



Prevention through **Design for Safety (DFS)** Guidance Notes & Worked Examples

透過建築安全設計作出預防 – 指南及實例

Dr. Winson Yeung
Principal Consultant
Occupational Safety and Health Council



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DESIGN FOR SAFETY

Modern Architectural Design



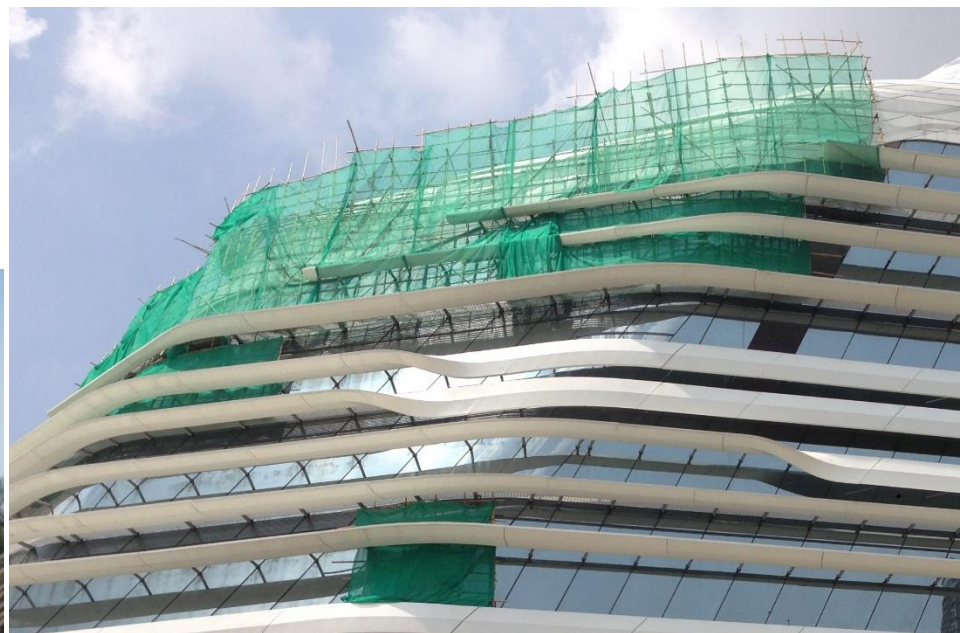
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DESIGN FOR SAFETY

Peculiar External Shape

Safe to Construct / Maintain ?



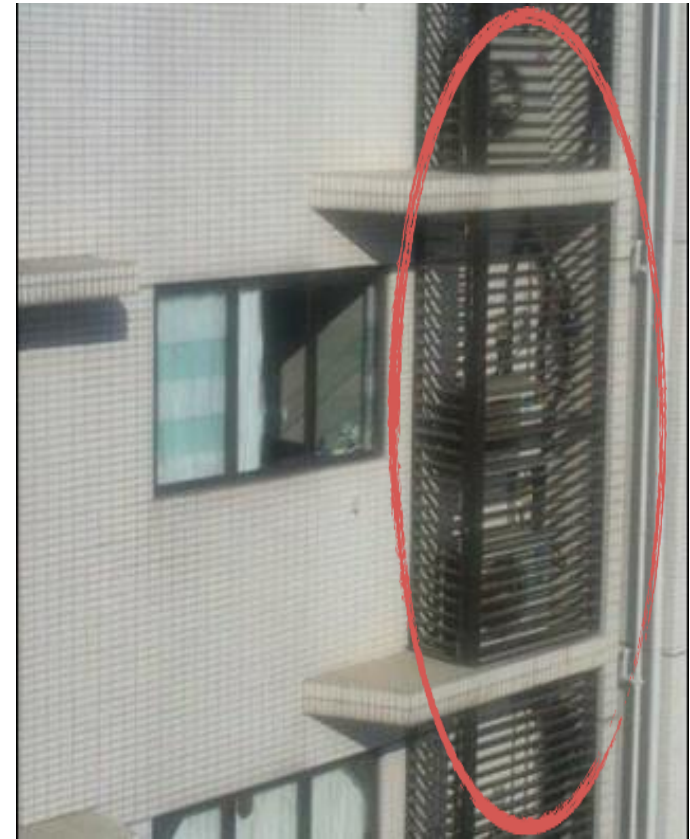
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Concerns on Safe Design (1)

No safe means of access to facilities and no safe means of support for workers to carry out RMMA works at external walls of buildings



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Concerns on Safe Design (2)



Impracticable to erect scaffold or
provide anchorage as fall protective
measures at external walls



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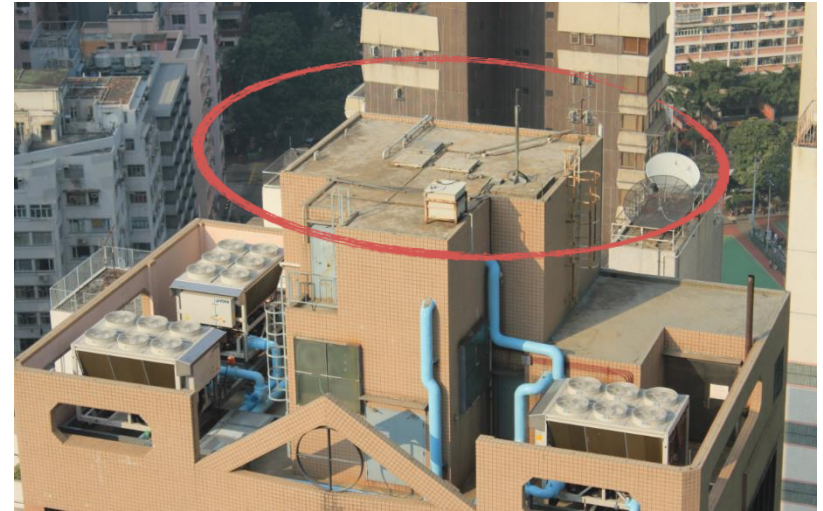


DESIGN FOR SAFETY

Concerns on Safe Design (3)



No guardrails or fall protective measures at rooftop / canopy

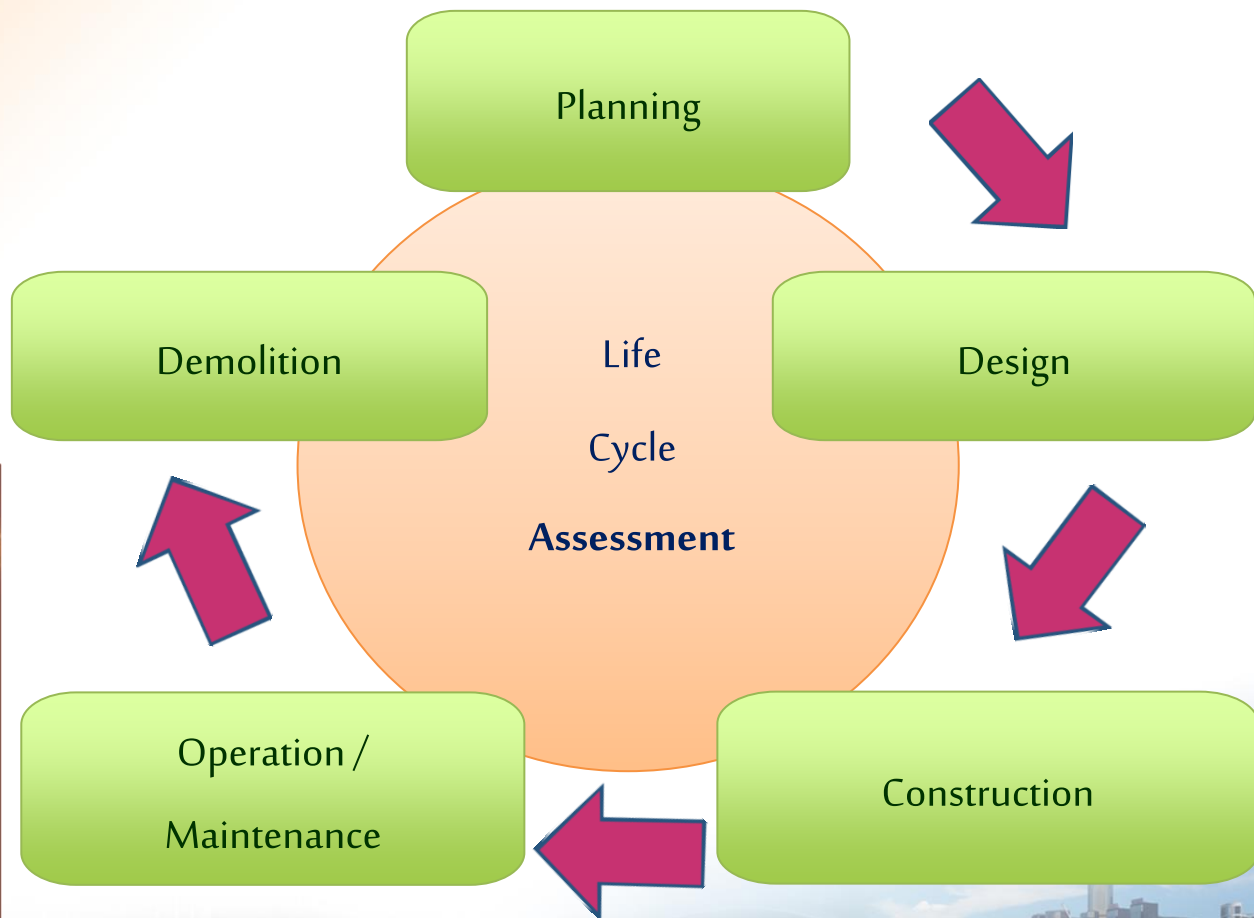
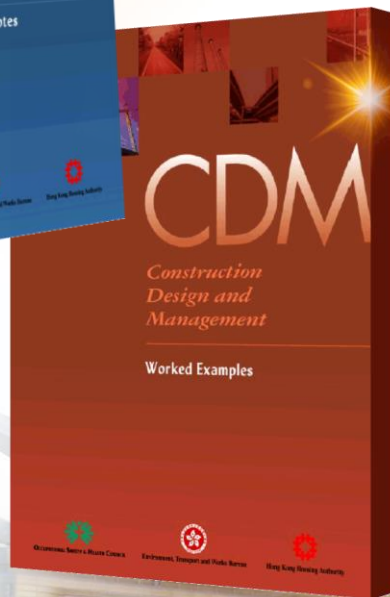


