Subsidence Surveys

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For the uninitiated, subsidence is the distortion by settling of small areas of the earth's surface due to artificial movement below the surface — a small area being approximately one mile square and artificial movement being primarily mining, although excavations into salt layers for storage are beginning to play a large part in subsidence surveys.

I would say that most subsidence is determined by engineering-oriented personnel or geologists, yet nevertheless the field work is basic field surveying, therefore requiring experienced survey personnel.

The *purpose* of subsidence measurements is to detect the magnitude of height differentiation.

"Ground Control" in most surveying work usually pertains to the type and location of monumentation that is used for horizontal and vertical control for such projects as construction, photogrammetry, etc.

However, "ground control" terminology in subsidence surveys is the amount of subsidence, or settling, allowable at a particular location.

I would insert here for interest only that responsibility for any damage to adjoining properties is obviously up to the person, company, etc., who was responsible for the underground excavation. However, let us suppose that excavation was finished and the excavating company was disbanded many years prior to subsidence occurring on an adjoining property. What then? Well, I am told that the "common law of subjacent support" exists in that the party causing the damage is still held responsible, but obviously it appears that this would be extremely hard to prove.

Now back to the surveying aspect.

The magnitude of settling at the surface is related to the physical properties of the surrounding geological material, that is to say, that clay may settle more than rock.

What is the object of all this?

It should now be clear that the object of "ground control" is to protect adjoining properties, buildings within the property, etc. I would imagine with the environmental controls presently going on, that local governments will be taking a closer look at subsidence.

As I mentioned earlier we are concerned with surface settling but this does not necessarily mean that only elevations are to be obtained.

In outlying lands only elevations are required. However, both elevations and horizontal dimensions are required in instances where buildings are located over, or near, a possible settling area. The horizontal dimensions are used to determine the stress and strain of the edges of settlement to predict building fractures.

The *surface zone* should be that area of land at 45° from the edge and bottom of the subsurface excavation. For example: if the bottom of an excavation is at a depth of 2000′ and is 100′ wide, then the area that should be covered by a subsidence survey would be 4100′ in width on the surface.

In outlying lands vertical control monuments can be spaced 500′ apart with two or more benchmarks outside the surface zone. If there is a suspicion of subsidence in a certain area then infilling of monuments should be spaced between the 500′ monuments at intervals sufficient to determine the limits of subsidence. In the vicinity of buildings or other structures monuments sufficient for subsidence "ground control" are to be established.

From discussions with others it would appear that if a change occurs on the ground surface of either a grade 2″/100′ on the side slopes or at a rate of ¼″/100/year then a danger of subsidence leading to a "sink hole" could occur. A "*sink hole*" is the sudden creation by underground activity of a depression noticeable to the eye, for example, a depression 400′ square with a 4 drop in the centre. Rumor has it that "sink holes" have occurred but were rapidly back-filled with earth material so that the public would not be aware of their occurrence.

Backtracking a bit to the field operation, I would point out that all the control monuments must be used as turning points. No intermediate sights should be used on the monuments. This is to preclude the cropping up of an error on the monument. All elevations from and to benchmarks should be closed within plus or minus 0.017 of the square root of M, with M being the distance in miles between control monuments and the benchmark(s).

Horizontal measurements, if used to determine grade on outlying areas. need only be within ¼′. However, they must be of the first order to determine stress and strain points in the vicinity of structures.

Vertical control monuments need only be surface type, such as concrete monuments 6″ in diameter by 4′ long with the top 1′ above ground level. Bedrock monuments are not usually required since they are expensive, and it is contended, that if they are in fact lying on top of a subsurface boulder or unstable rock, their efficiency cannot be relied upon as the subsurface excavation could disturb them.

From recorded results it appears that one year is required before the monuments can be depended upon to give consistent results. The first readings need only be recorded. Within six months a second set of readings should be obtained which could be out as much as 1¼ inches from the first set. At the end of one year and each six-month period thereafter, readings should be obtained that will give consistent results.

The reason for no reliance being given to the readings for the first year is that experience tells us that the monuments will move due to disturbing the soil to set the monuments, frost upheaval, disturbance by heavy equipment if the soil is a plastic type of soil such as clay, etc. In other words, it takes about one year for the monuments to settle down.

No survey crew should try to interpret the results but should merely give to the client the results in a prescribed form such as a graph, table, etc. Also, the survey crew should not know beforehand the existing elevation data. This is to avoid any psychological errors that could occur.

To reiterate — an ordinary field survey crew can perform all the operations for a subsidence survey in outlying areas, with a more experienced crew and more precise equipment needed for precise elevations at structure areas.