IN THE HIGH COURT OF THE REPUBLIC OF SINGAPORE

[1998] SGHC 197

Suit 288/1996

Between

Loh Siew Keng

… *Plaintiff*

And

Seng Huat Construction Pte Ltd

… *Defendant*

GROUNDS OF DECISION

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Loh Siew Keng v Seng Huat Construction Pte Ltd

[1998] SGHC 197

Suit 288/1996
Chan Seng Onn JC
05 June 1998

Judgment :

GROUNDS OF DECISION

1. The plaintiff is the registered proprietor of the house known as 72 Siang Kuang Avenue Singapore 347983 ('premises' or alternatively 'No 72'). The defendants were the contractors engaged by the Ministry of Environment ('MOE') to carry out certain sewerage works along Siang Kuang Avenue. Those works included the replacement of an underground sewer line adjacent to the premises. The plaintiff brought a claim against the defendants for negligence and nuisance arising from the defendants' excavation of the trench next to the premises. I allowed the plaintiff's claim and granted interlocutory judgment with damages to be assessed. Dissatisfied with my decision, the defendants have appealed. I now give my reasons.

Background

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2. The plaintiff and some of her family members have been staying in the premises for the last 30 years. Apart from some minor cracks, there were no serious cracks in the premises.

3. On 5 January 1996, the defendants commenced excavation of a 2.7 metre deep trench along the pathway between the premises and a neighbouring house No 70 Siang Kuang Avenue ('No 70'). Nine days later on 14 January 1996, serious cracks suddenly appeared in the walls and floors of the premises. No other construction or excavation activity, apart from the defendants', was carried out in the vicinity of the premises at that time.

4. Cracks penetrated the walls on the first and second floors of the premises. The external floor of the premises had a long continuous crack line. Separation gaps between the walls and floors could be seen at certain parts of the premises. There were also cracks in the floor tiles of the interior of the premises.

Particulars in the re-amended statement of claim

5. The plaintiff alleged that the defendants failed to exercise reasonable care in carrying out the sewerage works by --

(a) causing or permitting the foundations of the premises to be disturbed through movement and vibration during the excavation;

(b) causing or permitting the ground adjacent to the premises to settle through the draw down of the water table during excavation;

(c) failing to employ available methods for laying the sewer lines which would minimise the soil disturbance and pumping of the water;

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(d) failing to take adequate precautions to prevent the ground adjacent to the premises from being disturbed and from settling;

(e) failing to carry out adequate shoring work immediately after the excavation to prevent ground movement and settlement.

6. The damage to the premises was alleged to be caused by the defendants' negligent breach of their duty to take reasonable care and the plaintiff had suffered considerable distress, trouble, inconvenience and expense.

7. In the further and better particulars, the plaintiff stated that the locations of subsidence within the premises were located at areas where the cracks had occurred but their precise locations could not be identified. For the particulars under (c), the plaintiff stated that the available methods for pipe laying that would minimise the soil disturbance and pumping of the water were: soil treatment by jet grouting, steel sheet piling and pipe jacking. Under (d), the plaintiff said that the misalignment of the shoring of the excavation works allowed soil to escape through the gaps between the shoring, thereby causing the adjacent ground supporting the premises to subside.

Defence

8. The defence was that due diligence had been exercised and the method of trench construction was in accordance with that of a reasonable contractor.

9. The defendants alleged in their amended defence that the defects, if any, were wholly caused or contributed by the extensive renovations and additions made to the premises by the plaintiff. More particularly, a cantilevered balcony constructed on the second floor was not supported by any beam or column. That

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caused additional stress to the structure of the premises. As the ceramic tiles at the car porch were not laid on adequate foundation, cracks also resulted.

10. To substantiate their defence, they relied on the fact that no cracks surfaced at house No 70 where extensive renovations had not been done.

11. However, the defendants admitted pumping out water from the excavated trench.

Cause of action in negligence

12. To succeed in an action for negligence, the plaintiff has to establish that (1)

the defendants owed her a duty of care; (2) the duty of care was breached; and (3) the breach has caused the plaintiff damage.

13. The Plaintiff's case was simply that the defendants had by their excavation caused the cracks. These cracks resulted from: (1) the disturbance of foundation of the premises by the movement and vibration during the excavation; (2) the settlement of ground due to the draw down of water; and (3) the loss of soil into the trench because of the poor shoring construction.

14. The defendants owed a duty of care to the plaintiff as it was reasonably foreseeable that their failure to take reasonable care in the excavation could cause the ground adjacent and subjacent to the plaintiff's property to subside and the house to be damaged as a result of the subsidence. The physical proximity of the defendants' excavation to the plaintiff's land was so close that there was a foreseeable risk of harm arising from ground subsidence, when loss of soil into the trench occurred and large quantities of water were pumped out of the trench. However it was extensively argued as to whether the plaintiff

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could even maintain an action against the defendants if the land had subsided as a result of the abstraction of water from the trench.

15. In this case, it is more convenient to address the issue of causation and the effects of ground subsidence, before determining whether the defendants owed a duty of care to a neighbour to avoid causing subsidence when percolating water was abstracted.

16. The issues for determination are as follows:

(1) whether the defendants caused the cracks that appeared in the plaintiff's house;

(2) if the land had subsided as the result of the abstraction by the defendants of the water percolating under that land, whether the plaintiff could maintain an action for consequential damage either in negligence (or in nuisance); and

(3) whether the defendants were negligent.

First Issue: whether the defendants caused the cracks

Evidence of Plaintiff's witnesses

17. PW1, Mr James Chua Hai Joo, testified that he stayed in the premises with his 84 year old mother, the plaintiff, since 1967. Between 1967 and 1980, major renovations were done.

18. Sometime in early January 1996, the defendants began digging a deep trench about 6 feet away from the perimeter wall of the premises. When PW1 returned

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home from work on 15 January 1996, he saw that serious cracks had appeared at several places.

19. He noticed that planks for shoring the trench were not supported by any transverse beams. It rained heavily one evening. Black soil flowed out continuously from the gaps between the planks as the shoring was not well done. The defendants kept digging out the soil and transported it away by trucks. After the rain stopped, they pumped out the water and soil from the trench for a few hours.

20. PW2, the plaintiff, testified that serious cracks suddenly appeared in the walls and floors of the premises, both inside and outside of the house after the defendants started excavation. During the 29 years prior to the defendants' excavation, she had not seen such serious and extensive cracks before.

21. No horizontal struttings were put up while the digging was going on and soil fell into the trench from the sides. The soil dug out was black in colour. Once, during a heavy downpour, the walls of the trench collapsed completely and the trench was filled with mud. The defendants simply removed the mud and continued with their excavation. The struttings and other supports were put up only after the excavation had been completed.

22. According to PW2, the cracks appeared **before** the trench collapsed. When asked how extensive the collapse was, she said a few planks collapsed. When the contractors pulled them out, earth fell into the trench.

23. In PW2's affidavit, she stated that she first discovered the cracks when she returned from work on or about 14 January 1996. She could not open the gate as it was misaligned. One side of the gate was lower than the other and the bolt

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was jammed. She was very surprised as the gate could be opened in the morning when she left for work. That night and the next morning, cracks began to form all over the interior of the premises. Several of the room doors could not be closed as the door frames were misaligned. As the cracks were very serious, she was afraid for her safety.

24. Another son of the plaintiff, Mr Chua Kiang Joo (PW3), stated in his affidavit that an excavator was used to dig a trench deeper than the height of an average man. No horizontal struttings were in place when the excavation was carried out. A lot of wet black soil fell into the trench from the sides as the defendants were digging. A few days later, the walls of the trench completely collapsed. The defendants then quickly put up the boards and horizontal struttings at the trench. They even brought in soil to fill up the gaps at the sides of the trench to make them look straight and hide the fact that the trench had collapsed. The cracks in the premises began to appear a few days after the collapse.

25. In his cross-examination, PW3 stated that no horizontal struts and walers were in place to support the vertical timber boards when the excavator was digging the trench. When PW3 first saw the trench, it had been dug from the front to the back of the house. The deeper parts of the trench had vertical planks at both sides but not the shallower parts. Black water seeped through the gaps as the planks were not aligned properly.

26. PW3 was referred to photograph 3 in exhibit D12. He said that the vertical planks used at that time were not those that could be seen in the trench in photographs 2 and 3. The vertical planks used were broader and thinner, similar to those which could be seen lying on the ground at the top right corner of photograph 3.

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27. He clarified his evidence-in-chief that the black soil fell into the trench before the vertical timber planks were put up. After they were in place, he noticed black water oozing through the gaps between the planks. He also clarified that he did not see the actual collapse but he saw the trench after it had collapsed. At least 80% of the vertical planks were no longer vertical. He elaborated on his affidavit evidence that he saw the defendants put up the walers and horizontal struttings at the top and bottom part of the trench to support the vertical timber boards after the collapse. They stuffed dry yellow soil into the gaps in the ground on both sides of the planks on either side of the trench. PW3 said he watched them do this for an hour or more in the evening at about 4 to 5 pm.

28. On the next morning, they were still stuffing in the yellow soil and putting in the cross beams and horizontal beams. They did that for 3 mornings and 2 afternoons. On the third morning, they completed the horizontal and cross beams. It was a big job according to PW3. When it was put to him that there was no such collapse of the trench, PW3 said it was true as he saw it with his own eyes.

Evidence of Plaintiff's expert

29. PW4, Mr Wee Soon Eng, was the expert witness called by the plaintiff. PW4, a partner in the firm of Consultant Engineers, M/s Ove Arup @ Partners Singapore, is a civil/structural engineer with more than 19 years of experience. In his affidavit evidence, he stated that he inspected the premises on 12 December 1996. He was supplied with documentary records relating to the soil conditions, structural drawings of the premises, calculations and details of shoring, renovation drawings and the photographs taken of the premises.

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30. From the borehole reports nearest the subject property, PW4 said that the area was generally underlain by a layer of soft marine clay some 4m to 6 m below ground. Above that was loose silty sand or soft peaty/marine clay.

31. PW4 explained that settlement problems would arise when there was loss of ground water within the sand. With soft marine or peaty clay, it would be susceptible to slip circle failure. Care should therefore be taken to provide a temporary wall with strutting support to prevent a slip circle failure. If such failure were to occur, the soil would slump towards the excavation and ground settlement would result.

32. He estimated the cohesion C value and the angle of shearing resistance u for the soil to be as follows:

Silty sand or loose sand = C from 0 to 10 kN/m2

u from 20 to 30

Peaty clay = C from 5 to 15 kN/m2

u from 0 to 50

33. Angle of shearing resistance is the steepest angle at which a heap of that material would stand unsupported. It is about 30 for loose sand and for water, it is zero. The C value is a measure of the cohesiveness of the material or the ability of the material to unite or remain united with another: Glossary of Building and Civil Engineering Terms. The larger the C value of the material, the higher is its shear strength resistance.

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34. From the "as-built" drawings of the completed sewer, the sewer pipe was about 2.2 m below the ground. The trench excavation was about 2.7m deep to accommodate the concrete haunching below the pipe.

35. In view of the soft soil condition, PW4 was of the view that care must be taken to ensure the stability of the trench. The contractor's professional engineer ('PE') made a recommendation for temporary walling and strutting using timber based on assumed soil parameters of C = 15 kN/m2 and u = 5. PW4 felt that the C value of 15 kN/m2 used in the PE's calculations for the timber support system was too high. In his opinion, the C value chosen should have been in the region of 10 kN/m2. Furthermore, dewatering control as a precautionary measure was not specified although the ground water table was assumed by the PE to be 0.5 m below ground.

36. The PE's design called for timber planks to be driven vertically into the ground with penetration below the trench level. The vertical planks were to be supported by horizontal walers secured by timber struts across the trench. The first level of struts was at 600mm below the ground level. The design stipulated that the subsequent layers of struts underneath the first level of struts were to be at 1.2 m apart. According to PW4, at least 3 levels of struts and walers were required to support this 2.7 m deep trench.

37. PW4 noted however that only one layer of struts was installed at about 0.6m below the ground: see photographs 2 and 3. Without the second and third layers of struts, bulging in and escape of soil at the bottom of the trench could occur. In this case, some vertical planks had given way as could be seen in photographs 55 and 56. The pressure of the soil could have pushed away the timber boards.

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38. The gaps between the planks would allow soil and ground water to escape into the trench. The black material between the planks seen in photographs 55 and 56 could be the peaty soil seeping through. Plaintiff's counsel asked PW4 whether it was acceptable to have black water seeping out from the gaps in the shoring. PW4 said that the ground water was escaping into the trench. With a lowering of the ground water table, settlement would be expected in the adjacent ground. That would not be acceptable. Further, the peaty clay would tend to ooze out and if it was loose sand, it would also follow the seepage of the water into the trench.

39. PW4 described in detail in his affidavit the cracks and the settlement of the various parts of the house structure and the apron slabs. Exhibit WSE-6 showed the areas where the cracks were observed. Although it was a standard procedure to conduct a 'pre-condition survey' of the houses likely to be affected by the excavation, the contractor failed to do so. Thus, PW4 was unable to ascertain whether the cracks were new or existing cracks when he inspected the premises about a year later.