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Construction Design and Management (CDM 2006)

DESIGN FOR SAFETY



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DFS Review Programme Methodology in 2013

DESIGN FOR SAFETY

*Literature Review /
Questionnaire Survey*



Interview / Focus Group Meeting / Site Visit



Literature Review on the Review and
Preparation of Design for Safety
Guidelines for the Construction
Industry of Hong Kong

Reference: WQ/024/13



Occupational Safety and Health Council
October 2013

Organisation details

81. What is your organisation's primary role (more than one duty holders can be selected)?

☐ Client	☐ Project Supervisor (CDM Coordinator)
☐ Designer	☐ Principal Contractor
☐ Maintenance Supervisor	☐ Contract Supervisor
☐ Other	

If other, please specify: _____

82. How many employees do you have in HK?

☐ None	☐ 10 to 49
☐ 1 to 9	☐ 50 to 999
☐ 10 to 49	☐ 1,000 +

83. How many construction projects was your organisation involved with in the last 12 months? (e.g. developed, designed, built, maintained etc.)

☐ 1 to 9	☐ 20 to 49
☐ 10 to 19	☐ 50 to 99
☐ 50 to 99	☐ Not known

84. How many construction projects in your organisation have implemented the CDM approach?

☐ 1 to 9	☐ 20 to 49
☐ 10 to 19	☐ 50 to 99
☐ 50 to 99	☐ Not known

C Successes and problems with CDM

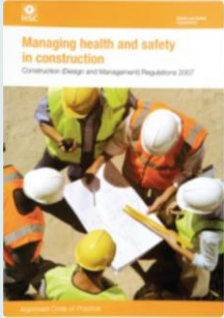
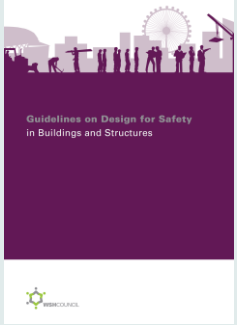
85. Can you point out the 3 key success areas where CDM brought improvement to Health & Safety standards in your construction project to ensure safer environments for construction and for maintaining it so as to control risks to workers by using the published Guidance Notes for CDM?

1.
2.
3.

Client

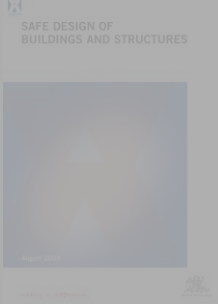
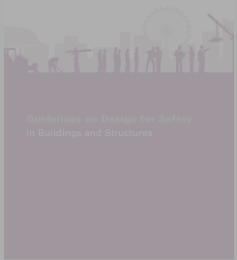


Literature Review - Experience of UK, Australia & Singapore

Country/ City	United Kingdom 	Australia  	Singapore 
Regulation	-introduced the CDM Regulations in 1994 -CDM 1994 was revised and replaced by CDM 2007 -CDM 2015 came into force on 6 April 2015, replacing CDM 2007	No specific regulation on Design for Safety	No specific regulation on Design for Safety in 2013
Code of Practice / Guidance	-issued the Guidance on “Construction (Design and Management) Regulations” in 2015  -issued the Approved Code of Practice “Managing health and safety in construction – Construction (Design and Management) Regulations” in 2007 	-issued the “Code of Practice on the Safe Design of Structures” in 2012  -issued the “Safe Design of Buildings and Structures Guide” in 2009 	-issued the “Guidelines on Design for Safety in Buildings and Structures” in 2008 
Execution	regulate Design for Safety by legislation	promote Design for Safety by training and issuing relevant Code of Practice	promote Design for Safety by training and safety award



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Execution	regulate Design for Safety by legislation	promote Design for Safety by training and issuing relevant Code of Practice	promote Design for Safety by training and safety award



DFS Review Programme

Questionnaire Survey – Target Response Group

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Client
19.4%

*Response Proportion

Project
Supervisor
22.8%

Designer
25%

Principal
Contractor
11.2%

Contract
Supervisor
13.4%



Maintenance Supervisor
8.2%

No. of Responses (from 70 sites)

232

Overall Response Rate

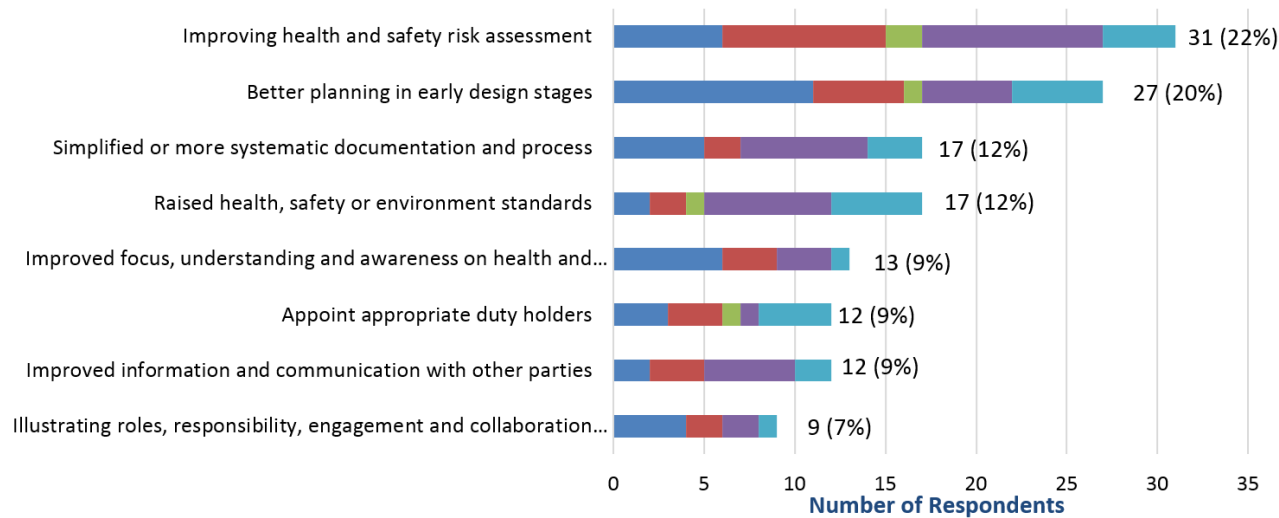
73%



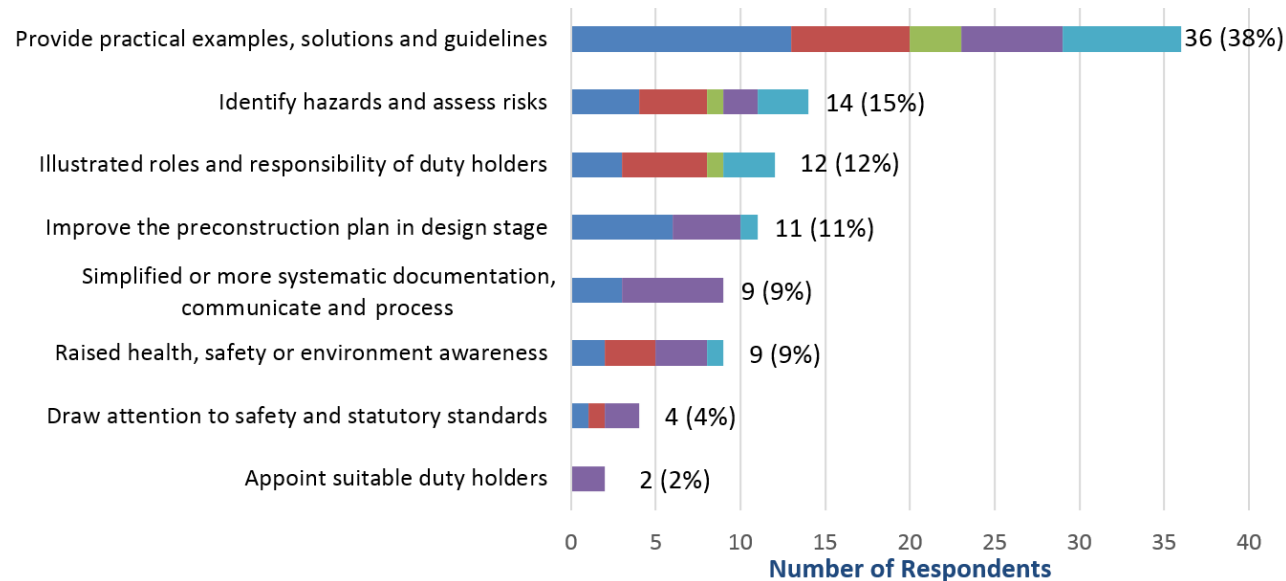
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Result: Key Success Areas - Questionnaire Survey

