DRAINAGE REPORT

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Preface

Just over three months ago, SARS started spreading around the world. It is the first major new infectious disease of this century, as of 12 May 2003, more than 7,000 people have been infected in 29 countries and if not contained SARS will change the way we live our lives. The relationship between a previously unknown Coronavirus and SARS was established [1] just one month after the WHO issued a global alert calling upon eleven leading laboratories to join a network for research. SARS knowledge is an ever-changing field.

Every effort has been made to provide information that is accurate and complete. However, in view of the rapidly changing data, this information is provided "as is" and without warranty of any kind.

Introduction

This report is based on the visual inspection of several sample apartments within the Lung Hang Public Housing Estate, Shatin, Hong Kong. The inspection, arranged and coordinated by the office of Legislative Councillor Emily Lau, was conducted at 2.30 pm on 2nd May 2003. Members from the Housing Authority Lung Estate office led by Mr Chu, representatives from Emily Lau's office, Mr Wilson Chu Esq. District Councillor, Shatin District Council and Mr John A. Herbert, Kelcroft Consulting Engineers attended.

The estate was opened in 1983 and comprising six high-rise apartment blocks, named Wai Sam House, Hok Sam House, Lok Sam House, Sin Sam House, Sheung Sam House and Wing Sam House, providing a total of 4,381 apartments [2].

Severe Acute Respiratory Syndrome

The Coronavirus that causes Severe Acute Respiratory Syndrome (SARS) [1] is a novel virus, with little information available at this early stage. We do know that it causes a potentially fatal disease, presenting with fever and symptoms similar to atypical pneumonia. Presently, there is no cure or vaccine available. SARS has an average mortality rate is 15%, increasing to >50% for the elderly [3].

Transmission Route

Initial indications showed that SARS was transmitted through the respiratory droplets over a "short distance". However, a cluster of cases emerged from Amoy Gardens apartment complex, with 321 cases rapidly recorded [4]. The Hong Kong Government launched an environmental and epidemiological investigation, with findings summarised in a report [4] issued on 17th April 2003. It revealed that the lightwell and the drainage installation were providing a conduit for SARS infection.

Subsequent studies [5,6,7] discovered that the virus was viable and shed from the urine and faeces of SARS suffers. Also, that this virus, unlike others, survived outside the body for a period of up to four days. The new evidence supported faecal-oral transmission, indicat-

ing that the disposition of the drainage system is an important factor. The implications for drainage systems are wide ranging, influencing design, standards and maintenance.

Drainage Installation

Storm Water Drainage Installation

Whilst this report is focused on SARS and sewer systems, the condition of the external storm water pipework is noteworthy. Unlike apartments, external maintenance activities are unhindered by tenant reporting or access restrictions, providing an indicator of current maintenance standards and strategy.

It was noted that the storm water system employed for "Double H" buildings comprise externally mounted 150 mm (6 inch) cast iron storm water downpipes. These are routed from roof level to ground level, with branch pipes from each floor are connected to downpipe. It is obvious that the storm water system was neglected, particularly the complete failure of a 150 mm (6 inch) cast iron pipe fitting (refer to photographs).

Apartment Drainage Installation

The drainage systems at Lung Hang Estate is similar to other public rental housing estates, utilising uPVC combined soil & waste stacks and associated pipework located internally within the building floor plate.

It is believed that the Coronavirus is primarily transmitted through sewerage, therefore the separate kitchen waste piping and stacks are excluded from this report.

Each apartment has one bathroom. No Bathtub's or shower tray's or cubicles are installed, the concrete structure forms an enclosure for showering. The bathroom's are provided with a water closet, wash basin and floor drain. It was noted that some tenant's have installed additional piping to accommodate appliances, for example an extra basin or position of washing machine, etc. these discharge over the floor drain.

The uPVC piping material was satisfactory, being manufactured in accordance with British or Australian Standards.

Two installation styles were identified, refer to attached Drainage Schematic Drawing number KCE/LHE/D2001;

- *Type A*

A group of apartments, on different floors all having the same unit number, are connected to a common 108mm (4 inch) uPVC combined soil and waste stack. This combined stack, carries soil from water closets and waste water from showers, sinks and wash basins. Branch pipework carries the discharge from the fitments to the stack.