Precautionary measures in poor soil conditions

40. In his expert opinion, the ground condition at the trenching work next to the premises was loose sand or peaty clay or a mixture of both. With heavy loads placed on the soil or water drawn off from the loose sand, the ground would become susceptible to settlement. Landslides could easily occur when sloping or vertically cut surfaces were left unsupported. Based on his analysis, if the soil properties were at the lower end of the estimation, such as C = 10 kN/m2 and u =0, or C =0 kN/m2 and u =20, the factor of safety against slope failure in a vertical cut of 2.7m was less than 0.6. This implied that a land slide was likely if the cut was not supported.

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41. In either loose sand or peaty clay, the voids among the soil particles were quite large. Drawing out water from the voids of saturated soil could result in large reductions in the soil volume and a reduction of 10% to 20% was not unusual according to PW4. Any settlement would most likely affect the ground near the excavation where the water had been drawn out.

42. PW4 suggested the following precautionary measures which could have been taken in the light of the poor soil condition in the area but were not:

Pipe-jacking method - This involves propulsion of the sewer line through the ground so that there is no need to excavate an open trench. Only a small pit is excavated for the pipe-jacking machine. Excavation is reduced. Problems of dewatering as well as slip-circle failure are also minimised.

Pressure cement grouting - This method enhances the stability of the trench. Depending on the spacing of the grouting points, the cement grout curtain formed minimises the seepage of ground water from adjacent ground into the trench.

Recharging - Water discharged from the ground into the trench is pumped up and discharged into perforated pipes sunk into the adjacent ground to replenish the water escaping into the trench. If this is done, the water table in the vicinity of the premises is maintained and ground settlement is avoided.

Stability of the house

43. Plans and records from the Building Control Division showed that the two-storey house was built on the premises sometime in 1950. It has a lightweight roof. The structural system of the house is generally of reinforced concrete

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beams and slabs, supported on columns resting on reinforced concrete footings. The columns carry the loads onto the pad footings, which are tied by ground beams. The ground slabs are non-suspended i.e. they rest on the ground.

44. In PW4's opinion, any settlement due to the building load would have taken place shortly after the house was completed. In any event, such settlement would be evenly distributed and structural cracks would not occur.

45. In 1968, some Additions and Alterations ("A@A") works were carried out. The front balcony supported by concrete slab and cantilever beams, was extended to cover the car porch. The new roof extension over the balcony above the car porch was built using lightweight, sheet metal. The concrete flat roof of the study room was converted into a balcony. These approved "Additions and Alterations" works were generally lightweight in construction and did not add much load to the existing structure. In his view, any settlement would have taken place soon after the loads were added.

46. In 1983, further A@A works were carried out. Part of the backyard was converted into a kitchen with a lightweight sheet metal roof. PW4 stated that it was probable that no major change in loading was involved.

47. The tiled concrete apron slab at the driveway rested directly on the ground and therefore added no additional load to the pad footings.

48. PW4 considered the following possibilities for settlement of the ground:

(a) The additional loading from the A@A works;

(b) The slip circle failure of the vertical cut at the trench;

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(c) The volumetric change in the soil underneath the premises due to the water table draw down; and

(d) A combination of some or all of the above.

49. Both (b) and (c) could happen if the defendants' trench excavation was not properly carried out.

50. As for (a), the major A@A works were completed some 27 years ago. Any settlement caused by the A@A works would have taken place long ago and it was unlikely that any cracks would be caused by these works in 1996. PW4 concluded that the cracks appearing in 1996 would likely be caused by (b) or (c) or a combination of both.

51. According to his calculations, any settlement caused by the A@A works was estimated to be less than 10 mm whereas a 10% change in volume in the top 2 m of soil would cause a settlement of 200mm. Hence (c) was far more likely to induce cracking than (a).

52. The fact that the apron slab side of the crack nearer the trench was lower than the part of the slab away from the trench and nearer the house supported his view that the cracks were likely to be caused by (b) and (c). The cracks on the apron slab were not likely to be caused by the additional loading since there was no heavy load placed on it. If the vehicular load on the driveway was considered to be a heavy load, then the differential settlement would cause the driveway to be lower than the apron closer to the trench, but on the facts, the reverse was true. PW4 therefore concluded that the settlement and cracks on the apron slab were most likely caused by either soil slope failure at the trench or volumetric reduction in the ground due to dewatering.

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53. PW4 summarised his conclusions in his affidavit evidence as follows:

(a) The property is resting on weak soil susceptible to disturbance.

(b) The A@A works are unlikely to cause the sudden appearance of cracks in 1996. Any additional loads on the ground caused by the A@A works would have been slight and any cracks caused would have been minor and would have appeared immediately or shortly after the A@A works were carried out.

(c) The cracks on the apron slab could not have been caused by the A@A works.

(d) The trenching works might cause ground failure if the shoring works were not carried out properly, and/or the watertable was drawn down with consequential ground settlement. Such ground failure could cause the cracks which have been observed in the house and on the apron slab.

(e) The cracks which have been observed in the walls and beams of the house show that the structure had ‘slumped’ towards the excavation and this is consistent with ground failure being caused by the trench excavation.

(f) The sewer works need not necessarily cause the same damage to both houses no. 70 and 72 since the loadings and surface finish are different.

Vibration

54. PW4 ruled out vibration to be of any significance. The only source of vibration would be from the engine of the excavator as well as the hammering of the timber boards into the trench. These vibrations would have dissipated when they reached the house, which was at a further distance from the trench. I agreed with his conclusion that the vibration did not cause the cracks.

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Timber shoring design

55. Page 43 of PW4's affidavit showed the various boreholes in the area around Siang Kuang Avenue where soil samples had been extracted for laboratory tests. Based on the test results for borehole locations BH9, BH2 and BH3, the average C value was computed to be 8 kN/m2. For this computation, PW4 used C = 8 kN/m2 at 6 m depth for BH9, C = 13 kN/m2 at 5.5 m depth for BH2, C = 5 kN/m2 at 3m depth and C = 6 kN/m2 at 7 m depth for BH3.

56. Thus there would be concern for the stability of the trenching works constructed in accordance with the shoring design provided by the PE because the lower C value of 8 kN/m2 implied that the forces on the shoring system would be higher than what had been provided for in the shoring design, which was based on a much higher C value of 15 kN/m2.

57. Due to the poor soil condition and the PE's adoption of a higher C value, PW4 said it was advisable to put in a third layer of struts and walers at the bottom of the trench as that was not far off (i.e. about 1.2 feet) from the next required support level in the design.

Cross-examination of PW4

58. During PW4's cross-examination, much time was spent on whether PW4 was correct in insisting that a lower C value should have been used in the timber shoring design calculations.

59. First, PW4 was challenged on whether it was appropriate to rely on borehole results not obtained from in-situ vane shear tests but laboratory tests, which apparently gave lower C values than the true C values. PW4 was shown the

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paper by S Buttling, JN Shirlaw and J James titled ‘The shear strength of Singapore marine clays’ which was presented at the Fifth International Geotechnical Seminar on Case Histories in Soft Clay held in December 1987 (see D3 at page 251). That seminar paper pointed out that:

Unconsolidated, undrained tests on ‘undisturbed samples’ can give undrained shear strength values that are similar to those derived from in-situ vane and cone tests. This method of measuring shear strength is, however, highly sensitive to sample disturbance. Evidence collected suggests that sample disturbance, possibly together with poor testing practice, has been fairly common in Singapore. This has sometimes resulted in the shear strength of the marine clay being seriously underestimated.

60. Counsel for the defendant put the question to PW4 that laboratory tests were unreliable because of the disturbance to the soil samples during collection and transportation and that in-situ tests gave higher C values than laboratory tests.

61. PW4 said he would not dispute what was stated in that seminar paper. He said that where marine clay was encountered, they would also carry out in-situ vane shear tests together with the laboratory tests. Both sets of results would then be correlated. From his experience however, the C value was low for marine clay at shallow depths. They ranged between 0 to 15 and at the most, the C value is 20. Marine clay at deeper depths of between 20 m to 28 m would have C values ranging from 30 to 50. When a sample of deep marine clay was disturbed, the C value range could therefore drop from 30 to 50 to a much lower range of values. Whereas for shallow marine clay as was the case here, which generally did not have a C value exceeding 15, that low C could not drop much further.

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62. PW4 agreed that if there had been in-situ tests conducted for the shallow marine clay, one could get a higher C value, but not exceeding 15 generally, and that the laboratory tests might give a lower C value. PW4 said that he had assumed a C value of 10 in his analysis (see paragraph 6.1 of his affidavit) although the average C value calculated was only 8 from the laboratory test results of the 3 relevant borehole locations.

63. Counsel asked PW4 to compute the soil bearing capacity for a square pad footing of size 2.2m by 2.2m based on a C value of 10. Assuming C = 10 and u = 0, PW4 agreed that the bearing pressure allowable on the foot pads was 25.1 kN/m2 using the formula given at page 56 in the book by Alfreds R. Jumikis on 'Foundation Engineering' (see D4 and D5). If C = 10, the bearing pressure allowable for marine clay was approximately 30 kN/m2**.**

64. Counsel then referred PW4 to the structural calculations for the design of the house (see PBD 127) for one of the foundation base footings at B7. The foundation base of 9 feet square was supporting a design load of 181,500 lbs. Based on this, the loading pressure was equivalent to 191 kN/m2 . This far exceeded the allowable bearing pressure of 30 kN/m2 based on C = 10 with u = 0.

65. PW4 tried to explain that there was a safety factor of 3 in the formula for deriving the allowable bearing pressure. The ultimate bearing pressure before failure was therefore 3 x 30 = 90 giving 90 kN/m2 for marine clay. Whereas for loose sand with C = 0 and u = 20, the ultimate bearing pressure was 194 kN/m2 .

66. To make sense, PW4 was constrained to say that the soil was more inclined to be loose sand because it was obvious that peaty clay with C = 10 with u = 0

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could not possibly support the load of 181,500 lbs. Even the best marine clay at such depths having a C value of 15 would not be able to support these loads for the pad footings. If it was purely peaty clay, the house would have collapsed. PW4 had to accept that the soil between 0 m and 2.7 m depth was not marine clay (pages 66/67 of the Notes of Evidence). He conceded that the soil was stronger than what he had assumed.

67. PW4 then offered the explanation that from boreholes 2, 3 and 9 (see pages 27, 28 and 37 of his affidavit), one could expect a 4 m layer of loose sand above the layer of marine clay. According to PW4, the building was still standing because it was sitting on loose sand with a u ranging from 20 to 30. The ultimate bearing pressure supportable by loose sand with C = 0 and u = 30 was 615 kN/m2, which exceeded the structural loading pressure of 191 kN/m2.

68. PW4 also raised the possibility that the contractor building the houses in that area in 1951 would have taken adequate steps such as bakau piling or deeper excavations to get better materials for sitting the pad footings on, if he had encountered peaty clay during the construction. Due to the thickness of the marine clay, it would have been impractical and costly to excavate to firmer ground. PW4 therefore agreed with defendant's counsel that the two remaining possibilities were either that the actual C value was higher than that indicated in the soil tests or bakau piling was used to help support the pad footings.

Slip circle failure

69. The next area of extensive cross-examination was on slip circle failure. PW4 drew a diagram P2 to show that unsupported soil adjacent to a vertical trench dug in the ground might slip, depending on the type of soil and the depth of the trench. If the soil slipped, then the slip zone was likely to be curved and the

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curved line would end at the bottom of the trench. That curved line was a segment of the slip circle. The failure of the soil would be described as a slip circle failure. If the trench was unsupported, the soil above the slip circle would be exerting pressure on the side of the trench. In a slip circle failure, that soil above the slip circle would fall into the trench whereas the soil beneath the slip circle would generally not be disturbed.

70. Using the Bishop's slip circle analysis and a computer to perform the iterative calculation, he found that for clayey material with C = 10 and u = 0, the factor of safety was only 0.6, which indicated that the unsupported trench of 2.7 m deep would suffer from slip circle failure. See exhibit D6. If only part of the trench failed, then the slip circle failure would take the shape of half a cup. See exhibit D7. If the soil in the unsupported trench was that of loose sand, there was no safety factor against slip circle failure and the loose sand would fall into the trench.

71. PW4 was asked by counsel for the defendants to perform the slip circle calculations for soils with cohesion values of C = 10 and C = 15. The results may be summarised as follows:

Cohesion Value C (kN/m2)	Surcharge q (kN/m2))	Factor of Safety Against Slip Circle Failure
10	10	0.6
10	0	0.8
10	10	1.0
15	0	1.2

72. The surcharge load q is the allowance for surface loading for equipment e.g. excavator, lorry. In the calculations at exhibit P8, 'F.O.S.' means the factor of safety. The density of the soil g is 16 kN/m3. Cu is the cohesive C value. Where the factor of safety is 1, it is on the verge of failing. Factor of safety less than 1

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depicts a slip circle failure situation. X and Y are the graphical co-ordinates for the centre of rotation of the clip circle.