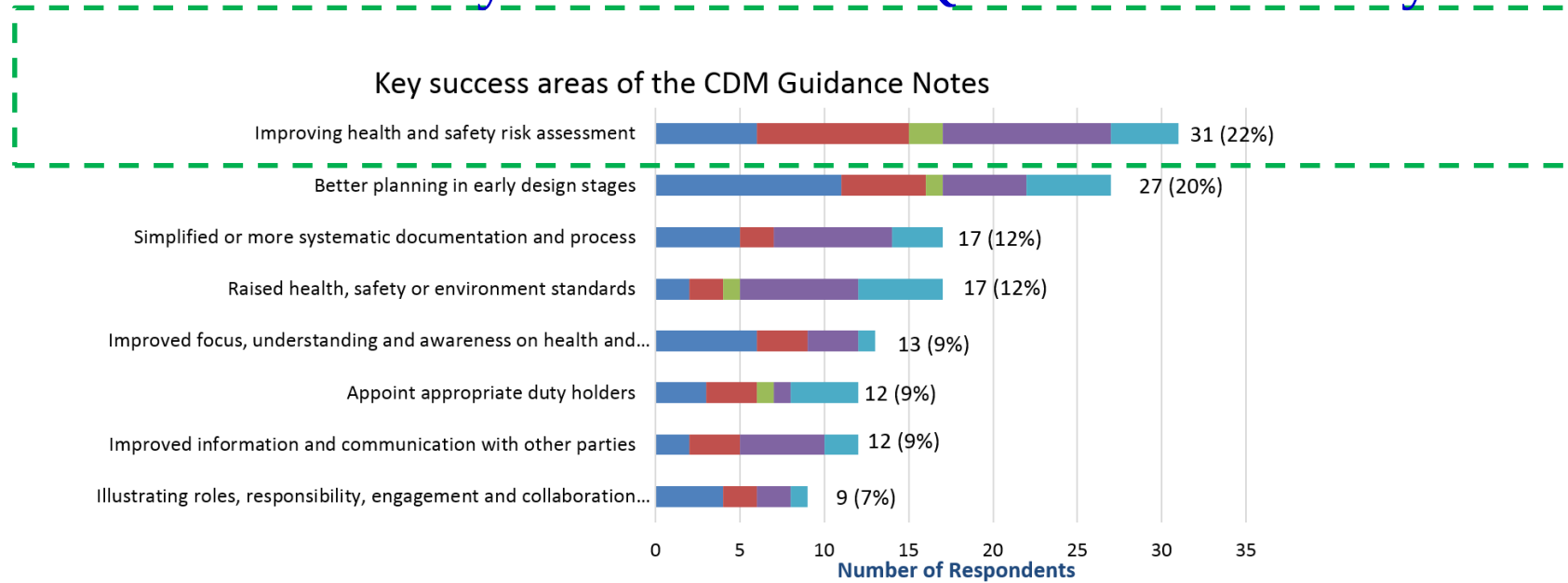
Key success areas of the CDM Guidance Notes



Key success areas of the CDM Worked Examples

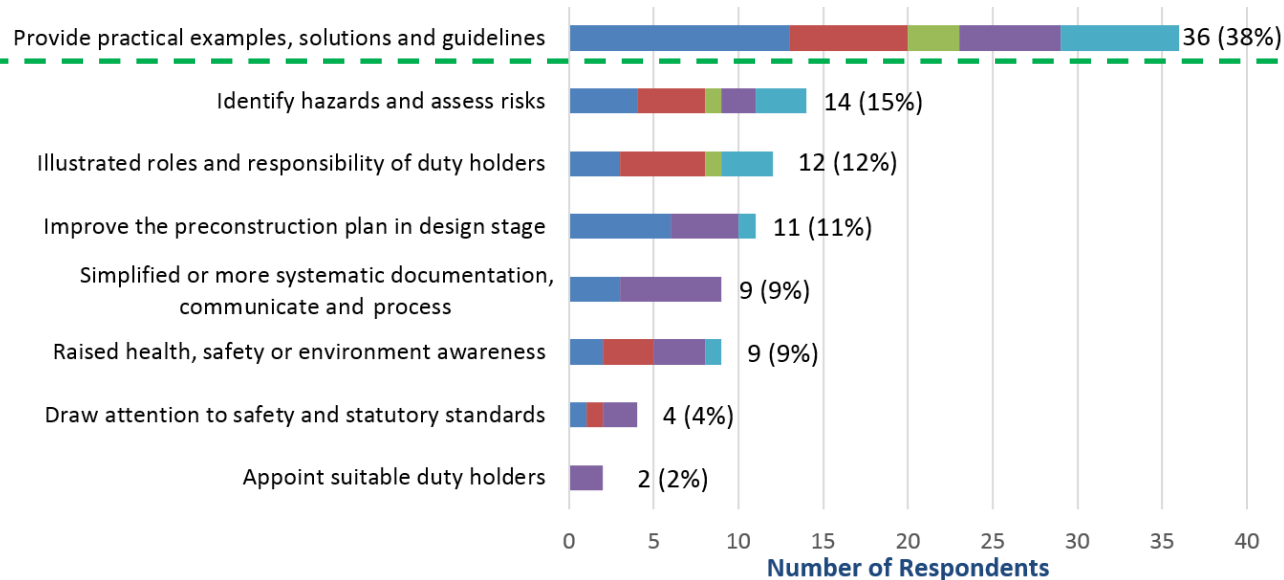


Result: Key Success Areas - Questionnaire Survey



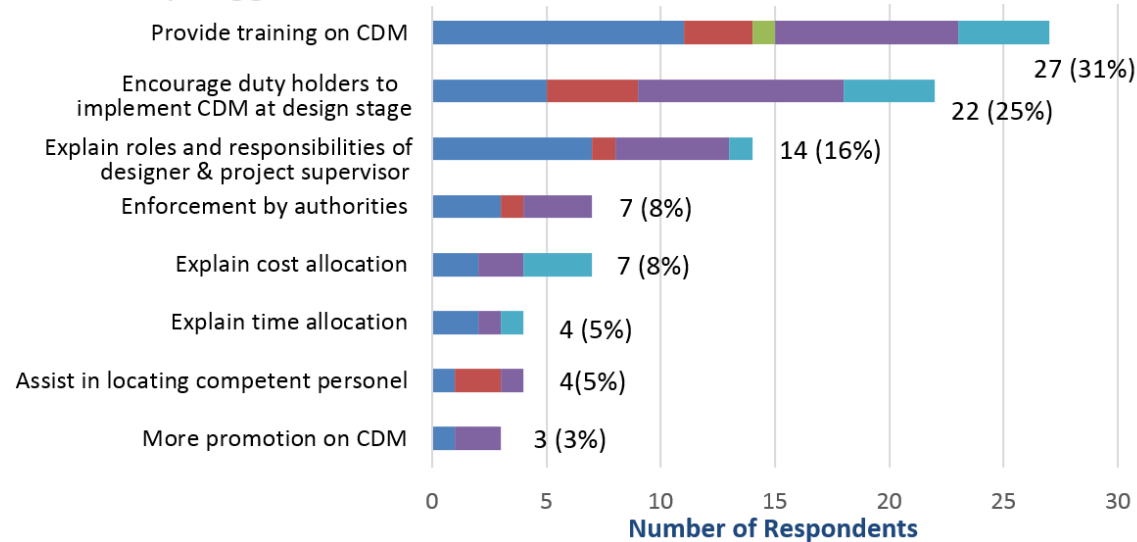
Result: Key Success Areas - Questionnaire Survey