- *Type B*

Similar to type A, except an adjacent apartments is added to the group, and are connected to a common 108mm (4 inch) uPVC combined soil & waste stack, carrying both soil and waste water, with branch pipework, carrying the discharge from fitments to the stack. Only branch pipes traverse the party wall.

Floor Drain

A recessed style floor drain (apparently formed from the concrete slab) is provided. Internal inspection reveals exposed the concrete structure (refer to photograph). No evidence of purpose made water tight components was noted.

In the bathroom directly below, the 54 mm (2 inch) uPVC waste discharge is trapped, vented with anti-syphonage connection and routed at high level to the combined soil and waste stack. It was noted that the floor drain is positioned adjacent to the bathroom internal wall, therefore the requisite swept pipe fitting could not be installed.

Few support brackets were noted to restrain the pipework. In some cases, the height of the water closet outlet was insufficient, necessitating embedding of the tee fitting into concrete slab.

Design Philosophy

Every design philosophy has inherent advantages and disadvantages, key decisions based on various factors including, but not limited to; code compliance, available labour, available material, installation cost and maintenance considerations. The design philosophy used for public rental housing estates is different to that generally employed in private developments, having both advantages and disadvantages:

Advantages:

❏ All above ground drainage pipework is installed within the apartment floor plate, therefore expensive external scaffolding is not required for regular maintenance;

❏ Each water closet and floor drain is fitted with anti-syphonage protection;

❏ Safer - the floor drain trap is continuously replenished from waste water flowing from the shower area, wash basin, etc. Therefore, under normal operating conditions, the trap would achieve self-scouring velocity (self cleansing) and would not loose seal through evaporation. Hence, the occupants maintenance activities and risk of SARS infection from a maintained system would be lower than private developments such as Amoy Gardens 4.

❏ Tenants more likely to report leakage;

❏ Lower environmental impact, filling floor drain traps

is generally unnecessary, potentially saving 1,280 tonnes (estimated) of water and associated sewerage monthly;

Disadvantages:

❏ The uPVC soil stacks are installed within the apartment area, requiring fire compartmentation precautions for each FRP penetration;

❏ The system is not self-contained, floor drain traps are installed at high level in apartment directly below.

❏ Maintenance activities are restricted, requiring access to individual apartments for inspection and to carry out repairs;

❏ Tenants have opportunity to damage piping;

Analysis

Introduction

Before the discovery of SARS, the integrity of the sewerage system was an important public health factor, preventing unpleasant odour, pests and disease. Following the advent of SARS, it is critical to maintain complete integrity of soil drainage systems in **'EVERY'** building to minimise the risk of SARS transmission. Key indicators, that demand immediate investigation are:

❏ Unpleasant odour indicating trap seal failure;

❏ Waste water leakage;

SARS Risk

The Amoy Gardens report[4] implies that "special circumstances" existed and only private residential developments were SARS prone.

However, analysis of the facts reveals that **'EVERY'** building with a sewerage stack has potential to disseminate the Coronavirus, whether internally or externally. The risk being a function of a number of factors:

❏ Combined Soil and Waste Stack;

❏ Number of fitments connected to the stack;

❏ Occupancy;

❏ Number of floors

All building type, schools, colleges, factories etc. that commonly utilise the combined soil and waste stack system have the potential to recreate the Amoy Gardens [7] cluster.

Incorrect design and application of trapping is very common feature throughout Hong Kong.

Design Strategy

If properly implemented and maintained, the drainage strategy employed within public rental housing estates is superior and in terms of SARS prevention safer, than private developments such as Amoy Gardens [4].

It should be noted that the design has lower environmental impact, since the floor trap does not require additional quantities of water/bleach mixture to maintain the trap seal integrity.

Repositioning the soil stacks externally would transfer the risk from an individual apartment to the entire building, as witnessed at Amoy gardens, also significantly increasing the maintenance difficulty and hence the maintenance cost.

Defects

During the inspection, several defects were noted, a schedule of defects is included for reference. Certain apartments were considered HIGH risk, immediate intervention from Housing Authority was requested.

The visible waste water leakage from bathroom's, soffit's and waste pipework was particularly troubling. Undoubtedly, had an infected person (or recovering patient) resided on a higher floor the risk of acquiring SARS infection would be very high.

A number of sample photographs, taken during the inspection, have been included for reference.