73. With C =15 kN/m2 and a surcharge of 10 kN/m2, the factor of safety is 1 and the soil is just stable. But for design purposes, a factor of safety of 1 is never used.

74. Based on the distance 1.4 m between the trench wall (nearer the premises) and the boundary wall of the premises, the boundary wall might be affected if there was a slip circle failure as shown at pages 16 and 26 of the calculations at P8. However, PW4 stated that it would depend on how the boundary wall settled. If the whole boundary wall settled by the same amount, then one might not see any visible damage.

75. Counsel asked:

Q : If during the construction of the trench, the walers and the struts were not put in, and there was a collapse of the trench, would the boundary wall be very seriously affected?

A : It may not be because if the whole boundary wall in that part, near the location where it has slipped, suffers the same amount, one will just see a vertical crack between the part within the slip circle and the part outside the slip circle.

Q : Refer to paragraph 6 of affidavit of Chua Kiang Joo. On the assumption that it is true that the trench completely collapsed and all planks had fallen into the trench, how would the boundary wall be affected?

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A : It will be no worse than what I have said, assuming that the trench is unsupported i.e. if the walls settle by the same amount, one will not see visible signs of distress. If the wall sinks as a whole, the wall may be tilted and there may be a vertical crack between the part of the wall within the slip circle and the part outside. It will not be a total collapse of the wall. When that happens the whole foundation of the wall is giving way, it must be a big collapse to do so.

76. PW4 nevertheless agreed that if the trench had collapsed, the wall and the drain line would not be what was shown in the photographs nos. 10, 12, 16, 17, 26 and 27 at Mr Low Gek Seng's second affidavit. The wall would be more seriously affected.

77. The plaintiff called PW5, a registered surveyor Mr Lee Li Chuan to survey the premises. He carried out a site survey of the premises on 13 March 1998 and he drew the survey plan P7. An automatic level instrument was used to measure the levels and the instrument had an accuracy of + 2.5 mm.

78. He explained that 'TBM B' on his survey plan represented the 'Temporary Bench Mark'. 'PW' referred to the parapet wall at the front gate. He used 2 bench marks at Houses No 39 and 41 for the survey. Scale: 1:50(H/V) referred to the horizontal and vertical scales.

79. From his survey, he confirmed that the ground between the outside wall of Room 1A and the boundary wall adjacent to the trench had a gradient of 1:38 falling towards the boundary wall. The gradient of the ground from the inside right wall of Room 1A to the dining room was 1:170 falling towards the dining room.

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80. As no pre-trench construction survey was done, he could not make any comparison. Thus, he could not say whether or not the levels as measured were the original levels for the house and whether there was any settlement.

81. The witness marked out the location of the long crack at the car porch area on page 4 of his survey plan.

82. PW4 commented on the survey results of PW5 that a gradient of 1:38 for the apron area sloping towards the trench was not a normal construction gradient. The apron at the boundary wall was 6.6cm lower than that at room 1A. It indicated that the apron slab had tilted towards the boundary wall.

Evidence of defendant's witnesses

Mr Louis Hwang Teng Sun, DW1

83. Mr Louis Hwang Teng Sun, DW1, the expert called by the defendants, is a registered professional Civil Engineer with 19 years experience in civil and structural engineering. He was the professional engineer engaged by the defendants for the sewerage work at Siang Kuang Avenue.

84. In his short affidavit, he said that he visited the premises on 16 January 1996 after he was informed of the cracks. He was shown around the house by Mr James Chua (PW1). DW1 saw some cracks in the tiles, walls and floor.

85. DW1 inspected the trench and took measurements. He found that it was constructed in accordance with the design. The supporting system and the bottom of the trench did not show signs of movement. From his site inspection, DW1 confirmed that there was no failure of the struts and there was no lateral movement of the drains adjacent to the trench.

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86. On the following day, he visited the premises. There appeared to be no further damage to the house. DW1 could see that some were old cracks as the crevices had dirt in them. Admittedly, there were also some new cracks because the cracks were not dirty and the cracked surfaces of the tiles were fresh.

87. He was of the opinion that the slightly inclined timber planks seen in photographs 55 and 56 were inserted slightly out of place into the ground. It had not given way subsequently. In his view, it was impossible to construct a ruler straight line of timber planks.

88. He said that the open trench was visually about equidistant between Nos 70 and 72 Siang Kuang Avenue. DW1 gained access into house No 70 and visually inspected the first storey of the two-storey building. There were a old few cracks, which were insignificant to those found in No 72. He noted that No 70, unlike No 72, did not have extensive renovations.

89. In his opinion, No 70 would be similarly affected if the cracks at No 72 was due to the inadequacy of the shoring and the lateral movement of the timber planks. But that was not the case.

90. He then referred to the alternative methods (i.e. soil treatment method, sheet piling method and the pipe jacking method) suggested by the plaintiff's expert, PW 4, in his affidavit. DW1 said that they were not suitable because:

the sidelane width was too limited;

the existing sewer line had to remain in use for as long as possible before it was replaced by the new sewer line; and

a vibratory hammer was needed.

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91. DW1 later retracted the first reason as it transpired that smaller machines for soil treatment or jet grouting were available.

Type of Soil

92. During his cross-examination, DW1 said that he had visited the site in November 1995 to ascertain the type of soil there. Three trial pits (one at each end and one at the middle of the proposed trench excavation) were dug to a depth of 1.5m to check for the existence of services like water pipes and electrical cables. DW1 saw that the material in the trial pits was dark peaty clay. He did not see any sand. There was no water in the trial pits. DW1 did not have any equipment to test for the soil properties. He simply used his finger nail to press one of the soil samples and it did not appear to be very soft to him. It was firmer than plasticine. In his opinion, the C value of 15 used in the design was adequate, based on his experience gained over the years.

93. Because of the difficulty in collecting undisturbed samples for soil material in the soft range, he said that recommended values from in-situ tests in research papers carried out on soft soil were normally used. For major projects, in-situ tests were used to obtain the actual C values. For small projects, the thumb test was a rough and ready guide based on experience. C = 15 kN/m2 was the value that most would use. But in soil which was a mixture of sand and clay, just taking the C value alone may not be accurate. Both properties of sand and clay should be used and that would result in a higher factor of safety.

94. DW1 commented that for engineering design, results of boreholes as close to the site as possible would be selected. But it might not be representative of what was on the site itself. Generally, the most conservative soil type would be adopted for design purposes. Then a site verification was carried out by visually

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inspecting the trial pits or the excavation. DW1 conceded that although boreholes 2 and 3 showed silty fine sand at 3 m depth, borehole 9 showed that the soil was that of soft dark brown organic clay. DW1 admitted that it would be advisable to use the properties of the dark brown organic clay as that would be the most conservative compared to sand. The actual physical site condition was closer to that of borehole 9.

95. Due to the inaccuracy of test results for soft clay, the soil property chosen for the trench shoring design was based on books and research papers which recommended C = 15 kN/m2 for soft clay.

96. DW1 also asserted that the soil properties of organic peaty clay was at least equal to or better than marine clay but he had nothing to support that proposition. Later, DW1 made a qualification that peaty clay would be weaker than marine clay if there was a lot of moisture in the peaty clay. If the moisture content was the same, then both materials had almost similar properties.

97. However, DW1 concurred with the general statement made by PW4 that the best marine clay at the depth in question would have a C value of 15 kN/m2. But it appeared from the calculations that the peaty clay at this depth was stronger than marine clay in order to support the loads of between 95 to 105 kN/m2 (see Notes of Evidence at pages 48 and 50 on 17 March 1998) at the pad footings taken from the construction drawings of the house at the plaintiff's bundle of documents PBD 127. With C= 15 kN/m2 , the most the soil could carry was 126 kN/m2 which only gave a safety factor of 1.25. As DW1 believed that a higher safety factor was used, the assumed C value for the design of the house foundation would be higher than 15 kN/m2.

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98. DW1 did not think that bakau piling was used. No notes of any bakau piling could be seen on the drawings. DW1 also discounted the possibility of refilling with better soil because the boreholes 3 and 9, even after testing to 10 m below ground level, showed soft marine clay. Refilling would be very extensive and was therefore unlikely.

99. Counsel for the plaintiff then asked DW1 how the house was built if there was no bakau piling and no refill. DW1 said that the house was designed to the footing pressure criteria in use in those days, which stipulated 95 to 105 kN/m2 for a worst case situation. There was no need to bakau pile.

Trench construction

100. DW1 had visited the site in early January 1996 to check whether the trench had been constructed in accordance with the design and to see if there were any problems. No problems were reported. The defendants had constructed the first 1/3 of the trench at the rear of the premises. He found that larger walers and struts than that specified in the design were used. Some sections had been dug to 2.7m and the struts were in place. The depth of the first level of struts was about 2'. The second level of struts was at about 6' below the ground level. For those sections they were digging, the top level struts in place were 8 feet instead of 4 feet apart as called for by the design. The contractor omitted the alternate struts as he had not reached the full depth of 2.7m. They were digging beneath the top level struts. For the full trench depth, the struts were required to be at 4 feet intervals. However, for a 2m deep trench, it was adequate according to DW1 to leave the strut intervals at 8 feet because of the shallower trench and the bigger waler and strut sizes used by the defendants.

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101. DW1 saw the defendants excavating the second level in one section of the trench. Each section of the trench was 12’ in length. They were then using the small excavation bucket to excavate to a depth of 6’. DW1 reasoned that the existing sewer line would have necessitated manual digging for the last 2 feet of the trench. Otherwise, the existing sewer would be damaged by the excavator and the residents would not be able to use their toilets.

102. When DW1 received the complaints, he went to the site on 16 January 1996 and measured the trench shoring. He found that the walers and struts were of cross-section 6" x 6". The planks were 12’ long and of cross-section 8" x 2". Plaintiff’s counsel then referred DW1 to photographs 2 and 3 because PW3 had alleged that the shoring planks in the trench were not those originally used, and that prior to the collapse of the trench, the shoring planks used were broader and thinner, similar to those which could be seen at the top right corner of photograph 3. On examination of the photographs, DW1 said that those planks lying on the ground adjacent to the trench were planks used for the formwork. However, he also said he could not really tell from the photographs. DW1 then said that the timber planks lying around were broader than the planks used vertically in the trench shoring construction but the thickness was about the same. In his opinion, pushing these broader timbers into the ground with the excavator would be more difficult.

103. DW1 was referred to photographs 55 and 56. He said that there was some water wetting the timber and also the soil excavated was black damp soil. As it was not possible to remove all the peaty clay during the excavation, some of that peaty clay had adhered to the timber. He did not see any clay oozing out from the planks. He saw dampness as in the photographs.

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104. Plaintiff's counsel cross-examined DW1 on the misaligned vertical timber boards particularly those found on the side of the trench nearer to No 72. DW1's explanation was that the timber used could have a permanent bowing.

105. DW1 commented that it was unnecessary to have 3 levels of struts as was suggested by PW4. The first level of struts was at 2'. The next level of struts was 6' below the ground level. The planks and the soil could in his opinion support the last 2 ' of the planks without the need for the third level of struts. His calculations showed that 2 levels of struts were sufficient. With the far end of the vertical planks sunk about 1m further into the 2.7m deep trench, the planks were not unsupported at the deep end. DW1 noted that photographs 2 and 3 (taken on 18 January 1996) apparently showed only 1 level of struts after the new pipe was in place. Even then, there was no failure of the trench. But when he visited the site 2 days earlier on 16 January 1996, he did see 2 levels of struts for the whole trench.

106. During his inspection of the initial excavation in early January when the defendants were excavating the 3rd section, he saw that both layers of struts were in place for the two completed sections. Nothing was missing. For the uncompleted 3rd section, the horizontal struts were 8' apart and the excavator was digging between the struts at depths between 2' and 6'. The factor of safety was not reduced although the intermediate struts were not put in place because at that juncture, the full depth of the trench was not reached yet. DW1 observed the work for about an hour to 1 1/2 hours during this second visit.

Dewatering

107. DW1 explained that in sandy soil conditions, it was easier for both sand and water to leak out into the trench. Pressure against the side wall of the trench

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was thereby relieved. For clayey material, it was more difficult for the water to leak out because that material was less permeable. Therefore, more pressure would be exerted on the side wall.

108. It was possible for settlement of the ground in the house to be caused by dewatering as the influence zone was larger. However for leakage of soil into the trench, it would still follow a 45o wedge line, which was basically the slip circle. The affected area would extend 3 to 4 m from the edge of the trench .

109. DW1 agreed that water would collect in the trench if it was below the water table. The defendants had pumped water out of the trench without taking any precautions against dewatering. However, DW1 said that dewatering should also affect No 70 but it did not.

Collapse of the trench

110. DW1 visited the premises together with the Managing Director of the defendant company and officials from MOE when the complaints were received. He met the plaintiff and her two sons. They did not mention anything about the collapse of the trench.