Key success areas of the CDM Worked Examples

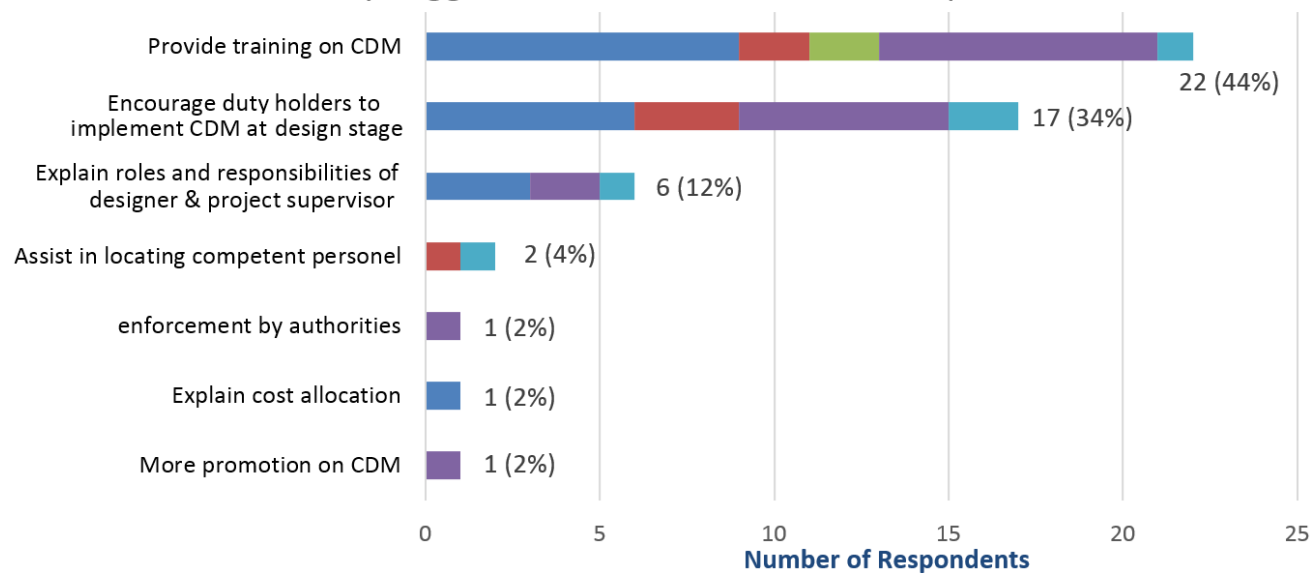


Result: Key Suggestions - Questionnaire Survey

Key suggestions on CDM Guidance Notes

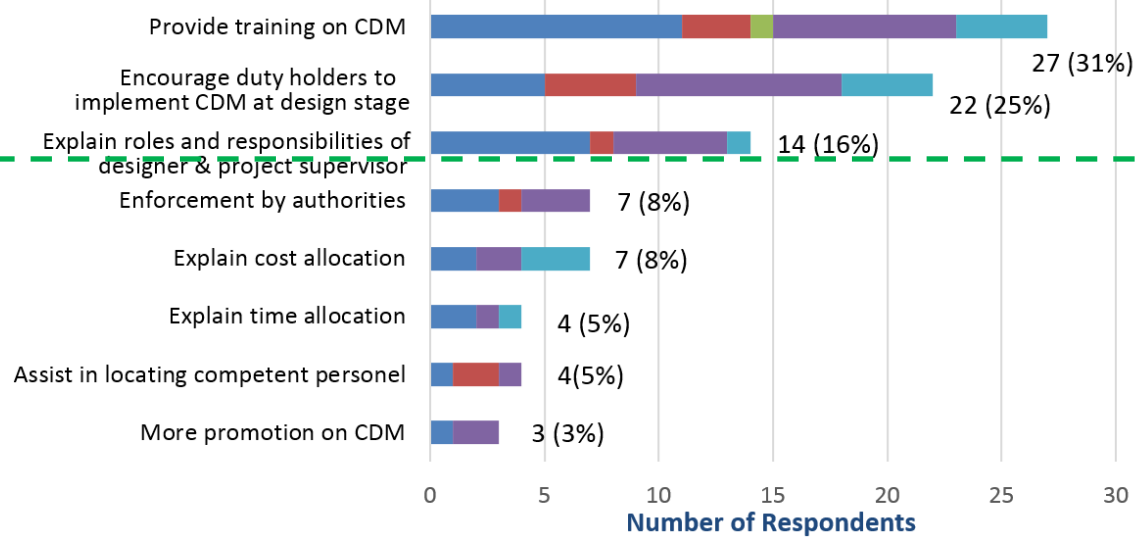


Key suggestions on CDM Worked Examples



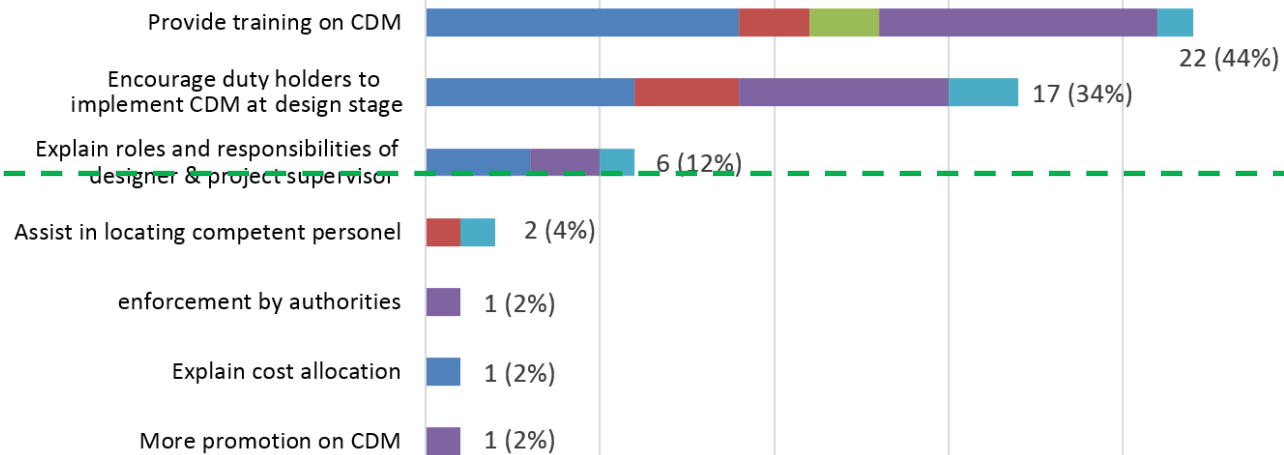
Result: Key Suggestions - Questionnaire Survey

Key suggestions on CDM Guidance Notes



Result: Key Suggestions - Questionnaire Survey

Key suggestions on CDM Worked Examples



Number of Respondents

17



DESIGN FOR SAFETY

DFS Review Programme

Focus Group Meeting / Site Visit



Focus Group Meeting



Site Visit





Design For Safety (DFS)

DESIGN FOR SAFETY

Main Objective:

- To promote early involvement, effective cooperation & communication of all stakeholders
- To improve clarity on the demarcation of roles & responsibilities of parties
- To strengthen hazard identification & mitigation at early design stages





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New Features in DFS – 1

Simplify the roles of duty holders

CDM

Client

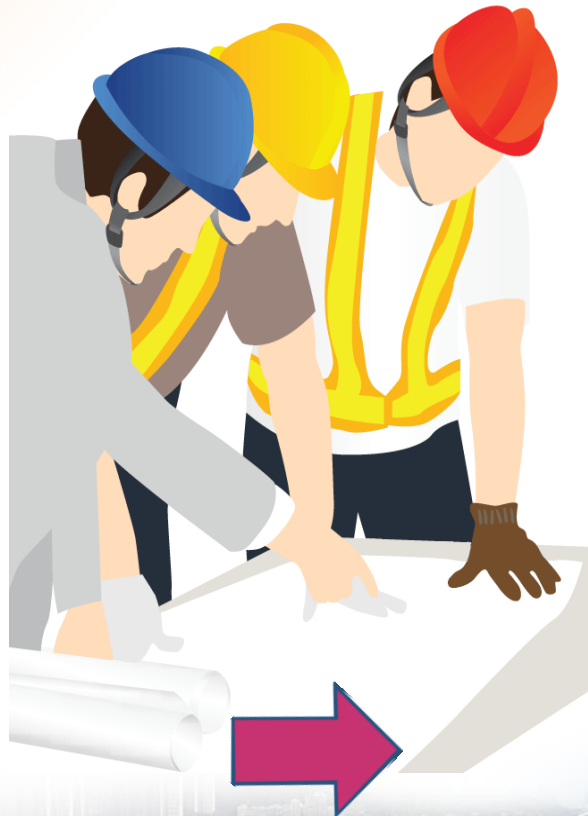
Project Supervisor

Designers

Contractors

Contract Supervisor

Maintenance
Supervisor



DFS

Client

Designers

Contractors

Maintenance
Supervisor



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New Features in DFS - 2

New Tool – Checklist for Duty Holders

Checklist for Duty holders

to illustrate the role and responsibilities and submission of documentation for different duty holders - **Client, Designer, Contractor, Maintenance Supervisor**, during each stage of the DFS process

Appendix A: Checklist for Duty holders

Checklist of considerations for Client

Pre-tender stage	Yes / No	Actions
1 Does the content of the proposed project come within any of the definitions for construction work?		
2 Does the project team identify who will be the client? (A group of clients can elect one of them to be treated as the client)		

Checklist of considerations for Designer

Pre-tender stage	Yes / No	Actions
1 Have you checked that the client is aware of his duties?		
2 Have you checked the competence of any sub-designers working for you?		