Bathroom Drainage

Several problems were noted:

1) Each bathroom floor drain is apparently formed from a bare opening in concrete structural slab, without waterproofing or suitable fitting. The arrangement is unsatisfactory, permitting water leakage and seepage directly into the concrete and then to the bathroom below creating an unnecessary maintenance burden;

2) Consistently leakage and seepage around pipe slab penetrations was noted;

Evidence of water damage was noted in every apartment, including but not limited to, peeling paint, water damage staining, flaking and spalling concrete (refer to photographs).

These problems could be resolved with the installation of properly installed pipe sleeves, water proofing and purpose made floor drains, preventing further leakage, hence reducing maintenance. It should be noted that the cost and disturbance to tenant's during remedial work would be significant.

Maintenance

The Housing Authority Estate representative Mr Chu, confirmed during the inspection that maintenance activities were "contracted out" to term contractors. As noted herein, poor workmanship was noted, including inadequate pipework joint and piping supports. Improved site supervision is needed.

Concrete Deterioration

Deterioration of structural concrete called spalling is an area beyond our expertise. However, its omission herein would not accurately reflect the true conditions noted during the inspection. As discussed with Mr Wilson Chu, a structural engineer is needed for a professional opinion.

Spalling is generally defined as flaking off or deterioration of concrete surfaces, often exposing the underlying reinforcement bars.

It is a very common maintenance problem occurring as every concrete structure ages, evidence of which was noted in every apartment inspected (refer to photograph number xxxx) and noted on the external face of the structure. Spalling is caused by:

❏ Inadequate water proofing measures, permitting water leakage and seepage in area of slab penetration;

❏ General water leakage and seepage from apartment above, coupled with the previously mentioned floor drain design that encourages leakage;

❏ Unsealed concrete, good quality paint will slow down carbonation and minimise the ingress of oxygen and moisture into the concrete;

❏ Inadequate concrete cover over reinforcement bars (refer to structural engineer);

Schedule of Defects

These defects were noted during the site inspection, on 2nd May 2003. References to individuals and buildings and apartments numbers are removed.

Although the current edition of the Building Regulation Cap 123 I [8] was not applied during construction, the present regulation provides a standard method for analysis of defects.

1. Contravention of regulation [8], clause 28. The 54 mm uPVC floor drain waste pipework is not fitted with swept bend, this causes a small quality of waste to be accumulated. The square tee fitting was probably installed because the position of the floor drain precludes installation of radius bend with accessible cleaning eye (refer photographs).

2. Concrete Spalling, probable sources include poor maintenance, water leakage from above, carbonation, and insufficient rebar cover (refer photographs).

3. Contravention of regulation [8], clause 35. Anti-syphonage pipework connection has failed due to poor workmanship. The pipework penetration into the neck of fitting is inadequate (refer photograph xx)

4. Contravention of regulation [8], clause 35. Indicates that 108mm (4 inch) uPVC Soil pipe is leaking, attempted remedial repair noted (refer photo xx) [SARS infection risk].

5. Contravention of regulation [8], clause 35. Waste pipework leakage [SARS infection risk].

6. Leakage from bathroom above.

7. A 54 mm uPVC anti-syphonage pipe, without brackets, was used as step, footprints noted. It appears that the connected main 54 mm uPVC ventilating pipe has moved slide vertically (refer to photograph xxx).

8. Contravention of regulation [8], clause 36. A 150 mm (6 inch) Cast Iron Storm drain bracket failed near ground level , probable cause lack of maintenance, new bracket required.

9. Contravention of regulation [8], clause 36. External 150 mm (6 inch) Cast Iron Storm water pipework fitting Lok Sam House at level 24, has failed (refer photo xxx).

10. Contravention of regulation [8], clause 36 and Code of Practice for Fire resisting Structure. Drainage pipework passing through fire compartment partitions shall be sealed.

11. A 108 mm (4 inch) uPVC Soil stack incorrectly installed (original installation). Pipe should be rerouted through waterproof pipe sleeve.

