CHAPTER 5

CASE STUDY
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5.1 General
As the experimental work carried out on smaller diameter openings, a case study was taken up to study the stability of opening in the field with limited observation. These field observations were intended to ascertain various failure mechanisms, slides, slope failures, effect variation of water table, and to study the effect of excavation near an existing structure.

5.2 Case Study
The study was carried out for the following cases.

1. Excavating small diameters wells near an existing structure.

2. Observation of settlement cracks in walls where small diameter open wells are existing for a long time (more than 3 years).

3. Observation/study of collapse/slide mechanism in large diameter open wells.

4. Observation/study of settlement cracks in walls where large diameter open wells are existing for a long time (elapsed time more than 3 years)

5. Study of stability of excavation of any shape and size in urban limits in the vicinity of existing structures.

In order to compare the collapse mechanism observed during experimental work and to ascertain its adoptability to field, a
detailed field study was planned. The study location was Bangalore urban limits, Mandya district, in Karnataka and part of Dharmapuri, Krishnagiri districts of Tamilnadu. Many open wells, which were being dug in the areas of BTM layout, Thyagarajanagar, Bangalore, were selected for the study. The wells were dug for domestic drinking water purpose and the depth of well were ranging between 4 m and 6 m. The diameters of openings were ranging between 0.9m and 1.2m. These open wells were dug adjacent to existing residential houses at a distance of less than 2 m from edge of the load bearing walls or column footings. (Table 5.1)

Table 5.1 Details of some open wells selected for study

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Location of the open well (Owner, Location, Purpose)</th>
<th>Diameter</th>
<th>Depth</th>
<th>Date of Completion of excavation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mr. John Chacko No.117,12 Cross, BTM Layout, Bangalore(Domestic)</td>
<td>0.90m</td>
<td>6.8m</td>
<td>June 6,7, 2007</td>
</tr>
<tr>
<td>2</td>
<td>Shri. Krishnaswamy. 2nd Cross, TR Nagar, Bangalore 16(Domestic)</td>
<td>0.9m</td>
<td>5.2m</td>
<td>March 28, 2008</td>
</tr>
<tr>
<td>3</td>
<td>Prof. Deshikachar, 50' Road, Hanumanthanagar Bangalore(Domestic)</td>
<td>1.3m</td>
<td>6.8m</td>
<td>June 6,7, 2002</td>
</tr>
<tr>
<td>4</td>
<td>N S Vishwanatha 1st Cross, CTB Area, BSK II stage, Bangalore (Domestic)</td>
<td>0.9m</td>
<td>6.3m</td>
<td>April 07, 2006</td>
</tr>
<tr>
<td>5</td>
<td>Datta Ashrama Complex, Hoskere halli, Bangalore (Domestic)</td>
<td>9.2m</td>
<td>12.6m</td>
<td>April 23, 1997</td>
</tr>
<tr>
<td>6</td>
<td>Bannur, Mandya District, Karnataka (Agricultural)</td>
<td>5.7m</td>
<td>3.8m</td>
<td>May 21, 2006</td>
</tr>
<tr>
<td>7</td>
<td>Bannur, Mandya District, Karnataka. (Agricultural)</td>
<td>6.2m</td>
<td>4.7m</td>
<td>March 16, 2006</td>
</tr>
</tbody>
</table>
5.3 Effect of Water Table.

During excavation water table was met with at various depths. In a well where the soil is sandy clay, the soil caved in at the interface of the water table and soil. The collapse was progressive and had moved inwards in a conical pattern as found in the experimental work (Plate 5.4). As the water level rises, as observed in experimental work, the wall of soil had collapsed into the opening. At the surface, the shape of the cone gets reversed (plate 5.1, plate 5.6) and the angle of cone with horizontal was observed to be very close to the angle of internal friction (27° to 32°).

In the case study it was observed that the top 1 to 1.5m of soil was hard and required more effort to advance the open well compared to deeper strata. This increases the stability of the well and it was observed that smaller diameter wells are least susceptible for collapse when they were unsupported for long time. The excavation of well was carried out in five days and during this time the well remained unsupported. The wells were supported by concrete rings of smaller diameter compared to the diameter of excavation, subsequently. A gap of 150 mm was left between opening and support and this space was filled loosely using rubble. The wall adjoining the well was observed for any visible settlement cracks for a period of 8 months. No settlement cracks were found on the walls of the building and no local depressions indicating the subsidence, on the ground surface was observed. The water was being drawn for
domestic purpose daily, which was lowering the water table to an extent of 1.6 metre, particularly during summer, for more than three months. No subsidence of soil at surface was observed.

5.4 Stability of Small Diameter Wells.

As observed in the field the vertical circular openings of small diameters were quite stable in general soils under varying moisture contents. Even though the water table was raised to ground level, the vertical sides of the well has not show any sign of collapse. This may be attributed due to the increased shear strength of the soil at the surface compared to the deeper strata. This increase in shear strength is attributed to alternate dying and wetting of top layer of soil over a period of time. This hardened soil holds the weaker sub soil strata, thus preventing collapse of open well. Also the state of stress with in the soil mass is three dimensional in case of smaller diameter wells, which attributes to the stability. This unusual stability was observed even when the ground surface was loaded.

5.5 Large Diameter Wells.

The stability of large diameter wells were investigated in the field at a location called Bannur, Mandya district, Karnataka. The soil was typically sandy, silty clay. Two unsupported vertical wells are excavated in the month of March and May (Table 5.1). The wells were of 5.7m and 6.2m in diameter respectively. Their depths were 3.7 and 4.8 metres. The wells were stable for four months and subsequently part of the wall slid down. The failure was typically a localized slope failure (Plate 5.5 and plate 5.7).
5.6 Stability of Vertical Cuts
Due to stringent time schedule leading to usage of heavy equipments for excavation, the study of stability of vertical cuts has become essential. For large excavations the equipment would be at dredge line and for relatively shallow excavations the excavators and transporting equipments would be at ground line (Plate 5.12). These equipments work at very close limits of vertical cuts. Under dry conditions these excavations are stable but under varied moisture contents stability concerns are essential. For general soil at dry conditions the cut would be stable up 4 metre and this height would reduce substantially with increase in moisture content.

5.7 Conclusion
By conducting limited case study on various types of excavations, which were made for different purposes, it is observed that

1) Small diameter excavations are more stable compared to large diameter vertical openings, for the same soil
2) With in observational limits, it is found the internal subsidence with in soil mass at the interface of water and soil that may not reach the ground surface.
3) Large diameter vertical circular openings behave as trenches when it comes to stability behaviour.
4) In large diameter openings the wall or wedge type of failure is not observed.
5) The stability of vertical circular openings is not the same when it is excavated near a structure and when a structure is built near an existing opening.
Plate 5.1 View of soil collapse with rise in water level

Plate 5.2 Top view of soil collapse with rise in water level
Plate 5.3 View of soil collapse at surface with rise in water level

Plate 5.4 View of soil collapse within soil mass at interface
Plate 5.5 View of soil collapse of large diameter wells

Plate 5.6 View of soil collapse at the interface of ground water and soil
Plate 5.7 View of two dimensional slope failure

Plate 5.8 Structure built neat existing large diameter openings
Plate 5.9 Structure built neat existing large diameter openings

Plate 5.10 Excavation made near to an existing (Two dimensional)
Plate 5.11  Cut made near to an existing structure (Three dimensional)

Plate 5.12  A case of heavy equipment on ground line.