Checklist of considerations for Contractor

Pre-construction stage	Yes / No	Actions
1 Are you aware of your duties as contractor?		
2 Are you competent to undertake the duties of contractor in dealing with the health and safety issues involved in the management of the construction stage?		

Checklist of considerations for Maintenance Supervisor

Pre-construction stage	Yes / No	Actions
1 Are you aware of your duties as maintenance supervisor?		
2 Are you involved in the meetings with client / designers for the design work?		
3 Are you familiar with the intention of the design?		

Post-construction phase	Yes / No	Actions
4 Are you competent to undertake the duties of contractor in dealing with the health and safety issues involved in the management of the construction stage?		
5 Have you taken steps to ensure that the maintenance work is properly planned, managed and monitored, with adequate resources and management appropriate to the risk and activity?		
6 Have you provided sufficient time and other resources for the routine/maintenance work?		
7 Have you provided to every contractor who will work on maintenance		

Client

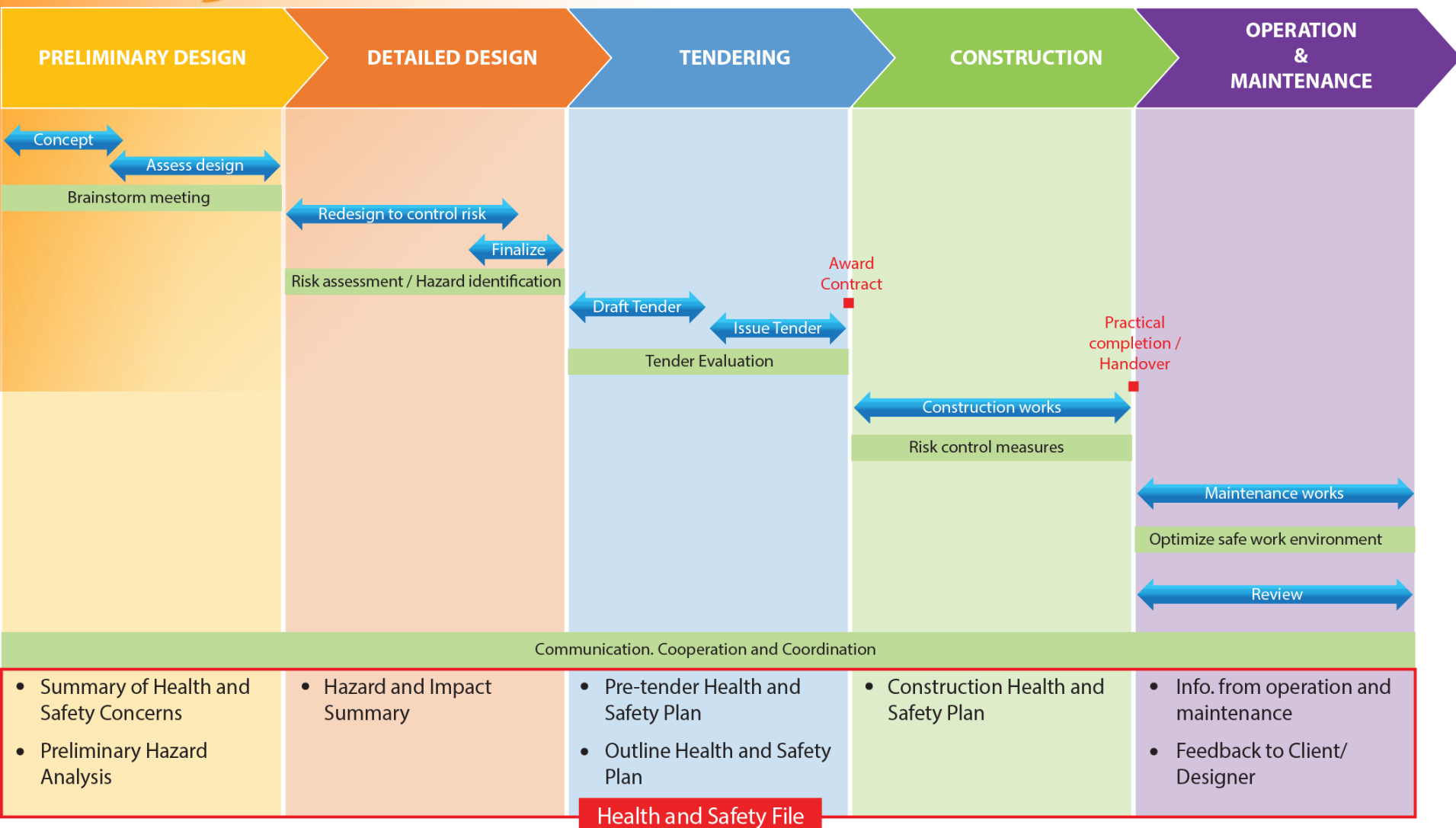
Designer

Contractor

Maintenance Supervisor



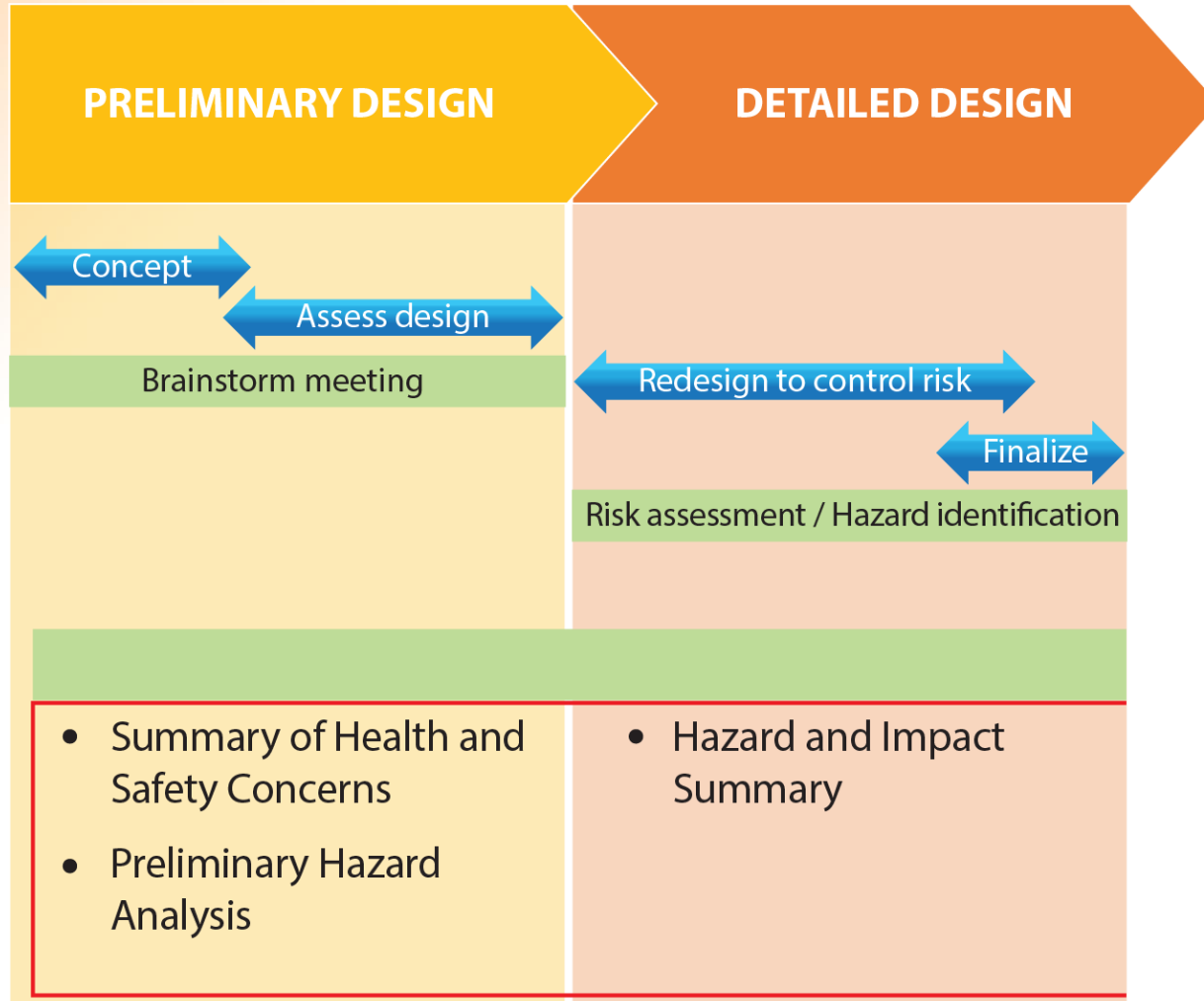
Application of DFS under different Project Stages





