the existing or proposed circuit alignment is at least in part in soft, weak soils.

New Plant The biggest concern about building new plant in an area of known soft soils is differential settlement. That could be different settlement between the manhole and the duct, but it can also be the different settlement between one end or corner of the manhole and another. If you start an excavation for a manhole and it looks something like this, you know you might have a problem! Even operating heavy equipment in this environment can cause settlement or damage to existing plant.

Soft Soils Excavation – very easy digging with obvious organic material and lots of groundwater

Peat is very light and compressible when compared to anything that might be put back in the excavation whether it is a concrete manhole, ducts or mineral backfill. Also, even if you are lucky enough to be able to excavate all the peat, it will typically be underlain by soft compressible silts so precautions still need to be taken to limit the long term post construction settlement. The challenge is to limit post construction settlement a manhole by trying to balance the weight of the peat being removed with the weight of the concrete, Styrofoam and water that will eventually fill the manhole, and / or you can wait until the area you need to work in has been preloaded before you build your final installation but you'll have to be patient, typical preload periods start at about 6 months. That's not the end of the challenge because the designer also needs to ensure there is enough weight to restrain the manhole from floating during high water. At the site where the photographs above were taken we over-excavated and tried to remove all the peat (unfortunately it seemed to be bottomless), we built the grade up to the manhole floor elevation with about 4 feet of closed-cell Styrofoam (not the kind your stereo is packed in) and used an extended base (wings) on the manhole and geogrid about a foot from the surface to keep the manhole in the ground during times of high buoyancy.



The details of above drawing are not important for this article, rather it is the placement of the geogrid which had to be larger than the footprint of the manhole to prevent the grid from pulling out of the fill should an upward pressure be applied if the manhole became buoyant that is noteworthy. We know this will help keep the manhole in the ground; the downside is that the pavement excavation had to be large to accommodate this extra measure.

We've also had to be creative in finding ways to keep the connections between the manhole and the ductwork flexible. We used a tough but flexible hose to connect the ducts from the manhole to the main ductwork, we used spacers to keep the ducts where we wanted them and wrapped the whole system with a geosynthetic to give it more stiffness and to keep the fill from migrating away from the ducts.

We were somewhat successful in that the cables did not fail when the differential settlement became excessive due to more preloading after our installation was complete. However, our success was limited because the resulting deformation rendered the ducts unusable and they had to be repaired. It was easy to figure out we had a failure because steeply dipping ducts could be seen from inside the MH. The last photo on the far right shows that the spacers we used didn't work very well but what you can't see is how the ducts had 'ovaled'. We have some

ideas on what we'd like to try using for spacers next time. In this case using the oversized 5" ducts saved us from having to rebuild everything.

1) installing the flex-connectors 2) wrapping the duct bundle geosynthetic – note white spacers in the far right 3) failed ducts – note a piece of failed spacer on the far right

As part of the repairs we had the contractor fabricate telescoping ducts to place along the duct run to give the system a little more flexibility. We have not yet excavated a telescoping duct to see how they are performing. If a telescoping duct is specified make sure the movable part is wrapped in a geosynthetic to keep grit out of the sliding joint.

New Plant Tips

Whenever possible install the manholes several weeks ahead of the duct. The largest proportion of post construction settlement occurs within the first few weeks, so if you are able to fill or partially fill the manhole with water – even better. Hopefully by the time the ducts are installed the bulk of the settlement will be worked out of the system.

Try to install the duct run with an upwards camber in the middle since it is likely going to settle, might as well do whatever you can to see that the final location is close to where you've designed it. Somewhere along these runs is where we believe the telescoping joints might be working well.

Existing plant

Anyone who has ever worked with a transmission geotech knows that we have a strong bias against using concrete encased ducts in soft soils. Simply put, in soft soils concrete will crack along the tension (usually but not always the underside) surface of the duct run. This problem is compounded if the concrete is unreinforced. In distribution ducts the concrete may be

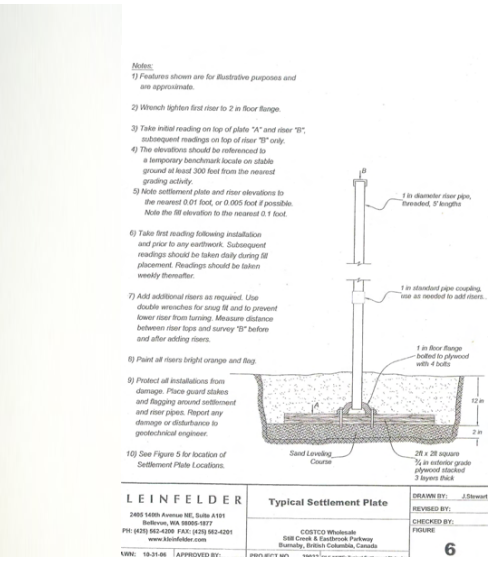
reinforced, however, in transmission cables for electrical reasons that I don't fully understand re-bar is not typically used so transmission cable trenches are often excavated to till or rock.

We get many requests to review placement of preload on or near distribution ducts. Even if the soil looks reasonable during the excavation, if the site requires a preload it is because post construction settlement is expected.

Before approval for placement of any material is given, any empty ducts should be mandrelled and videoed to have a record of what kind of shape they are in. If possible excavate part of the ductbank and inspect the concrete. If there are major cracks, determine if there has been displacement along the cracks. Measure the distance over the crack and use some kind of marking technique (nails, paint with a cross, etc.) to determine at a later date if they change during construction.

Use settlement plates to determine if your plant is moving. Mostly these are meant to measure vertical movement but of course you can also have horizontal movement depending on the preload location. In the photo below taken at YVR in August '06 the soil looks reasonable but they would not be preloading near the ducts it if they didn't expect settlement. Settlement plates and mandrelling before and after construction are the simplest ways of monitoring your plant during someone else's construction.

These quick and easy steps will establish the condition (and location) of your plant prior to construction on or near the BCH R/W. This way if problems do occur at least responsibly for damage can be established.



In Closing

If you are working in an area that has known soils problems you might want to give one of us a call and we can review it with you over the phone, face to face or on site. If you already have experience in areas of borderline soils and there aren't many issues that Edward discussed in Newsletter No. 2 than installing the MH early and putting a camber in the run might be enough. In any case, a quick chat with someone in the geotech group can prevent many surprises, delays and repair costs.