111. DW1 found it difficult to understand how the trench could have totally collapsed when it was constructed in sections of 12 feet length each. Even if there was a collapse, he would only expect a localised collapse. Anything within the slip area would be damaged particularly when the boundary fence was a brick wall filled with pre-cast brick blocks. The boundary wall in this case was only 1.4 meters from the edge of the trench (see exhibit D10) and was well within the slip circle failure zone. Yet photographs of the boundary wall taken after the complaint did not show substantial cracks.

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Soil stabilisation by cement grouting

112. DW1 said that cement grouting under pressure may not be effective for clayey soil. There was also the question of cost effectiveness. He had consulted the professionals in grouting from Presscrete Engineering Pte Ltd ('Presscrete') and he was cautioned against possible displacement of the ground due to the shallow depth of the soil treatment, and the presence of the acidic peaty clay, which would weaken the jet ground column.

Removal of lower level of struts

113. DW1 was asked whether removing the lower level of struts to facilitate the laying of the new pipe would overload the timber shoring. Based on the bending stress values from his calculations at exhibit D17, DW1 said there might be an overstress situation if C = 15 kN/m2. If C was greater than 15 kN/m2, then it might be satisfactory. When DW1 performed another set of calculations (see D20 and the attachments), he concluded that there should be a total collapse because the ultimate bending stress of the timber board, which he assumed to have the properties of Kempas wood of select grade taken from the Code of Practice for the Structural Use of Timber - CP7:1978, was exceeded by about 18%.

114. In re-examination, DW1 explained that there was a built-in safety factor for accidental overloading, errors in design assumptions etc. However, this safety factor could not be less than 1.5 otherwise it would not be able to sustain the short-term increase in loading of up to 50 % under paragraph 3.9.2 (i) of the abovementioned Code of Practice. According to DW1, this may explain why the vertical runners had not collapsed when the lower level struts and walers

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were removed to facilitate the installation of the new pipe on the concrete bed at the bottom of the trench.

Mr Chan Ewe Jin - DW2

115. Counsel for the defendants called Mr Chan Ewe Jin (DW2) to testify on their behalf. DW2 was the professional engineer first employed by the plaintiff to do an initial structural investigation report. He carried out a general inspection of the premises on 18 January 1996.

116. In his report, DW2 stated:

2.5 Possible Causes

The forms of cracks were generally in the vertical and diagonal direction. Many cracks were basically found at the corners of walls. Most of the cracks were observed to be penetrated through one face of wall to the other face.

Though the foundation of the original structure was not known in this study, it was believed that the structure was founded on footings.

Hence, in our opinion, the cracks developed in the house were mainly due to ground deformation and differential settlements between footings. We believe that the footings nearer to the excavation might been disturbed and gone to further settlement.

The following are the possible causes and factors that could affect the ground movement and settlement.

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1) A trench excavation was next to the affected house. During excavation, the ground water table would change and lower down. The lowering down of water table could easily cause the adjacent ground to settle. Generally, the ground deformation at the surrounding was not significant, but it was believed that little ground deformation would be adequate to cause cracks on walls.

2) The house geologically sited at area where the underlying soil stratum is Kallang Formation which comprises both marine and terrestrial sediment. Obviously, the soil condition at this region is poor. As the structure was believed to be supported by footings, settlement could easily be affected and aggravated by the adjacent excavation and vibration work.

3) The method of construction and the sequence of work could also affect the lateral movement of the walls at trench, which in turn could cause the ground settlement. The timing of shoring, whether the ground was shored immediately after the trench was excavated, was an important factor that could cause ground movement.

4) The inadequacy of shoring could also be a factor that affected the ground movement. It was noted that the trench was approximate 1.5 meter wide by 3 meter deep. As noted, timber planks with one layer of strut at approx. 0.8m from ground were used to shore the trench. At some areas, lateral movement with timber planks giving way was noted, see Photograph 55 @ 56.

3.0 Conclusion and Recommendation

Generally, the cracks appeared in the building were through cracks in the forms of vertical and diagonal. It was believed that the footings have been subjected to differential settlements and ground movement.

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As the cracks were reported after the adjacent minor sewer work started, the causes of settlements could be attributed to one or combination of the following.

1) Trench excavation next to the house.

2) Draw down of water table during excavation.

3) Ground movement and vibration during excavation.

4) Footings on poor soil formation.

5) Delay in the timing of shoring

6) Inadequacy of shoring.

117. On the inadequacy of the shoring, DW2 testified that he actually saw some planks giving way. (See page 63 Notes of Evidence on 17 March 98.) He was of the opinion that the cracks which could be seen in the photographs taken by him were developed through settlement of the surrounding ground.

Mr Wong Seng Toong - DW3

118. Mr Wong Seng Toong, DW3, works in the construction section of the Sewerage Department of the MOE as a Senior Technical Officer. His main duty is to administer and oversee projects. He visited the site along Siang Kuang Avenue once or twice in a week. He said that 2 methods of sewer laying were carried out by the defendants. The long sewer line along Siang Kuang Avenue itself was done by the pipe jacking method whereas the 5 short lines were by the open trench method.

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119. DW3 stated that ground treatment would be used only when the ground condition was very bad like marine clay. Although cement grouting had been stipulated by the contractor as a provisional item of work, he was afraid that the cement grout would infiltrate into the cracks in the existing faulty sewers and choke them up. If it had been soggy marine clay and where it would pose a danger, then he would use grouting. Since the soil at No 72 was black clayey soil and not marine clay, he decided against it.

120. The black heap at the top right of the photograph 3 showed the type of black clayey soil excavated. This soil was not very wet from his observation. Trial pits (1’ wide, 2’ to 3’ in length and 4’ deep) dug along the trench line showed that the soil was not marine clay but black clayey soil. The free standing pits did not collapse.

121. He described how the defendants constructed the trench. The defendants dug a section of about 8’ length to a depth of about 1’. They then put in the walers at both sides to guide the placement of the vertical timbers or runners, which were about 10’ to 12’ in length. These runners were pushed into the ground with about 6 ’ protruding above the ground. On his first visit, he only saw the initial part of the construction of the first section at the rear of No 72. His next visit to the site was after the complaints. He did not concentrate on this site but on the pipe jacking works along the main road.

122. The full time technician on site to supervise the construction works was Mr Michael Ngeow. If there was a collapse of the trench, the site technician would have to report to him and he would have to report to his chief engineer. The Ministry would stop the work and cause an investigation to be done by the Sewerage Department. But there was no report of a collapse.

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123. In this case, an internal investigation was done after complaints of cracks were received. Both the Deputy Chief Engineer and the Senior Engineer had gone down to the site to look at the cracks as well as the trench. He went with them. However, all of them could not come to any conclusion because some were old cracks and some could be new cracks. Not all the cracks had mould or dirt in them. The cracks on the boundary wall had black fungus. Some did not. Inside the house were cracks on the walls. The hairline cracks appeared to be fresh clean cracks.

124. DW3 spoke with the plaintiff and PW1. PW1 did not mention that the trench had collapsed.

125. On the need for a pre-condition site survey, DW3 accepted that the department should have asked the contractor to take photographs of the condition of the house prior to the sewerage construction. DW3 said it was the contractor who was supposed to carry that out. He was of the view that there was reasonable opportunity between October and December 1995 for the survey to be done. But the owner was not there according to Mr Ngeow.

Mr Michael Ngeow Siong Chow - DW4

126. DW4, Mr Ngeow Siong Chow is a Senior Technical Officer with the Sewerage Department of the Ministry of Environment. He was the full time supervisor of the Siang Kuang Avenue project. His duty was to ensure that the contractor carried out the work to the department’s requirements. He was on the site daily from 8.30 am to 5 pm.

127. He said that a general survey was carried out prior to the excavation. Some photographs were taken of the road and the exterior of the house at No 72. He

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was present when the 3 trial pits were dug. The soil beneath the 5" thick concrete pavement was brownish/black clay for the entire depth of the trial pits. He did not see any layering with other types of soil. From his visual inspection, the soil was quite firm. It was not wet. He did not see any sand in that soil. The top right of photograph 3 showed the type of soil excavated from the trench.

128. According to the site diary (D15) kept by him, work commenced on the trench on 5 January 1996. A Daewoo excavator with a big bucket was used to excavate to 2 ’ for one section of 12’ length. Vertical timbers of 12’ length were then placed at each of the 4 corners and driven all the way into the ground. 6" by 6" timber walers of 12’ length were then placed on each side. Horizontal cross struts of 6" by 6" cross-section were inserted to secure the walers against the sides of the trench. A rectangle was thus formed with 2 walers and 2 struts. With the walers as guides, vertical timbers were driven fully into the ground on both sides using the excavator claw. There was no difficulty pushing these vertical timbers into the ground. After the shoring walls were completed, the excavator dug out the black/dark brown soil between the 2 horizontal cross-struts. Digging proceeded in this way until a depth of 6’ was reached. Digging stopped and another set of walers were put in. Struts were placed at both ends and in the centre of this set of lower walers. Another strut was also placed between the struts at the upper level walers. The shoring system for the section was thus complete. The labourers would descend into the 6’ deep trench section to complete digging the remaining 3’, whilst the excavator moved on to dig the next section.

129. One section of the trench was completed on the first day of excavation. On the second day, 2 more sections were completed using the same method. Work progressed smoothly. The same took place on the third day. By the end of the

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fourth day on 9 January 1996, they were ready to prepare the base of the trench for bakau piling.

130. Nothing unusual happened. There was some trickling of clear water into the bottom of the trench. He could not see any soil seeping or oozing out between the gaps in the planks. In the morning, water could be seen in the trench. But according to DW4, there was not much water and the bottom of the trench was not that soggy.

131. On 10 and 11 January 1996, bakau piles of over 20' lengths were vertically pressed in for the entire length of the trench at 300 mm intervals in 3 rows. There was not much difficulty pushing in the bakau piles into the bottom of the trench. A total of 170 bakau piles were used.

132. In the morning, the trench was filled with water to a depth of about 1'. A small pump was used to pump the trench dry. Pumping took between 20 to 30 minutes. Before the pumping, the undisturbed water was clear. After the pump started, the water took on a brownish colour because the silt was churned up. They had to pump out water every morning. Sometimes, when concreting work had to be done, they pumped out water also in the afternoon.

133. On 12 January 1996, the trench bottom was cleaned up by removing cut wood ends, wedges, debris and wrappings etc. The heads of the bakau piles were cut on the following day, 13 January 1996. Formwork for the concrete base for the pipe to sit on was completed. The formwork was below the lower level of struts.

134. On Monday, 15 January 1996, complaints were received and work stopped on that day. DW4's superior, Mr Wong Seng Toong called DW4 in the morning

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to inform him that the occupants of No 72 had complained and he asked DW4 to investigate. DW4 was at the site at that time. He visited the house with Mr Low Gek Seng, the Managing Director of the defendants and met the plaintiff. DW4 saw some stained cracks and some fine line new cracks. His impression was that the old cracks were more than the fine new cracks at the car porch area. The plaintiff was upset that the contractor damaged her house. PW1 was also present.

135. On the morning of the following day, 16 January 1996, work resumed. They continued to clear rubbish from the trench. In the afternoon, concreting work for the base of the pipe was completed.

136. The actual pipe laying was carried out on Wednesday, 17 January 1996. Each section of the pipe was about 6' in length. In this case, it was difficult and time consuming to lay the pipe without first removing the lower level of horizontal cross-struts. The lower level of struts and walers were removed to facilitate the laying of the new pipe. There was however no movement of the vertical timbers when the lower level of walers and struts were removed.

137. Photographs 55 and 56 showed that the new pipe had been laid. The waler and the strut seen in these two photographs were the upper waler and strut. The concrete bed was about 1' high including the pile cap. At this stage, the vertical timber runners were supported only by the walers and struts at the upper end, and by the toeing in of the runners at the bottom of the trench. DW4 did not agree that the timbers seen in photographs 55 and 56 were coming loose at the toe end. He said that the black material might be water stains but he could not tell from the photographs.

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138. On 18 January 1996, cement was poured over the new pipe which was laid on the concrete bed. On the next day, the formwork was removed and the defendants commenced back filling of the trench.

139. There were instances of rainfall recorded in the dairy. It was DW4's duty to record the weather. When the rain was heavy and the workers were unable to work, he would record it as having rained. But if it was merely a drizzle and the workers could still continue their work, he would not record it. The extent of delays due to inclement weather would then be known.

140. From the diary, there was however no record of rain for the entire work period between 5 and 19 January 1996 for the trench adjacent to No 72. DW4 testified that it did not rain on those days between 8.30 am to 5.00 pm. However, if it rained in the night after he left the site, then he would not know.

141. DW4 was asked if the planks seen lying on the ground in photograph 2 were used for the vertical runners. He said they were 1" x 8" planks and they could not be used for the vertical runners. They were used for the concrete formwork.