Application of DFS in Design Stage

DESIGN FOR SAFETY

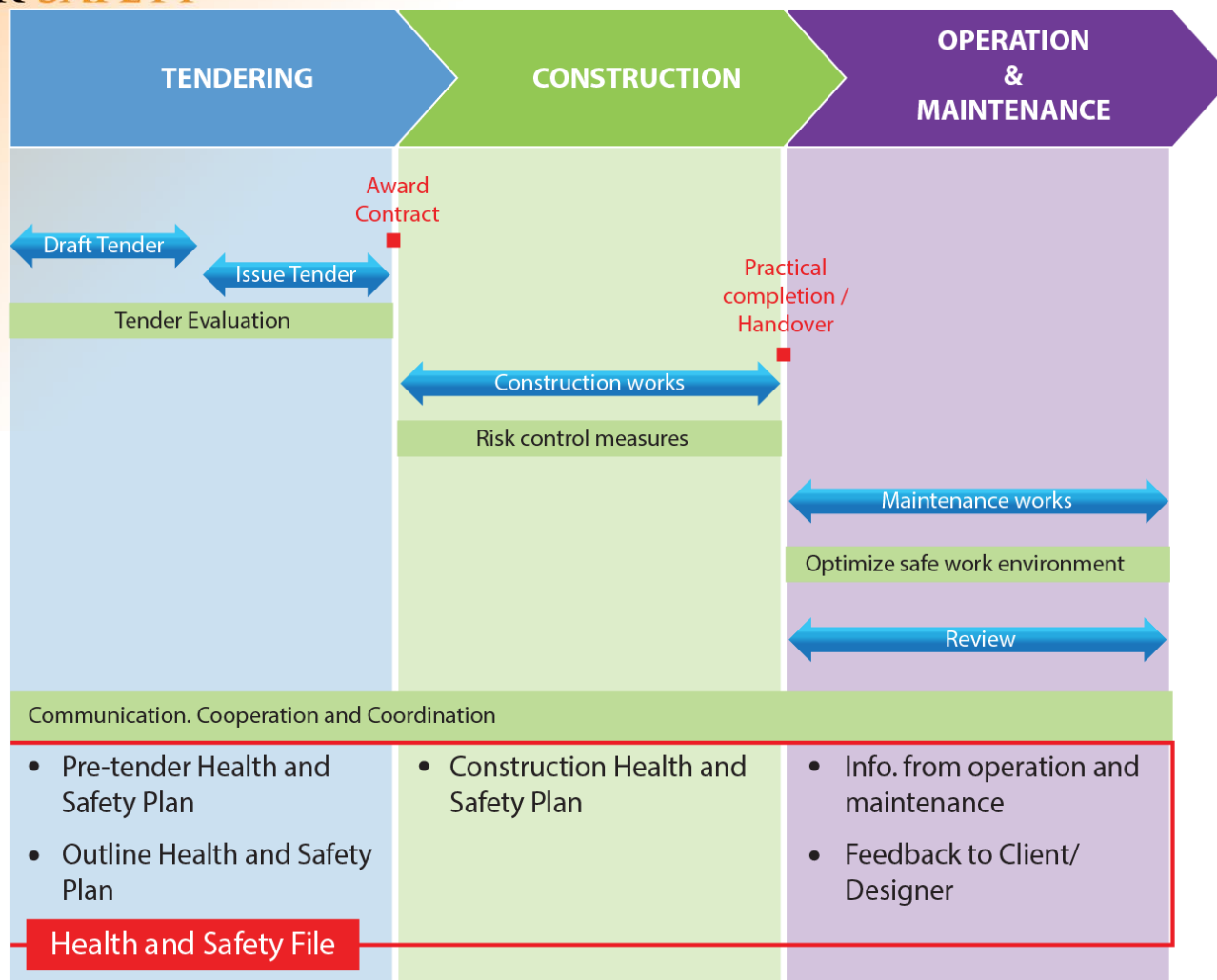


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Application of DFS from Tendering to Construction and Operation & Maintenance Stages

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New Features in DFS - 3

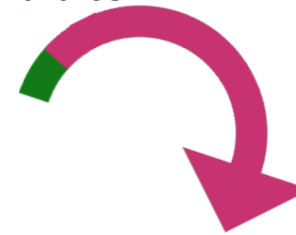


Enhanced Format for “Summary of Health and Safety Concerns”

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Preliminary Hazards Analysis Checklist

- safety analysis tool for identifying hazards
& their associated causal factor



Record of Major Issues Raised and Responses

Significant Hazards and Designers' Action	Significant Hazards Identified During Design (Tick if applicable)																					Designers' Actions			
Design Areas and Construction / Maintenance Activities	Hazardous Substances	Contamination	Fall From Height	Falling Objects	Site Plant Vehicles	Collapsing Structure	Manual Handling	Lifting Operations	Buried / Overhead Services	Interface With Others	Cut / Drilling Concrete	Noise and Vibration	Deep Excavations	Asbestos	Fire Means of Escape	Highway Traffic	Restricted Access	Access for Maintenance	Component Replacement	Confined Spaces	Working Over or Near Water	Temporary Works Required	Others		
																							Key C=Comments/Qualification; I=Information required to assist design, G=Guidance, summary of Principles of Prevention that MUST be applied to a significant risk when designing. A=Avoidance (Design to avoid identi- fied hazards but beware of introduc- ing others)		
Site Set Up Logistics																								Major Issues Raised by Stakeholders	
Access To Site																									
Site Offices and Compound																									
Site Surveys																									
Temp Services																									
Public / Highway Traffic Safety																								A. General Planning (Surrounding site access (onto / within site))	
Demolition and Dismantling																								a. Site located adjoining Tseung Kwan O Sports Ground (now under construction)	• Cl co pe • Pr on Sp • Pr no
Design Areas and Associated Construction Activities																									
Ground Excavation Works																									
Piling																									
Concrete Substructure																									
Slabs																									
Interfaces																									
Drainage and Utility Services																									
Superstructure Frame																									
Superstructure Flooring																									

Major Issues Raised by Stakeholders	Responses [see Note (1)]		Any Action Required	
			[see Note (2)]	
			Yes /No	Action Parties
A. General Planning (Surrounding Environment, Site clearance / demolition, site investigation, site access (onto / within site), site layout)				
a.	Site located adjoining Tseung Kwan O Sports Ground (now under construction)	• Close coordination with users to avoid noisy construction works to be conducted during EAG period (Dec 2009) • Proper planning on the site ingress / egress location on Po Hong Road to minimize the impact to TKO Sports Ground • Provision of proper physical isolation of dust and noise from site boundary (e.g. canvas for enclosure) to avoid debris leaking into the sports ground [Post meeting note: Construction is scheduled to commence in early 2010 in latest Master Programme, i.e. after EAG period]	Yes	PTAE



New Features in DFS - 4

New Design Tool – Red, Amber and Green Lists

DESIGN FOR SAFETY

Red, amber and green lists

the practical aides for designers on what should be eliminated/avoided, and what should be encouraged to be completed during the design stage

Red Lists: Hazardous procedures, products and processes that should be eliminated from the project where possible.

- Lack of adequate pre-construction information, e.g. asbestos surveys, geology, obstructions, services, ground contamination etc.
- Hand scabbling of concrete ('stop ends', etc);
- Demolition by hand-held breakers of the top sections of concrete pile techniques are available);
- The specification of fragile roof lights and roofing assemblies;
- Processes giving rise to large quantities of dust (dry cutting, blasting etc)
- On-site spraying of harmful substances;
- The specification of structural steelwork which is not purposely designed safety nets;
- Designing roof mounted services requiring access (for maintenance, etc) for safe access (eg. barriers).
- Glazing that cannot be accessed safely. All glazing should be anticipated cleaning and replacement, so a safe system of access is essential.
- Entrances, floors, ramps, stairs and escalators etc not specifically designed and trips during use and maintenance, including effect of rain water and
- Design of environments involving adverse lighting, noise, vibration, temperature, humidity and draughts or chemical and/or biological conditions during use operations.
- Designs of structures that do not allow for fire containment during construction
- During excavation, unable to allow sufficient space for the battering (slope) of excavations, to minimize the risk of collapse. Where possible, avoid local static loads (such as buildings, walls and immobile plant) or dynamic traffic and excavation equipment)

Amber Lists: Products, processes and procedures to be eliminated or reduced as far as possible and only specified/allowed if unavoidable. Including amber items would always lead to the provision of information to the Duty holders.

- Internal manholes / inspection chambers in circulation areas;
- External manholes in heavy used vehicle access zones;
- The specification of 'lip' details (i.e. trip hazards) at the tops of pre-cast concrete staircases;
- The specification of shallow steps (i.e. risers) in external paved areas;
- The specification of heavy building blocks;
- Large and heavy glass panels;
- The chasing out of concrete / brick / blockwork walls or floors for the installation
- The specification of heavy lintels (the use of slim metal or hollow concrete alternatives);
- The specification of solvent-based paints and thinners, or isocyanates, particularly in confined areas;
- Specification of curtain wall or panel systems without provision for the tying scaffolds;
- Substituting dangerous with inherently less dangerous chemicals.
- Modify the design to reduce areas where dust and dirt can collect and thus need for cleaning at height
- Design plant to extract dust and fumes effectively rather than deposit them will need cleaning
- Simplify the process control and reduce the sensitivity to deviation, therefore reliability of control systems when handling the hazardous chemicals.
- Using specific building components and construction methods that can eliminate for falsework or formwork for temporary works.
- Anchor points should be provided at suitable spacings to limit the worker's the protected area for temporary works.
- Information about restrictions, proper use and load bearing capacities components, and on lateral forces to be supported by temporary works equipment be provided for designing the temporary works.
- Site traffic routes that do not allow for 'one way' systems and/or vehicular traffic from site personnel

Green Lists: Products, processes and procedures to be positively encouraged.

