

Management Corporation Strata Title Plan No 2757 v Lee Mow Woo (practising under the firm of Engineers Partnership)
[2011] SGHC 112

Case Number : Suit No 845 of 2008
Decision Date : 03 May 2011
Tribunal/Court : High Court
Coram : Lee Seiu Kin J
Counsel Name(s) : Tan Teng Muan, Wong Khai Leng and Sharifah Farhana Binte Hasan Alsagoff (Mallal & Namazie) for the plaintiff; Lee Chin Seon (C S Lee) and Ng Thin Wah (Timothy Ong Lim & Partners) for the defendant.
Parties : Management Corporation Strata Title Plan No 2757 — Lee Mow Woo (practising under the firm of Engineers Partnership)

Tort – Building and construction

3 May 2011

Judgment reserved.

Lee Seiu Kin J:

Introduction

1 The plaintiff is the management corporation of strata title no 2757, which is an industrial development known as Northlink Development (“the Development”) located at 10 Admiralty Street, Singapore 757695. The Development comprises three connected blocks of 6-storey light industrial buildings (“the Building”) subdivided into 545 individual subsidiary units. The defendant is a consultant engineer and he had carried out the civil, structural and foundation design for the Development.

2 The plaintiff’s claims against the defendant are in negligence – the plaintiff alleges that the defendant’s design of the Building was negligent and this had resulted in defects therein which require to be rectified. The alleged defects are in the following areas of the Building:

- (a) expansion joints and surrounding areas;
- (b) lift motor rooms; and
- (c) mezzanine floors.

3 In the course of the trial, the parties reached a settlement on items (b) and (c) with the defendant agreeing to pay the plaintiff damages of \$49,000 in relation to the lift motor rooms and \$5,225 in relation to the mezzanine floors. The trial then proceeded on item (a), viz the expansion joints and surrounding areas. This claim arose from cracks discovered at the ends of several beams as well as at the edges of some corbels which are protrusions from columns to support beams. In the run up to the trial, both parties prepared expert reports in support of their respective positions. At the commencement of the trial, the parties’ experts attended a series of hearings in chambers which resulted in an agreement on a substantial number of points in relation to their evidence, leading to a considerable reduction of the issues in dispute. In the event, the parties agreed that the issue turns on whether the defendant’s design of the corbel/beam configurations at the expansion joints and

surrounding areas ("the Design") is defective.

4 The nub of the plaintiff's case is that the Design was not in compliance with the requirements of the British Standards Institution's (BSI) Code of Practice BS 8110:Part 1:1985 ("the Code"), in particular cl 5.2 thereof. The effect of this provision is that the bearing pad (which sits between the beam and the corbel, and transfers the load from the former to the latter) may only be located within the area where the steel reinforcement bars ("rebars") are horizontal in both the beam and corbel. The reason offered by the plaintiff's expert is that the part of the concrete where the rebars are bent does not have the ability to bear the tensile forces that would result from the load. In determining the dimensions of the corbels, the defendant had failed to take this factor into account and had specified corbel dimensions that, given the bar bending radius of the rebars selected, had insufficient overlap of horizontal bars; in some cases there was no overlap at all.

5 The nub of the defendant's case is that this was not a defective design. The defendant did not dispute that, given the dimensions and rebar sizes, there was either very little or no overlap of horizontal rebars. However the defendant's position is as follows:

(a) Clause 5.2 of the Code does not apply to it as it is stated therein that this clause is only applicable to precast concrete whereas the corbels and beams in question were cast *in situ* (ie cast on site).

(b) The Code is only for guidance and non-compliance *per se* does not render a design inadequate: what was important was that it was calculated to be able to safely bear the design loads, based on engineering principles.

6 In relation to contention (a) above, the plaintiff's expert opined that the requirements for *in situ* concrete construction in fact required more stringent constraints compared to precast concrete. This is because in the latter case the concrete elements are cast under controlled factory conditions and a higher level of quality control is achieved. As there is no other provision for corbels in the Code, the prudent thing for a designer to do would be at least to comply with the provisions of cl 5.2. Indeed, an extract from Allen: "Reinforced Concrete Design to BS8110" (marked as exhibit 3PE) tendered by the plaintiff's expert, at Cap 10, suggests that the Code be used as well for corbels cast *in situ*. I agree with the plaintiff's expert in this regard.

7 Nevertheless, I accept the defendant's contention that non-compliance with the Code does not, in itself, mean that the Design is inadequate. Both experts accepted that the Code represents cumulative engineering knowledge over a long period. It would follow that even though there is no strict requirement to comply with the Code, nevertheless, a design that is in compliance with it can generally be assumed to be safe. On the other hand, if a design does not comply with the Code, the designer would have to satisfy himself that it was safe by applying accepted principles of engineering. Therefore, in the present case, it is necessary for the defendant to demonstrate that his design is safe. To this end the defendant's expert produced an analysis (marked as exhibit 6DE) to show that the stresses induced by the bearing pad over the critical parts of the corbels and beams did not exceed the tensile bearing capacity of the concrete. On the other hand, the plaintiff's expert conducted his analysis (marked as exhibits 11PE and 15PE) of the stresses and strains in the corbel and found, for most of the loading scenarios, that the concrete would fail at the extreme end of the corbel. The analysis by the plaintiff's expert was carried out with a computer using the finite element analysis method ("the FE Analysis"). The defendant's expert accepted that the software used to produce the FE Analysis would produce an accurate answer if the parameters used were valid. He also accepted that the FE Analysis accurately showed that the corner of the corbels would be subjected to tensile strain beyond the acceptable range. I accept the findings of the plaintiff's expert that at

various points in the corbels and beams the stresses exceed the permissible tensile stress for concrete.