142. DW4 also said that there was no complete collapse of the trench. The statement in the affidavit of DW3 that there were no horizontal struts in place when the excavation was carried out was untrue. It was also not true that a lot of wet black soil fell into the trench from the sides as the defendants were digging. Except for the last line, DW4 denied the whole of paragraph 6 of DW3's affidavit that the walls of the trench had collapsed completely, the timber boards had all fallen into the middle of the trench, the ground at the sides had given way and collapsed into the trench. He denied that the defendants had quickly put up the timber boards and horizontal struttings at the trench and

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brought in soil to fill in the gaps at the side of the trench to make the sides look straight and hide the fact that the trench had collapsed. He did not see the contractor stuffing yellow soil into the gaps.

143. However in cross-examination, it was suggested to DW4 that the part of the vertical trench near the meter compartment where the misaligned vertical timbers could be seen (at photographs 2 and 3), had moved when it rained and the contractor pushed the timbers back again, and stuffed some wooden planks and soil into the gap there. DW4 paused for a while before saying that he had no comment.

144. DW4 stated during cross-examination that the water pumped out of the trench was discharged into a side drain behind a sand trap. He did not see any sand pumped out together with the water. But the sand trap was choked up with dark brownish silt, which had to be cleared after every few days. The temporary sand trap was a contraption of 3 or 4 gunny sacks of sand placed in the drain. Clear water flowed over the trap but other material would be trapped behind the gunny sacks. In re-examination, DW4 clarified that the water pumped out was dark in colour because the pumping disturbed the water.

Mr Ho Chee Eu - DW5

145. Mr Ho Chee Eu, DW5, is the General Manager of Presscrete Engineering Pte Ltd. in charge of the ground engineering division. He is a registered Professional Civil Engineer, a member of the Institute of Engineers in Singapore and the American Society of Civil Engineering. He has been working as an engineer since 1986.

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146. He testified that he had replied to queries from Mr Hwang on the basis of the information provided to him. He had no opportunity to visit the site. He said that it was possible to use a small machine to do grouting work. However, the displacements of the ground were very difficult to control when grouting work was done in soft clayey soil. Disturbance to nearby structures was likely. Therefore, damage to existing walls, drains and services might pose problems.

147. An alkaline environment was required when mixing the grout. An acidic environment would neutralise the effects of the gain in strength in the grout. It was known in practice that poor quality grout might form in acidic soil such as peaty clay.

148. According to DW5, jet grouting was highly specialised work. As it was not a cheap solution, it was normally used in situations where other methods were not possible and projects were much bigger. Then the method would be more cost effective.

Mr Low Gek Seng - DW6

149. Mr Low Gek Seng, DW6, is the Managing Director of the defendant company. He personally supervised the sewerage work at Siang Kuang Avenue.

150. DW6 engaged a professional engineer, Mr Koh Bock Cheng, to check the shoring design for the open trench excavation. Mr Koh's calculations were submitted to MOE prior to the excavation.

151. DW6 admitted knowing that he had to carry out a pre-condition survey before commencing excavation. It was a condition of the insurance policy taken out for the project that he carried out a pre-condition survey. DW6 said he went

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on 2 occasions to the premises but no one was at home. As no pre-condition survey was done, his insurers did not entertain the defendants' claims.

152. In his affidavit, DW6 stated that the actual excavation commenced on 5 January 1996 and was completed on 9 January 1996. The cracks appeared on 15 January 1996 after excavation had been completed. He said that it was not possible to align all the timber shoring in a ruler-straight line and it could not be said he was negligent for not having done so.

153. He admitted that there was water in the trench which had to be pumped out. If the ground had settled, it was because the water table had been lowered thereby causing the cracks. DW6 admitted that they pumped water out of the trench every morning for 40 to 45 minutes via a 2 " diameter sump pump. Water pumped out was clean water without any sand or earth. (See pages 142 and 143 of the Notes of Evidence on 18 March 1998). In any event, DW6 clarified in re-examination that there was no sand in the soil there.

154. DW6 said that the owner had done extensive renovations and additions to the premises. In particular, a new terrace was erected at the second floor. He saw many old cracks in the premises. These old cracks could be due to the extensive renovations to the building which rested on a beam slab system without piled foundations on poor soil.

155. DW6 alleged that the plaintiff had told him during the house inspection on 16 January 1996 that 2 of the bedroom doors could not be closed properly for years due to misalignment. DW6 stated that the new cracks were the continuation of the process which had commenced a long time ago and had nothing to do with his sewerage works.

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156. When he was referred to photographs nos 2 and 3 during cross-examination, DW6 admitted that the struts at the fist level were more than 2’ but were less than 3’ below the ground level. The deviation from the design was slight. He was also referred to photographs 55 and 56 and DW6 stated that the runners were stained with some silt. DW6 admitted that the vertical timbers or runners were slanting but they were straight when they were first driven into the ground. In re-examination, DW6 said he personally saw these runners being driven in. If this were so, then the implication would be that the vertical timber shoring in photographs 55 and 56 had subsequently given way.

157. He related how the shoring was done as follows:-

First I dig about 2’ down. Then I insert 2 planks, runners, on each side. Then I put in the 6" x 6" waler. Then I put in the struts at both ends. So I insert runners. Then I dig for more earth to a depth of 4’. After that we put in another 2 x 6" walers. Then I put in two struts at each end. So the 2 struts are 8’ apart, and we put another strut in between making 4’ apart. When the waler of 12’ is placed, the first 2 struts are secured about 2’ inwards from the ends of the waler. Therefore the space between the 2 struts is 8’. The insertion of an intermediate strut, makes the spacing of the struts 4’ apart.

We then get people to clear the earth. After clearing the earth, the old pipe is exposed. Then we continue to dig, to do other sections. Each section is 12’. The same process is repeated until the trench is completed. After the trench is completed, we remove the old pipe by breaking it up first. After the old pipe is removed, we also removed the concrete base of about 3" completely. Then we did bakau piling for about 2 days, on 10 and 11 January 96. Because the bakau piles are of different lengths, we level the bakau pile heads to the same height of about 2". 3 days to cut the piles and remove the debris and put in quarry dust,

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steel reinforcement and do the formwork also in sections. After the formwork is completed, concrete is poured on the next day. Concrete took 1 day to set. Then we put in new pipe. Each pipe section is about 1 to 2m long.

I had a discussion with MOE people who wanted the job to be done as quickly as possible. So I removed the lower level of struts. Those struts in the way, I removed. Not sure how many of the lower level struts were still in place.

However, I did not remove any of the upper level struts.

158. Photograph no. 2 was shown to DW6 and it was suggested to him that the runners on the left side of the trench had slipped and moved and that his workers tried to arrange them back in line after having stuffed some soil at the side together with some planks to cover the hole caused by the slippage of the planks and the loss of soil into the trench. DW6 said that there was an electrical box on the left and there were cable ducts. So the runners had to be inserted at an angle to avoid the cables. When he inserted the runners, he put in soil.

159. It was put to him that there was heavy rain during the excavation works and some of the vertical runners, slipped and moved and earth fell into the trench from the sides. DW6 said there was no rain and no slippage.

Analysis of the evidence and findings

Additional loading due to renovations

160. In their defence, the defendants attributed the cause of the cracks to the

renovations and new structures put in by the plaintiff. Though the renovations had increased the loading on the existing structure, I did not think that the

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increased loading caused these sudden cracks. No serious cracks had appeared since the completion of the renovations. The foundation and soil condition were able to sustain the increased loading for many years and there was no reason why they could not continue to do so. The fact that a long continuous crack had suddenly appeared on the ground at the front car porch area, not subject to any additional structural loading, showed that the renovations and new structures could not have been the cause.

161. The defendants' counsel spent a considerable amount of time questioning and putting their case particularly to the plaintiff's expert witness PW4 on the renovations and increased structural loading. It was put to PW4 that it was possible that all the cracks could have been caused by the renovations to the house. I accepted the explanation by PW4 that if there was any effect due to the renovation work completed about 20 years ago, cracks would have happened then, and not in 1996, when there were reports of fresh cracks occurring soon after the trench had been dug by the defendants. Excavation of the entire trench to full depth was completed on 9 January 1996. Cracks appeared on 14 January 1996. Sewerage pipe replacement work was completed and the trench was back filled on 19 January 1996.

162. After realising that this was not going to help advance their case, the defendants abandoned this defence. No evidence was led from the defendants' expert DW1 to substantiate this aspect of their defence. Neither were there any submissions made by defendants' counsel that the plaintiff's renovations had caused the cracks.

163. In any event, the defendants could not shift the blame to the plaintiff on the basis that the premises should have stronger structural fortifications to withstand whatever soil subsidence that might arise out of their trench excavation. The

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plaintiff's premises might have been more susceptible to subsidence due to the renovations and the increased structural loading. But the defendants had to take the 'victim' as they found him.

164. In the law of tort, this is commonly referred to as the 'thin skull rule'. If it is reasonable to foresee some injury, however slight, to the plaintiff, assuming him to be a normal person, then the defendants are answerable for the full extent of the injury which he may sustain owing to some peculiar susceptibility. This principle is well established in the case of physical injury (e.g. *Smith v Leech Brain* [1962] 2 QB 405) and there is no reason why the principle should not apply to property damage: see eg *Clerk & Lindsell* (1995) para 7-192.

Soil properties

165. A number of witnesses had given evidence of what they saw when the 3 trial pits and the trench were dug. The free standing or unshored trial pits of 1.5 m (or about 5') depth did not collapse. The soil dug out was black peaty clay. The peaty clay was not very wet or soggy. There was hardly any sand in it. That this was the kind of soil present could not be seriously disputed.

166. Although the boreholes 2 and 3 suggested the presence of some sand at depths less than 3 m, the soil there was closer to that of borehole 9 which indicated a thick layer of very soft dark brown organic peaty clay soil between 0.6 m and 5.4 m depth. The soil condition at No 72 was rather poor.

167. After hearing the evidence, I accepted the opinion of DW1 that in-situ vane shear tests were more appropriate in soft clayey soil conditions and would give more accurate and higher C values than those obtained from borehole soil samples tested in the laboratory. The laboratory tests were unreliable due to the

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disturbance of the samples during collection and transportation. There was supporting literature on this based on the Nanyang Technology Institute of Singapore - Paper on Case Histories in soft clay (D3), which was not disputed by the plaintiff's expert PW4.

168. Both expert witnesses PW4 and DW1 came to the same conclusion based on their calculations that black peaty clay with an assumed C value of 15 kN/m2 would not have been able to support the design loads used for the pad footing foundations for the house unless there was bakau piling or the C value for the black peaty clay was in fact much higher than 15 kN/m2. No one could be sure if indeed bakau piling or deeper pad footings were used in the construction. But I certainly did not accept the opinion of PW4 that the building was still standing because it was sitting on loose sand with a f value ranging from 20o to 30 o when he tried to explain why the house had not collapsed.

169. In my opinion, what should have been the actual C or f values for the soil at No 72 need not really concern us. This case could be decided without the need to have the actual soil properties determined as a fact.

Trench shoring design and construction

170. I did not think that the trench shoring design was inadequate. The formula used and the computations themselves were not challenged by the plaintiff's expert PW4. Only the correct soil parameters assumed for the calculations were challenged.

171. The soil parameters of C = 15 kN/m2, f = 5o used in the computation appeared not to be overly optimistic. The fact that the house had not collapsed indicated that the actual C value would have been higher than 15 kN/m2. The

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fact that the removal of the lower level struts to facilitate the laying of the new pipes had not resulted in any collapse of the trench shoring indicated that there was sufficient safety margin in the original trench shoring design approved by the professional engineer Mr Koh Bock Cheng.

172. Whether the construction was in accordance with the design was another matter. A good design would be of no use if the contractor failed to construct in accordance with that design and his workmanship was not up to the required standard.

173. I accepted the evidence of DW4 and DW6 on how the trench shoring was constructed. I was of the opinion that the sequence of construction of the trench shoring and the way the excavator was used to dig only the first 6 feet leaving manual labour to finish the bottom 2 to 3 feet were both in accordance with the accepted practice of the construction industry. I did not find anything wrong or improper with the construction sequence adopted by the defendants.

174. However, the defendants could have done a much better job of pushing in the vertical runners such that they were better aligned to minimise the gaps between the vertical runners. Photographs 2 and 3 showed that the runners, particularly those nearer to No 72, were rather poorly laid. I did not accept the explanation offered by DW6 that the runners were inserted at an angle to avoid the cable ducts from the electrical box because the misalignment stretched over a considerable length of the trench away from the electrical box. Photographs 55 and 56 also showed the extent of the misalignment. Some of the black soil could be seen seeping though the gaps. The misalignment here obviously could not be the result of avoiding any electrical ducts as some of the runners were vertical and some were not. I would have expected them to be similarly angled if indeed there were any electrical ducts running parallel to the length of the

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trench line. In fact, DW5 stated in his investigation report that there was lateral movement with the timber planks giving way as could be seen in photographs 55 and 56 which he took. Whether the misalignment was due to the poor construction or subsequent giving way of the timber planks, it would not have been acceptable in any case.