- Adequate access for construction vehicles to minimise reversing requirements (one-way systems);
- Provision of adequate access and headroom for maintenance in plant rooms, and adequate provision for replacing heavy components;
- Thoughtful location of mechanical / electrical equipment, light fittings, security devices etc. to facilitate access and keep away from crowded areas;
- The specification of concrete products with pre-cast fixings to avoid drilling;
- Specify half board sizes for plasterboard sheets to make handling easier;
- Early installation of permanent means of access, and prefabricated staircases with hand rails;
- The provision of edge protection at permanent works where there is a foreseeable risk of falls after handover;
- Practical and safe methods of window cleaning (e.g. from the inside);
- Off site fabrication and prefabricated elements to minimize on site hazards;
- Encourage the use of engineering controls to minimize the use of Personal Protective Equipment;
- Using high durability and low maintenance materials that do not need to be re-coated or treated;
- Designing the structure so that maintenance can be performed at ground level or safely from the structure, for example, positioning air-conditioning units and lift plant at ground level and designing inward opening windows etc.
- Using continual support beams for beam-to-column double connections, be it adding a beam seat, extra bolt hole, or other redundant connection points during the connection process. This will provide continual support for beams during erection – to eliminate falls due to unexpected vibrations, misalignment and unexpected construction loads;
- Reducing the space between roof trusses and battens to reduce the risk of internal falls during roof construction;
- Separate heavy transport access from lighter vehicle access, and separate pedestrians from vehicle access.





Examples – Red, Amber and Green Lists

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Red Lists: Hazardous procedures, products and processes that should be eliminated from the project where possible.

- Designing **roof mounted services** requiring access (for maintenance etc.), **without provision for safe access** (e.g. barriers)
- **Glazing that cannot be accessed safely**. All glazing should be anticipated as requiring cleaning & maintenance, so a safe system of access is essential



Amber Lists: Products, processes and procedures to be eliminated or reduced as far as possible and only specified/allowed if unavoidable. Including amber items would always lead to the provision of information to the Duty holders.

- Substituting dangerous with inherently **less dangerous chemicals**
- **External manholes** in heavy used vehicle access zones



Green Lists: Products, processes and procedures to be positively encouraged.

- **Off site fabrication** and **prefabricated elements** to minimize on site hazards
- Designing the structure so that maintenance can be performed at ground level or safely from the structure, e.g. **positioning air-conditioning units at ground level** and **designing inward opening windows** etc.





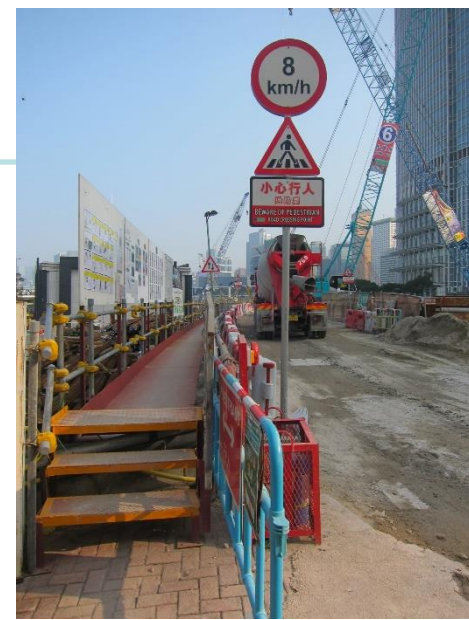
Good design practices

Design for safe construction & maintenance

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Examples of Good Design Practices

Safe Design for Temporary Works



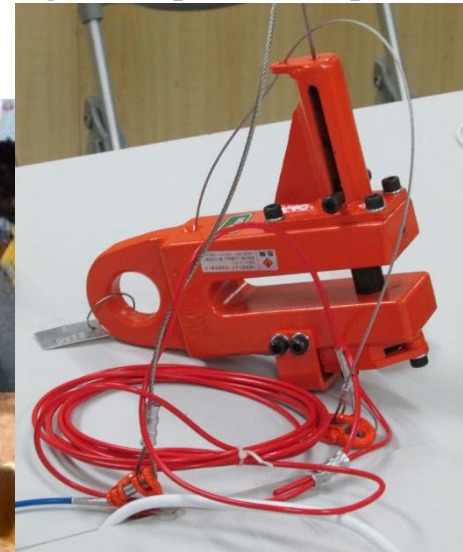
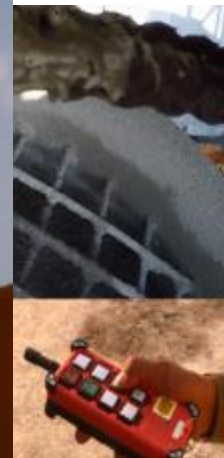
Fail-safe Design for Machinery

Design for Hazardous Material
to limit people at risk



Design for Temporary Traffic Management

Design to minimize Working at Height
e.g. remote control for concrete skip and lifting sheet piles & H piles



DFS - Worked Examples



1. Sports Centre and Library,
Tseung Kwan O

3. Indoor
Velodrome-
cum-Sports
Centre, Tseung
Kwan O



4. Kai Tak Nullah – Reconstruction & Upgrading



5. Kai Tak Approach
Channel –
Improvement works



6. Sha Tin Water Treatment Works –
Design and Construction



7. North District and Tolo
Harbour Sewerage Upgrade



2. Joint-user Complex, To Kwa Wan



Worked Example No. 1 – Joint-User Complex at Bailey Street, To Kwa Wan Reclamation

DESIGN FOR SAFETY

Ten - storey complex accommodating
two co-users – Department of Health
and Home Affairs Department

The building consists of

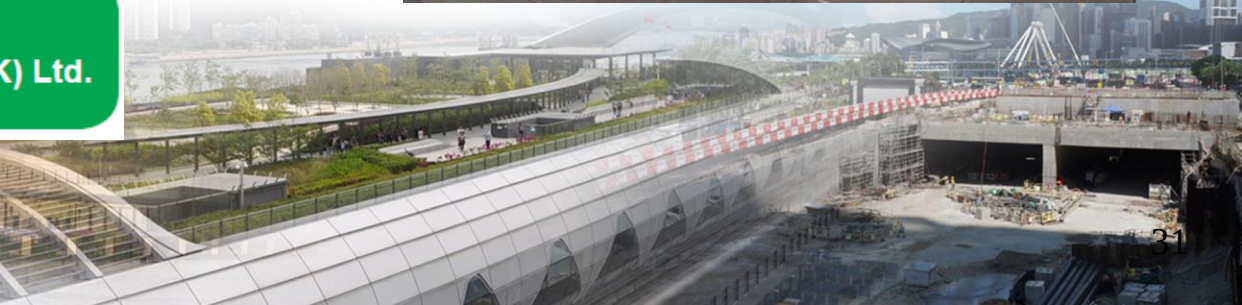
- Hung Hom Community Hall
- Kowloon City District Office
- Dental Clinics
- Maternal and Child Health Centre
- Families Clinic

Client & Project Supervisor &
Designer ArchSD &
Contract Supervisor

Contractor China State
Construction Engineering (HK) Ltd.



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DESIGN FOR SAFETY

Brainstorming Sessions to Identify Potential Risk Items of Project (examples)

Hazard and Impact Summary						
Task	Hazards and Impacts	Risk Assessment Rating	Control Measures	Hazards Resolved Yes/No	Necessity to Notify Contractor Yes/No	Other Relevant Parties to Be Notified
On-site installation of plant material at height (e.g. installation at ceiling level)	Falling from heights	6	Provide guarded stairs, catwalks, working platform, etc. for equipment require regular service/ maintenance	Yes	Yes	E&M Contractor
Manual handling of heavy and bulky equipment	Cause harm / injury to workers, e.g. sprains, strains and back pain.	4	Provide mobile trolley for transporting bulky machine parts	Yes	Yes	E&M Contractor