References

1 Peiris JSM, Lai ST, Poon LLM, et al. Coronavirus as a possible cause of severe acute respiratory syndrome. The Lancet published online; 8 April 2003; [http://image.thelancet.com/extras/03art3477web.pdf]

2 http://www.housingauthority.gov.hk

3 World Health Organisation, Update 47 - SARS case fatality ratio, incubation period; 7 May 2003; [http://www.who.int/csr/sarsarchive/2003_05_07a/en/]

4 Main Findings of an Investigation into the Outbreak of Severe Acute Respiratory Syndrome at Amoy Gardens; 17 April 2003; [http://www.info.gov.hk/info/ap/pdf/amoy_e.pdf]

5 World Health Organisation, First data on stability and resistance of SARS coronavirus compiled by members of WHO laboratory network; 4 May 2003; [http://www.who.int/csr/sars/survival_2003_05_04/en/index.html]

6 World Health Organisation, Update 47 - Studies of SARS virus survival; 5 May 2003; [http://www.who.int/csr/sarsarchive/2003_05_05/en/]

7 Peiris JSM, Chu CM, et al. Clinical progression and viral load in a community outbreak of coronavirus-associated SARS pneumonia: a prospective study. The Lancet published online; 9 May 2003; [http://image.thelancet.com/extras/03art4432web.pdf]

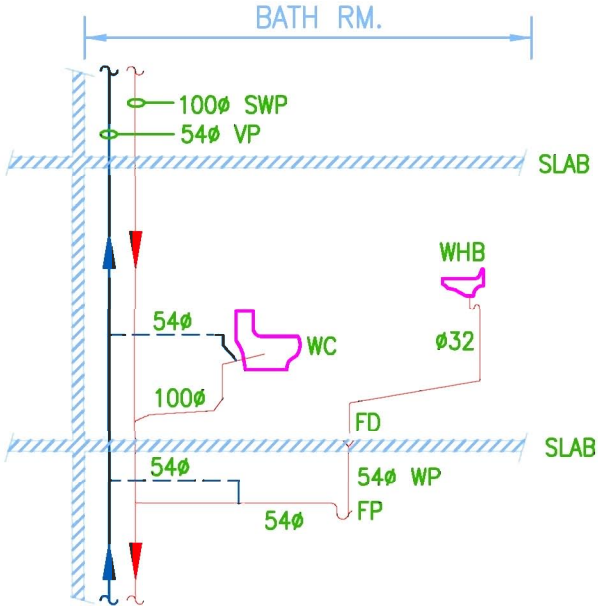
8 Building (Standards of Sanitary Fitments, Plumbing, Drainage Works And Latrines) Regulations Cap 123 I; latest edition.

9 American Society Plumbing Engineers (ASPE)

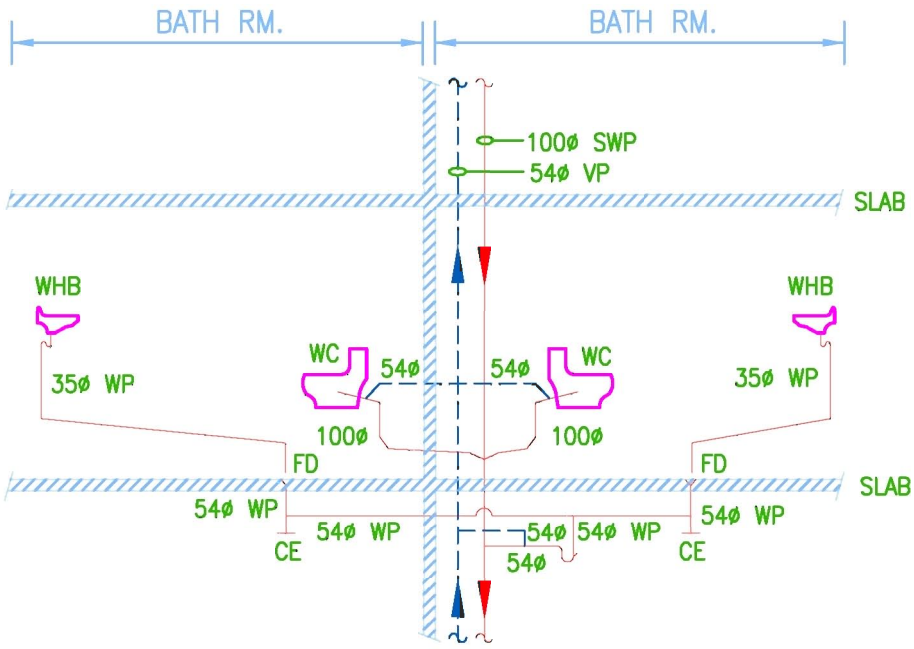
10 Hong Kong Buildings Department, Guidelines on Maintenance and Repair of Drainage System and Sanitary Fitments;17.4.2003;