175. Although I accepted that it was not possible to lay a ruler-straight line of runners, nevertheless I think the workmanship of the defendants was something less than acceptable judging from the ordinary standard of a reasonably competent contractor. Photographs 10 to 16 of D9 taken at another construction site would be a good example of what I considered to be the construction standard that I would expect from a reasonably competent contractor. In my opinion, the defendants were negligent in their erection of the vertical timber runners that were not properly aligned or were giving way.

176. The rather poorly erected timber runners allowed seepage and loss of soil from the sides of the trench wall into the trench. The greater lateral soil pressure nearer the trench bottom would force more soil out through the gaps between the misaligned timber runners. The wider gaps also allowed the underground water seeping through to carry more soil into the trench.

177. DW4 said that the main job on 12 January 1996 was the removal of silt and debris from the trench. The workers used spades and buckets to remove the silt and sludgy soil. They took the whole day to do that. It is important to note that the excavation of the trench was completed 3 days earlier on 9 January 1996. Bakau piling was done on 10 and 11 January 1996. If there was no soil leakage into the trench, there would have been little need to spend so much time to dig out the silt around the bakau piles. DW4 appeared to suggest that the silt

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formation was caused by pumping water out of the trench which stirred up the silt.

178. In my opinion, the inlet suction of the pump might have caused some localised disturbance of the water and soil near that inlet suction head. But that would not need nearly the whole day to resolve. The extensive work suggested to me that a substantial portion of the entire length of the trench must have silted up. Clearly, there must have a fair amount of soil leakage into the trench throughout its entire length after the excavation had been completed on 9 January 1996. I also noted that the cracks appeared on 14 January. Thus there was sufficient opportunity for the soil or soil mixed with water to continue to seep through the poorly aligned timber runners into the trench for 5 more days before the cracks eventually appeared. However, I did not think that the loss of soil was so significant as to have been the sole or major cause of the new cracks in the house.

179. The loss of soil into the trench due to the poor shoring construction was only a minor contributory cause.

Collapse of the trench

180. The plaintiff had taken out summary judgment proceedings against the defendants sometime in June 1996. In all the affidavits and documents filed in the Order 14 hearing and in the appeal that followed, there were no allegations that the trench had collapsed.

181. DW2, who was first engaged by the plaintiff to conduct a structural survey and identify the possible causes of the cracks, testified that no one told him that the trench had collapsed. If indeed there was such a major mishap as a complete

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collapse of the trench shoring and the trench wall, counsel and DW2 would likely have been told of it. The allegations would probably have surfaced in the Order 14 affidavits but did not.

182. After the cracks appeared, the contractor, the engineers and site supervisors visited the premises on a few occasions. Those of them who testified said they were not told that there had been a collapse of the trench. Again that omission was quite telling.

183. Further, DW4 would probably have recorded that event in his site diary if there had been a collapse. His superiors would be notified accordingly. Giving way of the timber planks would have endangered the lives of the workers working at the bottom of the trench. It would be of concern to the Sewerage Department of the Ministry of Environment. Work would likely be stopped. I could not see how DW4 could have simply swept that incident under the carpet.

184. It was only at the trial that PW1 alleged for the first time during his cross-examination that it rained heavily one evening and black soil flowed out continuously from the sides of the planks into the trench. The contractors kept digging out the soil and transported the soil away by trucks. I had difficulty accepting this evidence. It seemed improbable that this witness would be standing in the heavy rain in the evening to observe what was happening inside the trench. It would also take extremely good eyesight to see black soil flowing out from the gaps between the planks into the presumably dark trench that evening. Furthermore, why should the workers be working in the heavy rain in the evening to dig out the soil?

185. The plaintiff, PW2, alleged that during a heavy downpour, the walls of the trench collapsed completely and the trench was filled with mud. The defendants

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simply removed the mud and continued with their excavation. The struttings and other supports were only put up after the trench was excavated. According to PW2, the cracks appeared **before** the trench collapsed. When asked how extensive was the collapse, she said that a few planks collapsed. When the contractors pulled out the collapsed planks, earth fell into the trench. Strangely, she never told her son PW1 of the collapse. Yet she told the other son PW3, who did not stay with her.

186. If it were true that the cracks appeared before the trench had collapsed, then the cause of the cracks could never be attributed to the collapse. Her evidence that the cracks appeared **before** the collapse was contradicted by PW3. This material contradiction gives me some ground to doubt the truth of their allegation.

187. PW3 said in his affidavit evidence-in-chief that a few days after the defendants began digging, the walls of the trench completely collapsed. At least 80% of the vertical planks were no longer vertical. The defendants quickly put up the boards and horizontal struttings at the trench. They even brought soil to fill the gaps to make the sides appear straight and hide the fact that the trench had collapsed. A few days after the collapse, the cracks in the premises surfaced.

188. On the next morning, they were still stuffing in the yellow soil and putting in the cross beams and horizontal beams. They continued for 3 mornings and 2 afternoons. On the third morning, they completed erecting the horizontal and cross beams. It was a big job according to PW3. When put to him that there was no such collapse of the trench, PW3 said it was true as he saw it with his own eyes.

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189. I noted that PW3 was not a particularly reliable witness. He was obviously wrong when he testified that he saw the trench being dug from the front of the house to the back of the house.

190. I compared the sequence as described by PW3 with the diary of events kept by Mr Ngeow. According to that diary, excavation commenced on Friday 5 January 1996. By the end of Tuesday 9 January 1996, excavation was completed and they started bakau piling on 10 January 1996.

191. If the collapse had occurred a few days after the excavation had commenced and it took another 3 mornings and 2 afternoons to stuff in the yellow soil and put in the cross beams and walers, then the work schedule would have gone way past the 10 January 1996, the date they started the bakau piling. The delay in the work for 2 days would have shown up in the site diary. The diary could not have reflected 10 January 1996 to be the date that bakau piling commenced. Were the contractor to bring such an enormous amount of soil to do stuffing for 3 mornings and 2 afternoons, Mr Ngeow would most certainly have noticed. Mr Ngeow testified that he did not see the contractor stuffing yellow soil into the gaps.

192. The continuous lorry loads of yellow soil were probably those brought in by the defendants to backfill the trench after the new sewer pipe was laid and not that used to stuff the alleged gaps in the ground after the sides of the trench had collapsed.

193. DW1 took measurements of the inclination of the boundary wall at No 72 using a plumb line. He found that it was still vertical within the construction tolerance of about 5 mm for the distance of a man’s height. I had no reason to suspect any error in these measurements. In my view, if there was a major

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collapse of the trench with significant loss of soil from the sides of the trench, the failure would have caused serious cracks and more pronounced tilting of the boundary wall, which was only about 1.4 m from the edge of the trench and well within the slip circle failure zone. The fact that the boundary wall and the drain-lines were relatively unaffected indicated that there was no serious loss of soil into the trench arising from a collapse.

194. For the reasons given, I was not inclined to believe that there was an almost total collapse of the trench as described by the witnesses for the plaintiff. In my opinion, this fact was not proved on a balance of probability.

195. Neither did I accept the evidence of the plaintiff's witnesses that the defendants had not used cross-beams or struts to support the trench timber runners forming the walls of the trench prior to its collapse. I had no reason to disbelieve Mr Ngeow who gave a good description of how the defendants proceeded to do the work from the first day of excavation on the 5 January 1996 to the 19 January 1996 when the trench was backfilled upon completion of the work.

196. PW3 said there were no horizontal struts and walers used in the trench shoring. From the computations and the evidence of the expert witnesses PW4 and DW1, I came to the conclusion that the unsupported vertical timber runners would have almost immediately fallen into the trench as the toeing in of a mere 3' into the soft soil at the bottom of the trench would not be able to sustain the side loading on the timber runners for a trench dug to the **full depth** of 2.7 m. Clearly, the plaintiff's witnesses were embellishing and exaggerating the facts in an attempt to strengthen their case.

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197. As for the initial incomplete strutting, there was obviously no need to fully strut the walers when they started digging and the trench was still shallow. The lateral forces would be much lower and hence the full system of struts would not be necessary at that stage. But when a depth of about 6' was reached, I believed that the defendants had put in place all the required walers and struts in accordance with the design approved by the professional engineer, before they continued digging manually to the full trench depth of 2.7 m (or about 9').

198. I also did not accept the evidence of PW3 that the timber runners in the trench initially were not that shown in photographs 2 and 3 but the thinner and broader timber planks that could be seen lying on the ground adjacent to house No 70. I was inclined to believe the evidence of the defendants' witnesses that those timbers were for the concrete formwork and were never used as timber runners for the trench.

Alternative methods of construction proposed by PW4

199. I accepted the expert opinion of DW5 from Presscrete Engineering Pte Ltd. that jet grouting might not be suitable nor effective because of possible ground displacement due to the shallow depth of the soil treatment, which in turn could cause cracks to nearby structures. Further, the acidic peaty clay might weaken the jet grout columns.

200. Pipe jacking method was obviously too expensive a method to use for the short length of sewerage pipe replacement adjacent to No 72. Plaintiff's counsel quite rightly abandoned pushing this point in his submission.

Existence of ground subsidence

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201. I accepted the survey results of PW5 that the gradient was 1:38 for the apron area sloping towards the trench. The survey showed that the apron at the boundary wall was 6.6 cm lower than that at room 1A i.e. the apron slab sloped towards the boundary wall. I also accepted the opinion of PW4 that a gradient of 1:38 was not a normal construction gradient. Although there was no survey conducted prior to the construction of the trench, it was reasonable to infer that the evidence of the unusually steep gradient of the apron slab falling towards the trench indicated that there was settlement of the ground due to soil subsidence, which generally increased as one approached the trench.

202. In this case, there was no evidence of any earthquakes. The house was not hit by hurricane or by other external forces above the ground. Nothing heavy dropped on the building or apron slab to cause the kind of cracks shown in the photographs. The only identifiable cause of the cracks was ground settlement. The cracking was itself a manifestation of the soil subsidence having taken place beneath the structure.

203. The defendants could not seriously dispute that the cracks were not caused by subsidence. In fact, defendants' counsel in his submissions agreed unequivocally that if there were new cracks, they were caused by soil subsidence.

204. On the totality of the evidence, I found that soil subsidence had occurred underneath the premises during the excavation of the trench by the defendants.

205. The next obvious question was who caused the ground subsidence. It must follow that whoever caused the ground subsidence did cause the new cracks to develop in the premises.

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Whether the defendants caused the subsidence and the resulting cracks

206. The defendants were the only ones excavating near the premises. They had full control of and were entirely responsible for the excavation. There was no other trench being dug around the vicinity that could account for the loss of soil or a lowering of the water table, which in this case, were the only traceable causes of soil subsidence.

207. Counsel for the defendants categorically stated that it was their case that the cracks were caused by the drawing of water from the trench, resulting in a lowering of the water table, thereby causing settlement and this drawing out of the water was by the defendants. (See page 25 of the Notes of evidence at the adjourned hearing on 16 March 1998.) It was therefore not disputed that dewatering of the surrounding soil did cause settlement of the ground which in turn caused the affected structures to crack.

208. The defendants' Managing Director, DW6, admitted that water was pumped out of the trench every morning for 40 to 45 minutes via a 2 " diameter sump pump. When done over a period of several days, it was sufficient in my opinion to cause the surrounding ground to settle. This I believe was the **major cause** of the extensive cracking to the house. I accepted the evidence of the defendants' own expert witness DW1 that the influence zone of dewatering for settlement was more extensive than that for soil loss.

209. On a balance of probability, I found that it was the defendants who caused the ground subsidence and new cracks by:

(a) pumping out water from the trench thereby lowering the water table in the immediate vicinity of the premises; and

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(b) allowing loss of soil from the side of the trench adjacent to the premises because of the seepage between the rather poorly constructed timber shoring.

Second issue: whether the plaintiff could maintain an action in negligence where what was abstracted was water percolating underground in undefined channels

210. Given my finding that the major cause for the ground subsidence was the pumping out of water from the trench, I had to determine whether such actions of the defendants were actionable. The defendants' case was based largely on the somewhat peculiar rule in *Acton v Blundell* [1834] 12 M. & W. 324, viz. that the owner of the land owed no duty to prevent the subsidence of his neighbour's land caused by the abstraction of water, percolating underground in undefined channels. The defendants relied on the following passage in Clerk & Lindsell at para 18-75:

There is no right to have land ….. supported by water. Therefore to pump out percolating water from excavations and to cause thereby damage to a neighbour's building by ground subsidence is not actionable as a nuisance, and this is so whether an injured party claims in nuisance or in negligence. There is no duty of care to a neighbour, in abstracting percolating water, to avoid causing subsidence.

