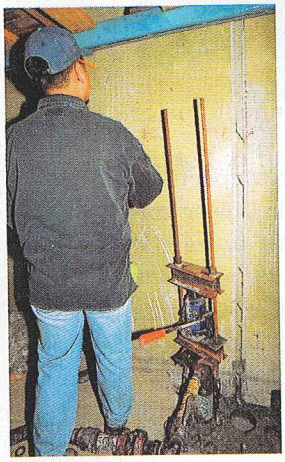
Oh that *Sinking Feeling*

By Correspondent Tonia Jurbin

At first glance it's just another building in a typical industrial setting at the side of the road. There's nothing spectacular about the architecture, it's not adorned with statues or fountains and, in fact, it's a pretty normal-looking building... the kind you'd see almost anywhere across Canada.

Behind this facade of normality, however, is a beehive of activity as contractors, armed with dozens of hydraulic jacks mounted on mini piles, pump grout through a series of pipes going through the building's concrete foundation, to keep the 6300 m^2 building afloat, so to speak.



A crew member prepares the grout mix outside the building while other photos show work inside and jacks on mini-piles at corner of the building.

The soils along parts of the Fraser River in Coquitlam, BC (just east of Vancouver where this building is located) are made of up soft saturated silts with peat and because it has been industrial property for so long, there is also a lot of construction debris.

Excavations and most other subsurface procedures will almost certainly be interrupted at some point because of abandoned wood or methane gas and less often hydrogen sulfide gas. Preloading is the typical soil improvement technique used in this industrial neighbourhood, with post-construction settlement rates being calculated for 25 years.

One company that has become very familiar with the problems of the area is DynaSTAT Systems Incorporated, a firm that has been stabilizing soil masses underneath buildings and re-levelling them for 30 years.

Norm Fowler, president of the company, says they have lifted hundreds of buildings all over North America during those 30 years, including buildings up to 32 storeys. This warehouse levelling job in Coquitlam, worth $600,000, will take about 18 months to complete.

"You can't rush this work. It's similar to the principle of preloading in that you gradually remove the water, but it's done from the subsurface rather than the surface, says Fowler.

"This building, because it is not uniformly loaded, is being lifted through a combination of hydraulic jacks on mini-piles and deep grout injection. More control over the lift-

ing is required around the heavily loaded columns. In some cases, we have a crew bring 'ballast' in to load the floor and create a more uniform loading.

"The goal is to stop the movement, but realistically, you can only eliminate future differential settlement," says Fowler.

The first stage in levelling or raising a building is to install all of the subsurface steel pipes and mini piles. Mini piles are only needed to level buildings that are not uniformly loaded.

A heavily uniformly loaded building, say 450 kg pounds per square foot, actually yields better results without jacks. In this building, however, mini piles were installed at roughly 3 to 4 m intervals around the interior of the building and 6 to 7 m intervals around the exterior walls. They are installed right through the floor slab near the support columns.

A horizontal channel or waler is placed between the top of the pile and the 20,000 ton jack, and another waler is placed on top of the jack. A 5/8" – 35 Kip Dywidag rod fastens the assembly together with a nut anchored under the concrete floor slab and on top of both walers.

As the jack is pumped up, the top channel moves up and takes the concrete floor up with it. This works because the jack is sitting on a mini pile which is founded on the denser material that underlies the soft silts and peat. At least one laser is used to monitor the relative movement between adjacent rooms while pumping.

"We try to limit the lifting to one inch at a time, we know we've got the right combination of pressure and timing when the cracks in the walls start to close," says Fowler.

"These are long term jobs that you can't rush. If you try to do this work too fast you will fracture the soil instead of consolidating it."

Once the steel is installed, the subsurface water gets displaced or squeezed out of the area under the building by replacing the water with grout. The grout, which is a low slump mixture of cement, water, and bentonite, is about 75 pounds per cubic foot, or the weight of conventional concrete.

Not all of the pipes are injected right away. The area directly under the lowest part of the floor is treated first using a very low pressure to inject the grout. Most of the grout is injected through the pipes, but some is also placed through the open-bottomed mini-piles that have two to three feet of perforations along the lower length.

At this stage, the goal is to let the soil suck in as much of the grout as it will accept. The success of this stage of the work is very dependant on operator experience. Once a lift is achieved locally, more aggressive pumping rates will be used through a greater number of injection points.

Pumping the grout into the pipes does about 75% of the lifting, the jacks account for the rest of the work.

To lift this warehouse, 70 – 102 mm piles with "thick walls" were installed hydraulically around the building to depths of 4 to 7 m. Most of these piles are around the exterior, but there are a few interior piles as well.

About 120 grout injection pipes are also installed around the outside of the building that are angled at 45 degrees under the slab. They range in length from 7 m to 9 m, thereby treating the soil down to about 5 m.

About 12 000 m^3 of grout or the equivalent of 120 truckloads of grout will have been injected when the job is done. ◆