LEGEND:

CE – CLEANING EYE
FD – FLOOR DRAIN
FP – FILL POINT
SWP – SOIL WASTER PIPE
VP – VENTILATING PIPE
WC – WATER CLOSET
WHB – WASH HAND BASIN
WP – WASTE PIPE

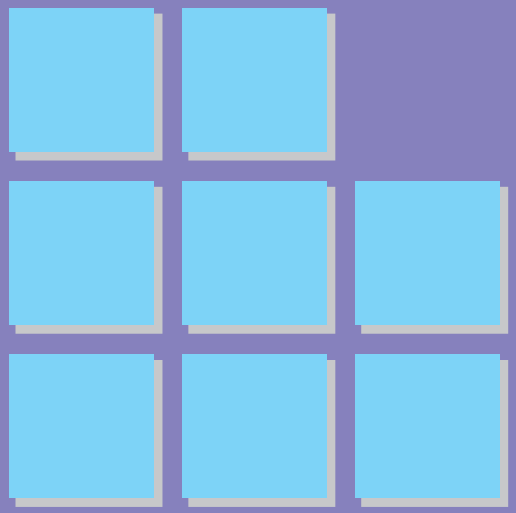


TYPICAL UNIT TYPE A



TYPICAL UNIT TYPE B

KELCROFT CONSULTING ENGINEERS	LUNG HANG ESTATE, SHATIN	DRAWN: CAD	DRAWING NO: KCE/LHE/D2001	
	TITLE: DRAINAGE SCHEMATIC	SCALE: NTS	DATE: MAY 2003	ISSUE: 1



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Drainage Installation - Photograph 1

High SARS Risk 1

- WC Anti-Syphonage pipe failed
- High SARS Risk
- Poor jointing workmanship
- Missing pipe brackets

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Drainage Installation - Photograph 2

High SARS Risk 2

- High SARS Risk
- Leaking Pipework
- Water Damage / future spalling
- Missing pipe bracket

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Drainage Installation - Photograph 3

High SARS Risk 3

- High SARS risk
- Waste Pipe leakage
- Missing brackets

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Drainage Installation - Photograph 4

Soil Pipe Leakage 1

- Soil Pipe Leakage
- SARS risk
- Inadequate repair attempted

Note: Anti-syphonage piping (white colour pipe in foreground) used as step

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Drainage Installation - Photograph 5

Soil Pipe Leakage 2

[as photo 4 different angle]

- 108mm uPVC soil and waste stack pipe fitting partially embedded within slab
- Anti-syphonage pipe below flood level, wrong gradient
- Missing pipe bracket

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Drainage Installation - Photograph 6

Typical Floor Drain

- Opening formed in concrete slab
- No water proofing visible
- No components visible

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Drainage Installation - Photograph 7

Floor Drain Leakage 1

- Pipework Misalignment
- Water damage / future spalling
- Water leakage from above
- Missing pipe bracket

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Drainage Installation - Photograph 8

Floor Drain Leakage 2

- Water leakage from floor drain arrangement in bathroom above causing concrete deteriorating and spalling

- Missing pipe brackets

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Drainage Installation - Photograph 9

Fire Compartmentation

- Inadequate Fire Stop
- Pipe failing (centre top)
- Ceiling water damaged
- Missing pipe brackets

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Drainage Installation - Photograph 10

Storm Water Downpipe

Storm Drainage

- H block Style building
- 150mm Cast Iron downpipe
- Pipe fitting failed
- Leakage and corrosion and noted

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Drainage Installation - Photograph 11

Water Damage

- Bathroom ceiling water damage
- Seepage/leakage from above
- Corrosion staining from above

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Drainage Installation - Photograph 12

Pipe Sleeve

- Pipework routed outside pipe sleeve
- Anti-syphon pipe below flood level

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Drainage Installation - Photograph 13

Spalling 1

- Water Damage
- Spalling concrete deterioration
- Adjacent to kitchen slab waste pipe

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Drainage Installation - Photograph 14

Spalling 2

- Sample of fallen Concrete

Section of concrete, was stored by tenant. It measures approx. 200mm x 150mm x 10mm, with rebar corrosion clearly visible.

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Drainage Installation - Photograph 15

Spalling 3

- Three small areas repaired
- Repaired areas not yet re-painted
- Large spall area developing in corner

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