211. In *Acton v Blundell*, the plaintiff sunk a well in his property for raising water for the working of his mill. Subsequently the defendant sunk two coal pits in his land adjacent to the plaintiff's. The result was that the supply of water to the plaintiff's mill was considerably diminished and the plaintiff sued for interference with his right of enjoyment of the water flowing under his land. Tindal CJ held:

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… we think the present case … is not to be governed by the law which applies to rivers and flowing streams, but that it rather falls within that principle, which gives to the owner of the soil all that lies beneath his surface; that the land immediately below is his property, whether it is solid rock, or porous ground, or venous earth, or part soil, part water; that the person who owns the surface may dig therein, and apply all that is there found to his own purposes at his free will and pleasure; and that if, in the exercise of that right, he intercepts or drains off the water collected from underground springs in his neighbour's well, this inconvenience to his neighbour falls within the description of damnum absque injuria, which cannot become the ground of an action'.

212. *Acton v Blundell* had been applied in England in *Langbrook Properties Ltd v Surrey County Council* [1970] 1 W.L.R. 161, in *Stephens v Anglian Water Authority* [1987] 1 WLR 1381 and locally in *Singapore Finance Ltd v Lim Kah Ngam (S'pore) Pte Ltd. & Eugene H.L. Chan Associates (Third Party)* [1984] 2 M.L.J. 202. In *Langbrook Properties*, the plaintiffs claimed damages for nuisance and negligence against the defendants, and alleged that by pumping out excavations on land in the vicinity of the plaintiffs' land, the defendants had abstracted water percolating beneath the plaintiffs' land. Plowman J held that the plaintiffs had no cause of action since the defendants were entitled to abstract the water under their land percolating in undefined channels to whatever extent they chose, notwithstanding that this resulted in the abstraction of water percolating beneath the plaintiffs' land and thereby caused damage.

213. The rule in *Acton v Blundell* would be inapplicable if the right of support that was abstracted was silt or wet sand or other partially liquid substance. The owner did not have, as an incident of his ownership at common law, the equivalent right to have the surface of his land supported by water: *Popplewell v Hodkinson* (1869) L.R. 4 Ex. 248. However the owner had a right to the

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support of his land in its natural state from the adjacent and subjacent land of the neighbouring owners. In *Jordeson v Sutton, Southcoates and Drypool Gas Co.* [1899] 2 Ch 217, where the substance abstracted from beneath the plaintiff's land was not water but running silt, resulting in subsidence of the surface, the defendants were liable for the consequent structural injury to the plaintiff's houses. Here what was abstracted was not totally percolating underground water; the premises were supported by ground consisting largely of peaty clay with a high moisture content (silt), where it was below the water table. Water together with a fair amount of silt found its way into the trench and these were pumped out or removed from the trench by the defendants. The defendants therefore could not rely on the rule in *Acton v Blundell.*

214. In the case of *Cabot v Kingman* 166 Mass. Rep. 403 decided by the Supreme Court of Massachusetts, Field C.J, said:

Whatever may be true of percolating waters, we think that the defendants had no right to take away the soil of the plaintiff in land which they had not taken under the statutes, and that it is immaterial that the soil was removed by means of pumps from the trench into which it had fallen by its own weight, or had been carried by percolating water. We are unable to distinguish the case from one where the soil falls in from the surface in consequence of an excavation in the adjoining land. The plaintiff, if the facts be as he offered to prove, has been deprived of the lateral support to his land, in consequence of which the quicksand has run from under the surface of his land into the trench, and has been removed by means of pumps, and this has caused the surface to settle and crack. It was the duty of the defendants to prevent this in some manner, if they did not take the plaintiff's land.

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215. Given my finding that what was abstracted was not purely percolating water under the plaintiff's land, it was strictly not necessary to decide if the rule in *Acton v Blundell* was applicable in Singapore. However as there were extensive arguments before me and for completeness, I would deal with that question. Counsel argued that the common law rule found in *Acton v Blundell* was binding on the Singapore High Court, relying on Lai Kew Chai J's decision in *Singapore Finance.* Lai J held at p 205:

In my considered opinion, the English common law which was first declared in *Acton v Blundell* is received into and is a part of the law of Singapore. Having regard to the reasons in support of the rule in *Acton v Blundell* which I had examined and which operate with particular force and validity between neighbouring owners, whose respective rights have to be given due weight and carefully balanced, I am of the view that that the Canadian case of *Pugliese* has no application to and bears a crucial distinction from the case before me…

216. To determine whether *Acton v Blundell* was indeed binding on me, the issues of stare decisis and reception had to be carefully examined. No assistance could be obtained from the Application of English Law Act (Cap 7A) ('AELA'). Section 3 of the AELA merely preserved the position as it stood prior to the repeal of section 5 of the Civil Law Act (Cap. 43). Section 3 AELA provides that:

(1) The common law of England (including the principles and rules of equity), so far as it was part of the law of Singapore immediately before 12th November 1993, shall continue to be part of the law of Singapore.

(2) The common law shall continue to be in force in Singapore as provided in subsection (1), so far as it is applicable to the circumstances of Singapore and

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its inhabitants and subject to such modifications as those circumstances may require.

217. Hence the applicability of the common law of England continued to be governed by the position prior to 12th November 1993. The common law was received into Singapore only via the Second Charter of Justice 1826 and under section 5 of the Civil Law Act.

218. Section 5(1) of the Civil Law Act (since repealed) is as follows:

(1) Subject to this section, in all questions or issues which arise or which have to be decided in Singapore with respect to the law of partnerships, corporations, banks and banking, principals and agents, carriers by air, land and sea, marine insurance, average, life and fire insurance, and with respect to mercantile law generally, the law with respect to those matters to be administered shall be the same as would be administered in England in the like case, at the corresponding period, if such question or issue had arisen or had to be decided in England, unless in any case other provision is or shall be made by any law having force in Singapore.

219. *Acton v Blundell*, which dealt with the law of negligence and nuisance, clearly was not dealing with matters relating to mercantile law and as such, could not have been received under section 5 of the Civil Law Act.

220. Was *Acton v Blundell* received via the Second Charter of Justice 1826? *Acton v Blundell* was decided after the Second Charter of Justice 1826. It was a decision of the Court of Exchequer Chambers in 1843, a court of error from all the three common law courts (Court of Exchequer, Court of Common Pleas and Court of King's Bench). It was the first English decision which laid down that

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rule. Tindal CJ refused to follow the earlier decisions governing surface stream which provided that the owner could not diminish the quality of water that naturally flowed through his land. If Lai J in *Singapore Finance* was right in holding that the rule was received and was part of the law in Singapore, it could only be that it was received as part of the unwritten common law prior to 1826. This would mean that the common law was received as a continuing basis under the declaratory theory of the common law. Under such a theory, this rule would be considered to have always existed in England and therefore, it could be said that it must have come to Singapore under the Second Charter. This would mean that all common law decisions in England after 1826 are still being received into Singapore today by virtue of the Second Charter. It is doubtful that is the correct legal position.

221. The case law supports the plaintiff's proposition that post-reception common law decisions in England would not be binding. In *Jamil bin Harun v Yang Kamsiah Bte. Meor Rasdi* [1984] 2 WLR 668, a Privy Council decision from Malaysia, it was argued that the common law of damages in *Lim Poh Choo v Camden & Islington Area Health Authority* [1979] 2 All E.R. 910, H.L. (E) was inapplicable because it was decided after 1956. Malaysia has the Civil Law Act 1956 which provided for the reception of English common law at a cut-off date of 7 April 1956; this is similar to the cut-off reception under the Second Charter of Justice 1826 that we have. The Privy Council held that the English authorities after that date were only persuasive but not binding in Malaysia. It follows that English authorities post 1826 would continue to be highly persuasive in Singapore but they are not binding on the Singapore courts. Academic views also support this conclusion: see Walter Woon, *The Singapore Legal System* (1989) Chapter 4.

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222. The result then is that I have to consider whether the Singapore courts should adopt the rule in *Acton v Blundell* as a matter of choice. On careful consideration, I came to the conclusion that it should not be the law of Singapore. With respect, I found myself unable to agree with Lai J's decision on this point. In *Acton v Blundell*, the plaintiff complained of being cut off from the water caused by the defendants' action; it was not a claim of physical damage to his land caused by loss of support. However, subsequent case law on the problem of subsidence resulting from the abstraction of underground water came before the English courts in *Popplewell v Hodkinson* (1869) LR 4 Ex 248, which was followed in *Bradford Corporation v Pickles* [1895] AC 587 and in *Langbrook.* These cases extended the principle in *Acton v Blundell* to one where there was no right of support of land from water.

223. In my opinion, this extension does not appear to be justifiable as it went beyond a case of abstraction of subterranean water causing the plaintiff loss of supply of that water, to one where the abstraction of underground water causes ground subsidence and structural damage to existing buildings on the plaintiff's land. With respect, I find myself unable to agree with Slade LJ in *Stephens v Anglian Water Authority* [1987] 1 W.L.R. 1381 where he said that it was a 'distinction without any real difference'. I do not think that the rule in *Acton v Blundell* can be justified today. It may be that in old England, the courts had to take into account the right of the landowner to extract water percolating underground for drinking purposes and farmland irrigation. Even if soil subsidence of adjacent farmland resulted, I do not think the damage, if any, would be significant. I think that the rule is clearly ill-adapted to conditions in Singapore, where many areas are densely built up, with adjacent buildings very close to, if not adjoining each other, and where there is hardly anymore open land farming activities being carried out. Drinking water is no longer drawn

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from wells sunk into the ground. Water is supplied by an extensive system of water pipes to distribute water to all who need it.

224. I am not inclined to follow *Acton v Blundell* because there is insufficient consideration given to the rights of adjacent land owners. One has to balance the rights of a landowner to have support and the proprietary right to exploit one's land e.g. the right to pump water: *Jordeson v Sutton.* Rigby L.J. expounded the limitations as follows:

There are two doctrines sufficiently indicated by the maxims "Cujus est solum ejus est usque ad inferos," and "Sic utere tuo ut alienum non laedas," which have to be considered. These doctrines, driven to their logical extreme, are irreconcilable. Some practical limitation of one by the other has to be arrived at. The first doctrine gives everything below the surface to the landowner; but it has been settled that by reason of the second doctrine he cannot take away his own minerals with the result of letting down his neighbour's surface, or ancient buildings on his neighbour's land, to the damage of that neighbour, without being liable, so long as he remains in possession of the chamber from which the minerals have been withdrawn, to an action by that neighbour. Here is one plain and important limitation of the landowner's right.

225. The right to exploit on one's land should always be qualified by the law of nuisance and negligence. I see no reason why the abstraction of water should be immune from that qualification when there is careless conduct that causes foreseeable physical harm to one's neighbour. In my opinion, extraction of minerals, water and silt must yield to the neighbour's right of support, where the loss of that support causes physical damage. Regard must be had to the interest and rights of neighbouring land owners. In civil society, a rule that allows unqualified exploitation or use of one's land in total disregard of

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whatever consequences that may have on neighbouring land owners would hardly be acceptable. Discord and disharmony among neighbours would arise if proper consideration is not given to both competing rights.

226. How the court tried to balance the rights of adjoining house owners can be seen in the case of *Brace v South East Regional Housing Association* [1984] 270 EG 1286. The plaintiff there brought an action based on nuisance and negligence against the owners of an adjoining house. This adjoining house was demolished and the owners converted what had been a party wall into a flank wall. The demolition allowed the subjacent clay to be exposed to atmospheric conditions. When the moisture dried out, there was shrinkage in the soil. Cracks in the walls and ceilings of the plaintiff's house developed which indicated subsidence and a loss of support for the house. The Court of Appeal considered *Jordeson v Sutton* and *Langbrook Properties v Surrey CC*. On the question of liability in nuisance for the interference with a right of support, the Court assumed that there was no right to support of water itself. However in that case, the plaintiff had acquired a right of support by the party wall belonging to the defendants. That wall depended on support from the clay soil. By altering the conditions and changing the land such that the moisture in the clay dried out, the defendants were held liable as they had interfered with and weakened the support that had been provided. The court distinguished between one who took water in some quantity from the land where it was found to be percolating and one who dried out the moisture content of the clay.

227. Counsel for the plaintiffs referred me to decided cases in other jurisidictions, which were of much assistance to me. I noted that *Acton v Blundell* had not been followed in Canada and had been disapproved in Australia. In *Pugliese v National Capital Commission* (1977) 79 DLR (3d) 592, an extensive review was made of the English and American decisions after

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Acton v Blundell. The defendants were constructing a collection sewer and had to pump subterranean water. The pumping caused the differential settlement over the base of the plaintiffs' homes, and the foundations of the homes suffered cracking. They sued in negligence and nuisance. The Ontario Court of Appeal held at p 615 as follows:

While recognising the well-settled English rule as to the abstraction of percolating water, I consider that recognition should be given at the same time to the equally well-settled doctrines in the law of torts which impose liability for property damage caused by negligence and nuisance. To conclude that those who abstract percolating water have an unbridled licence to wreak havoc on their neighbours would be harsh and entirely out of keeping with the law of torts as it exists today…

With reference to the question referred to this Court, an owner of land does not have an *absolute* right to the support of subterranean water which is not flowing in a defined channel so that damage caused by the abstraction of such water automatically gives rise to a cause of action. His neighbour in the user of his own land has a right to abstract such subterranean water for his own use which may have the effect of removing the support of the water under adjoining land; but, similarly, the neighbour's right is not an absolute right.