8 There is also the question of what is the acceptable range of tensile stress and strain. Both experts agreed that concrete is strong under compression and is designed to take compressive stresses. They also agreed that concrete is not strong under tension; its tensile strength is only about 10% of its compressive strength. Therefore, any part of a concrete structural member that has to bear any substantial tensile load should contain steel rebars to take over the tensile load. Where the load is below the tensile capacity of the concrete it is permissible for that part to be unreinforced. However, the two experts disagreed on the limit of such loading: the defendant's expert was of the view that it may be the full 10% whereas the plaintiff's expert opined that it should be reduced by a partial safety factor of 1.5, which is the same factor applied to limit the compressive load on concrete. This factor is applied to take into account variations in construction quality. However, both experts agreed that the constraining factor is the limiting strain of 0.0001. Nevertheless, although it is not really material, I find the position of the plaintiff's expert that the tensile strength should be reduced by a factor of 1.5 to be logical: this same factor is applied to the compressive strength and there is no reason why a reduction to take into account construction variations should not apply to both limiting strengths. I would just say that the fact that there is no guidance on this appears to be because, as both experts had said, engineers are not supposed to design concrete to take any significant tensile load without steel reinforcement.

9 I should add that the plaintiff's position accords with the position taken by the Code, *ie* that the concrete cover region of the corbel and beam should not be subjected to any loading at all. It seems to me that this was an oversight on the part of the defendant, and it had resulted not only in an inadequate design, but had in fact resulted in actual failure in various corbels in the building. The defendant's expert admitted that in principle there was a shortcoming in the design of the expansion joints. He said that he would have provided 25mm chamfers at the edges of the corbel and beams. This means that those structural elements should not be loaded at the concrete cover zone.

10 The foregoing covers, in a nutshell, the main issues in the case. In the course of the trial, various other issues were ventilated. For example, the plaintiff also contended that the defendant had failed to make allowances for (a) thermal expansion and (b) shrinkage and creep. The plaintiff's case is that these would cause the beam to move lengthwise, and doing so in the direction away from the corbel would cause a horizontal force to act on the surface of the corbel increasing the tensile stresses on the concrete. The defendant's position is that the bearing pad was supposed to allow the beam to slide without friction. However, the defendant conceded that the bearing pad that was installed had a coefficient of friction of 0.6 and therefore the friction force caused by horizontal movement would be substantial. Indeed, the specifications for the bearing pad installed showed that the bearing pad was designed to allow lateral movement by deformation of the material. In the case of the bearing pad used, the maximum lateral movement was 7mm. However, the plaintiff's case is that the maximum lateral movement from (a) and (b) would exceed this 7mm capacity of the bearing pad; indeed, thermal expansion alone is computed to be 13mm, with at least another several millimetres for shrinkage and creep. Apart from bearing pad failure, the defendant did not take into account horizontal forces on the surface of the corbel due to friction from horizontal movement of the beam. The defendant said he had specified that the bearing pad should allow for frictionless movement. However, he was unable to point out where he had specified this.

11 Taking into account all the evidence before me, I find that the Design was inadequate and under the design loads, the stresses that would be found in the crucial zones of the corbel and beams would exceed the allowable stresses for the concrete. I should state that this affirms the wisdom in the Code that requires that the concrete cover at the ends of corbels and beams should not be

subjected to any loading. The FE Analysis showed that limiting tensile stresses have been reached in parts of the corbel. Most importantly, many cracks were manifested in the corbels and end beams at the site. Although these could have been caused by defective construction, there was no evidence of this. In the light of the shortcomings highlighted by the plaintiff's expert, it is plain that these were caused by inadequacies in the Design and I so hold. As this is the sole issue between the parties, it would follow that the defendant is liable to the plaintiff in negligence in respect of the inadequacies in the Design. The defendant is therefore liable for the costs of rectification of all expansion joints in which he had failed to comply with the Code.

12 The plaintiff has prayed for an order for the defendant to indemnify the plaintiff "in respect of any claims made by any subsidiary proprietors against the plaintiff, caused by or arising from defects in the common property". This prayer is too wide and to the extent that it extends to defects that are not caused by the defendant, there is no evidence that he is so liable. In relation to the liabilities of the defendant established in this suit, whether by consent or pursuant to my findings, it appears to me that the orders for damages are sufficient.

Orders

13 There will therefore be judgment for the plaintiffs in the following:

- (a) Damages to be assessed, in relation to costs of rectification of expansion joints and surrounding areas in which the Design had failed to comply with cl 5.2 of the Code.
- (b) By consent, the defendant to pay the plaintiff the sum of \$49,000 being damages in relation to the lift motor rooms.
- (c) By consent, the defendant to pay the plaintiff the sum of \$5,225 being damages in relation to the mezzanine floors.

14 There will also be an order against the defendant for costs of this action on a standard basis. The defendant is also to pay interest on damages ordered at the usual rates from date of writ and of judgment.

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