In order for the plaintiffs to succeed in their actions they must, in my opinion, have a right which the law deems worthy of protection: see Restatement of the Law of Torts Second, 1965, s. 1, p.2. While the plaintiffs do not have an absolute right of support, I consider that they have a right not to be subjected to interference with the support of the water under their respective lands, amounting to negligence or nuisance. Infringement of that right can give rise to a cause of action in nuisance or negligence.

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228. Hence it was not an absolute defence that the interference was only with the right to support from subsurface water. The Court held that the plaintiffs had causes of action in negligence and nuisance. There was a duty of care owed by the defendants because the defendants ought to have foreseen the risk of harm suffered by the plaintiffs. For nuisance, the question was whether the defendants' conduct was reasonable, considering the fact that he had a neighbour.

229. In *The Mayor, Councillors And Citizens of Perth v Halle* (1911) 13 C.L.R. 393, the High Court of Australia disapproved of *Acton v Blundell*. The appellants, a statutory authority, constructed a drain in a public street. As it was poorly constructed, there were holes in the drain. Large quantities of sand and water found their way into the drain and were carried away from the adjoining land thereby causing the loss of support. Houses fronting the street suffered from cracks. The appellants were held to be liable. *Acton v Blundell* was distinguished on the ground that the appellants were not adjoining owners of the soil of the street. The appellants derived their powers from the Statute and their rights to the land were only those as were authorized by the Statute. Their power was to drain the streets properly and not to drain the subsoil of surrounding localities. Griffiths CJ expressed the view that the appellants were not protected by the doctrine of *Chasemore v Richards* 7 H.L.C. 349 and *Popplewell v Hodkinson* where the work constituted a nuisance by reason of its negligent construction or maintenance by the appellants. Where the appellants exceeded their powers, they were in no better position than a mere wrongdoer creating a public nuisance in the street. However, O'Connor J, by way of dicta, restricted *Acton v Blundell* by holding that the landowner had a right to have his land supported by underground water and was entitled to assert that right of support, which was one of incidents arising out of his ownership, against the whole world

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except for the adjoining landowner. He said however that 'even the latter is entitled to interfere with the full enjoyment of the right **only when** the lawful use of his own land necessarily involves that interference'.

230. None of the justifications for upholding *Acton v Blundell* is compelling. In *Jordeson*, Vaughan Williams LJ supported the ruling in *Acton v Blundell* as he held that it was practically impossible to predict at what point or at what distance the withdrawal of the equal pressure of the water might cause subsidence in the soil previously affected by water pressure. However this justification is hardly justifiable today. *Jordeson* was decided in 1899 and nearly a 100 years have since passed. As pointed out in *State v Michels Pipeline Construction, Inc* (1974) 217 N.W. 2d 339, quoted in *Pugliese*, 'today scientific knowledge in the field of hydrology has certainly advanced to the point where a cause and effect relationship can be established between a tapping of underground water and the level of the water table in the area so that liability can be fairly adjudicated consonant with due process.' I might add that modern engineering techniques have also advanced to the point where proper methods are available to minimise the risk of damage to adjacent properties through dewatering.

231. Should I be wrong in not adopting the principle laid down in the line of cases following *Acton v Blundell* and that indeed the owner of land, in law, had unlimited right to abstract for his own use or drain away as much subterranean water from under his land as he wishes, without any regard as to whether his exercise of that right was reasonable or not, and whether it would cause physical damage to the owner of adjacent land through the loss of support by that water, I would still have held the defendants liable because the defendants, in constructing the trench line, had no authority from the MOE to cause physical damage to neighbouring property by draining away the subterranean water. Neither were they the owners of the land exercising their proprietary right as

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owners. Thus, they did not strictly come within the principle in *Acton v Blundell* nor the extended principle in *Chasemore v Richards* and *Popplewell v Hodkinson* in my view.

The third issue: Were the acts of the defendants negligent

232. The excavation work was carried out by the defendants' workers including DW6. Counsel for the plaintiff argued that the defendants ought to have taken precautions when pumping the water and silt from the trench. The standard of care required of the defendants was that of a reasonably competent sewerage contractor. The classic statement was that by McNair J in *Bolam v Frien Hospital Management* [1957] WLR 582 at page 586: ' The test is the standard of the ordinary skilled man exercising and professing to have that special skill. A man need not possess the highest expert skill; it is well established law that it is sufficient if he exercises the ordinary skill of an ordinary competent man exercising that particular art.'

233. Had the defendants shown reasonable care and skill expected of a reasonably competent sewerage contractor? I did not think so.

234. Any reasonably competent contractor involved in sewerage works should be able to foresee the natural and probable consequences of (a) not properly constructing the timber shoring, which allowed loss of supporting soil into the trench from adjacent ground, and (b) pumping out substantial quantities of water together with silt with no precautionary measures taken against the deleterious effects of dewatering. Having seen the rather poor soil conditions in the area where the trenching works were to be carried out, and the closeness of the trench to the premises, the defendants ought to have ensured that his workers constructed the shoring properly and that proper and adequate precautions were

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taken to prevent damage to adjacent properties arising from loss of ground support through subsidence.

235. The necessity of pre-construction site surveys and insurance requirements showed that it was inherent in such excavation work that damage might be caused to neighbouring premises. It was not as if such damage was normally considered to be unlikely or remote. Hence, it was incumbent on the defendants to ensure that all appropriate measures were put in place to minimise the possibility of soil subsidence, which could lead to cracks in floors and structures of neighbouring premises. In this case, that subsidence did cause the serious cracks in the premises. The causal link to the defendants' negligence was clear.

236. It was common ground that no precautions were taken to prevent or minimise the effects of dewatering. One common measure that could have been taken was recharging, which was not expensive. As described by PW4, this method involved drilling holes to insert perforated pipes into the ground. Instead of discharging the water away, it could be pumped back into the surrounding ground area through these pipes. By recharging, the water table in the vicinity of the excavation would not be lowered unnecessarily. If such precautions were not taken, particularly when the soil condition was poor as in this case, there was obviously a much greater risk of soil subsidence causing cracks to affected structures. If the defendants chose to take no precautions and run this risk, which clearly was foreseeable, then they must be made to bear the consequences of their negligence in my opinion.

237. As stated earlier, the loss of soil from the side of the trench through seepage arose because of the rather poorly constructed timber shoring. Although I considered this to be a minor contributory factor for the cracks, nevertheless,

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the defendants must still be held liable for the negligently constructed timber shoring.

238. In the circumstances, I found that the defendants were negligent in their excavation as they had failed to take adequate steps to erect proper timber shoring and to take precautionary measures against the effects of dewatering. The defendants had failed in their duty to take reasonable care in carrying out the excavation.

Res ipsa loquitur

239. Counsel for the plaintiff relied on the doctrine of res ipsa loquitur to establish that there was negligence on the part of the defendants. This doctrine is but a rule of evidence and not a principle of law: *Lloyde v West Midlands Gas Board* [1971] 2 All ER 1240, approved in *Keller Piano Co (Ltd) v Management Corp Strata Title No 1298* [1995] 1 SLR 355. It was clear that the doctrine only applied where the cause of the damage was not known. In such a case, where the occurrence was such that it would not have happened without negligence and what inflicted the damage was under the sole management and control of the defendant, it followed on balance that the defendant must have been negligent: *Scott v London and St Katherine Docks Co* (1865) 3 H. & C. 596. The prima facie case of negligence against the defendant was then established and the defendant would have to rebut the case by showing he was not negligent. However where there was evidence showing how the occurrence took place, res ipsa loquitur was inappropriate. In *Barkway v South Wales Transport Co., Ltd* [1950] 1 All E.R. 392, the Court of Appeal held that the doctrine was dependent on the absence of explanation, and although it was the duty of the defendants to give an adequate explanation of the cause of the accident, however, if the facts were sufficiently known, the question ceased to be one where the facts spoke

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for themselves, and the solution was to be found by determining whether, on the facts as established, negligence was to be inferred or not.

240. In this case, there was evidence to show that the cracks in the plaintiff's house were caused by subsidence, and the subsidence was due to the combined effects of dewatering and loss of soil through the gaps in the poorly constructed trench shoring by the defendant. The court would then have to determine whether the defendant was negligent on the evidence, and I found he was indeed negligent. All the facts of the occurrence were known.

Cause of action for nuisance: Liability for Nuisance

241. Counsel for the plaintiff further argued that the defendants were liable for nuisance by its excavation on the land adjacent to the plaintiff so as to cause subsidence to the plaintiff's premises. I have found that the defendants had pumped out substantial quantities of water from the trench thereby lowering the water table in the immediate vicinity of the premises. The water pumped out had included silt some of which had found its way into the trench through the gaps in the poorly constructed shoring. This caused the surrounding ground including the premises to settle, and that settlement was the cause of the extensive cracking to the house.

242. For the claim in nuisance to succeed, the plaintiff had to show that there was unreasonable use by the defendant of his land to the detriment of his neighbour. In determining whether the use of land was reasonable, the question was not so much whether the defendant had taken reasonable care when using his land. Rather, the focus is on whether the plaintiff's enjoyment of the land has been unreasonably interfered with bearing in mind the nature of the defendant's activity and the kind of precautions that could have been taken. All

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the circumstances of the case must be considered. However, where there is physical damage to the neighbour, as opposed to intangible damage, the balance usually tips in the plaintiff's favour.

243. If the interference is unreasonable by any standard, then the fact that all the necessary care had been taken is no defence to an action in nuisance. Negligence on the part of the defendant is not a prerequisite to liability in nuisance. As held by Lord Goff in *Cambridge Water Co. Ltd v Eastern Counties Leather plc* [1994] 2 AC 264, where a nuisance has been created by one for whose actions the defendant is responsible, 'it is still the law that the fact that the defendant had taken all reasonable care will not itself exonerate him from liability, the relevant control mechanism being found within the principle of reasonable user'. However liability in private nuisance is still not a strict or absolute liability. If the damage was of a type which the defendant could not reasonably foresee, he would not be liable. In that case, the defendants were not liable for pollution of the underground water supply caused by seepage into it of chemical accidentally spilt during their leather tanning process, on the ground that seepage had not been foreseeable.

244. That does not mean that negligence is never relevant. Where the defendant has been negligent this may be evidence of unreasonable user, since it is not reasonable to expect adjoining owners to put up with interference that could be avoided by the exercise of reasonable care. Consider first the situation as set out in *Clerk & Lindsell* para 18-33: If the defendant deliberately or recklessly uses his land in a way which he knows will cause harm to his neighbour, and that harm is an unreasonable infringement of his neighbour's interest in his property and hence being an unreasonable user of his property, the defendant is liable for all the foreseeable consequences. It is no defence to say that the defendant has taken all possible steps to prevent his activity from amounting to a nuisance:

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Read v Lyons & Co Ltd [1947] AC 156. However where the nuisance is not obvious but develops as a result of the defendant's lawful activity that goes awry, he would be liable if he was negligent in that he ought to foresee the likelihood of the mishap and damage. In such a case, liability in negligence and nuisance coincide.

245. The key is to determine what constitutes reasonable use of the land. Pumping of water does not per se constitute a nuisance. However where pumping of a large quantity of water especially when abstracted in a negligent manner thereby causing damage to the plaintiffs' properties through subsidence, it constituted a nuisance. Any competent contractor should have taken the required precautions to minimise the possibility of soil subsidence particularly in poor soil conditions.

246. The minimum that the defendants ought to have done was to recharge the water that was pumped from the ground into perforated pipes sunk into the adjacent ground in order to replenish the water that had been pumped up. I accepted that the alternative precautionary measures of pipe-jacking or pressure cement grouting were impractical or unsuitable for the kind of work in question. However the defendants did not even attempt to take any precautions even though they knew the soil condition in that area was poor. Pumping large quantities of water in such a negligent manner would constitute an unreasonable user of the land in relation to the neighbours. This went beyond that which the plaintiff could reasonably expect to tolerate. There was no doubt that the damage in the form of subsidence was the type of damage that was reasonably foreseeable by the defendants when they pumped out large quantities of water without taking any precautionary measures. There was no doubt in my mind that the defendants should have forseen that uneven settlement of building structures due to subsidence would cause cracks. It was not surprising if water

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seeped into the room when it rained because of the cracks at ground level between the walls and the floors and if some of the doors could not be properly closed due to misalignment arising from the settlement of the ground. Clearly, there would be much inconvenience to the plaintiff and other occupants of No 72. Such damage in my opinion were entirely forseeable by any reasonably competent contractor.

Conclusion

247. Since both negligence and nuisance had been proved by the plaintiff, I awarded interlocutory judgment for the plaintiff with damages to be assessed and costs to be taxed if not agreed.

SGD : CHAN SENG ONN

JUDICIAL COMMISSIONER

SUPREME COURT

Chan Seng Onn JC

Ronald Choo (Allen & Gledhill) for the plaintiff
Ang Kim Leong (Ang & Associates) for the defendants

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