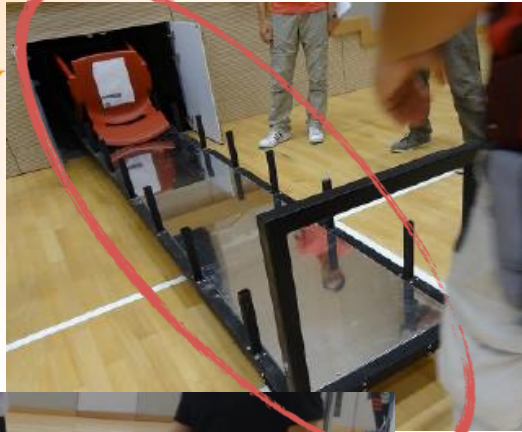


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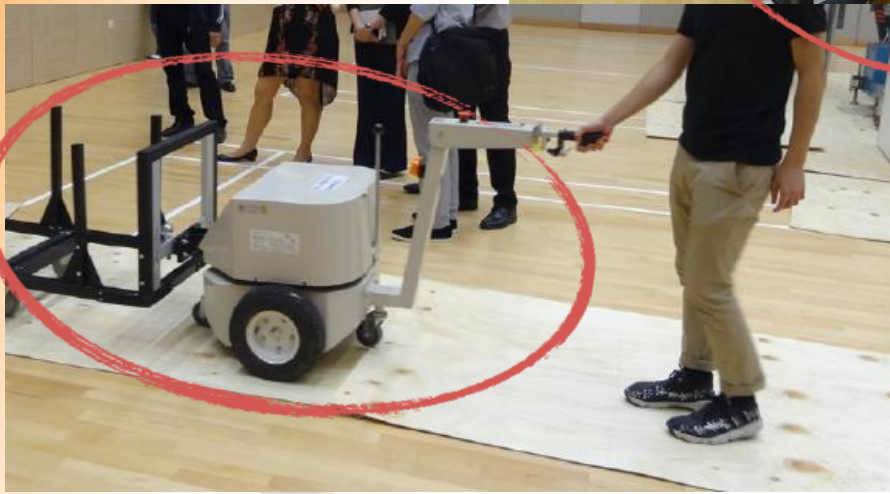
DESIGN FOR SAFETY

Examples of Safe Design



Maintenance corridor on external facades

- improve the safety and access for the workers during window cleaning & maintenance of facilities



Use of electric trolley in the multipurpose hall

- to transport the audience chairs easily, minimizing the manual handling work



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Worked Example No. 2 - Town Park, Indoor Velodrome-cum-Sports Centre in Tseung Kwan O

DESIGN FOR SAFETY

- a town park
- an indoor velodrome-cum-sports centre (provide a cycling track, spectator stand and other ancillary facilities which meet standards for international competition)

Client
ArchSD & LCSD

Project Supervisor & Designer
P&T Architects and Engineers Limited

Contractor
Shui On Construction Co., Ltd.



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Brainstorming Sessions to Identify Potential Risk Items of Project (examples)

Hazard and Impact Summary						
Task	Hazards and Impacts	Risk Assessment Rating	Control Measures	Hazards Resolved (Yes/ No)	Necessity to Notify Contractor (Yes/ No)	Other relevant parties to be notified
Fall from height while carrying out maintenance works / cleaning	Fall from height while carrying out maintenance works / cleaning / watering of green roofs - especially the bottom of cycling track	6	Access for maintenance of building services inside the Velodrome will be facilitated by maintenance catwalk. Proper material to lengthen the lifespan of cladding and avoid materials / finishing that require aggressive cleaning	Yes	No	Maintenance staff
Ergonomics - muscular-skeletal injuries from posture/ manual handling	Potential hazards (e.g. health hazard due to inadequate spatial requirements) while carrying out maintenance works	4	Proper lifting appliance / trolleys will be provided for transportation of materials	Yes	No	Maintenance staff

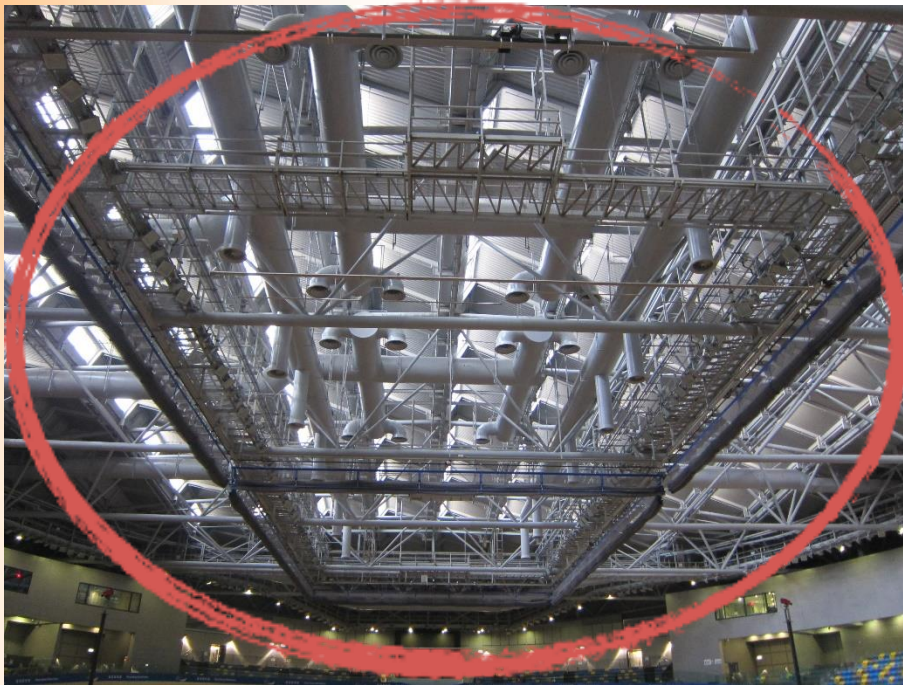


Examples of Safe Design (1)

DESIGN FOR SAFETY

Catwalks and Maintenance Platform

- provided safe access and platforms for maintenance of all ceiling mounted services including fire services facilities, lighting system, ventilation louvers system and acoustic panels





Examples of Safe Design (2)

DESIGN FOR SAFETY

Link Lift system

- Installed the hydraulic elevator driving systems for multi-purpose venues
- Facilitate the transportation of the bulky equipment from G/F to 1/F
- Platform with suitable guardrails to prevent risk of fall during operation





DESIGN FOR SAFETY

Worked Examples No. 3 -

North District and Tolo Harbour Sewerage, Sewage Treatment and Disposal - Regional Sewerage Works, Sewerage Upgrade

- construct / upgrade a total of 14 km of sewers and 3 sewage pumping stations, with over 20 work sites scattered among three districts (Sha Tin, Tai Po and North District)



Client
Drainage Services Department(DSD)

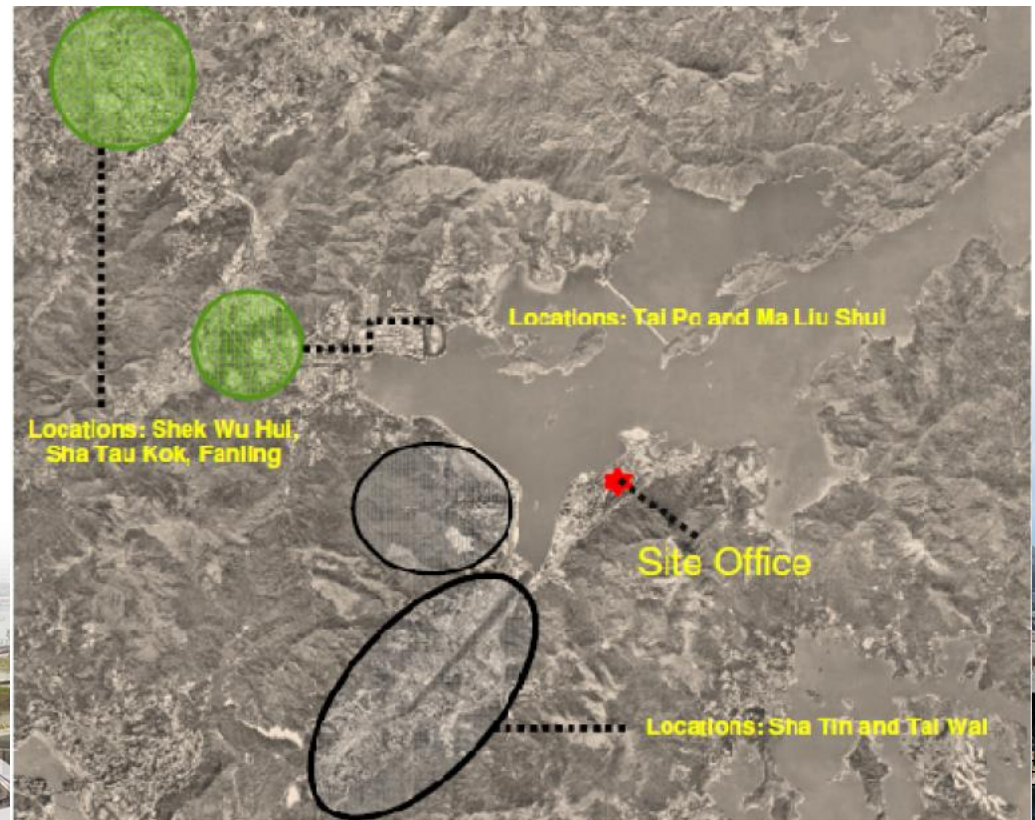
Project Supervisor & Designer &
Contract Supervisor
AECOM Asia Co. Ltd.

Contractor
China Road & Bridge Corporation - Dix
Construction & Transportation Ltd. Joint
Venture and Sang Hing Civil Contractors
Co., Ltd

Maintenance Supervisor
Drainage Services Department (DSD)



職業安全健康局
OCCUPATIONAL SAFETY & HEALTH COUNCIL



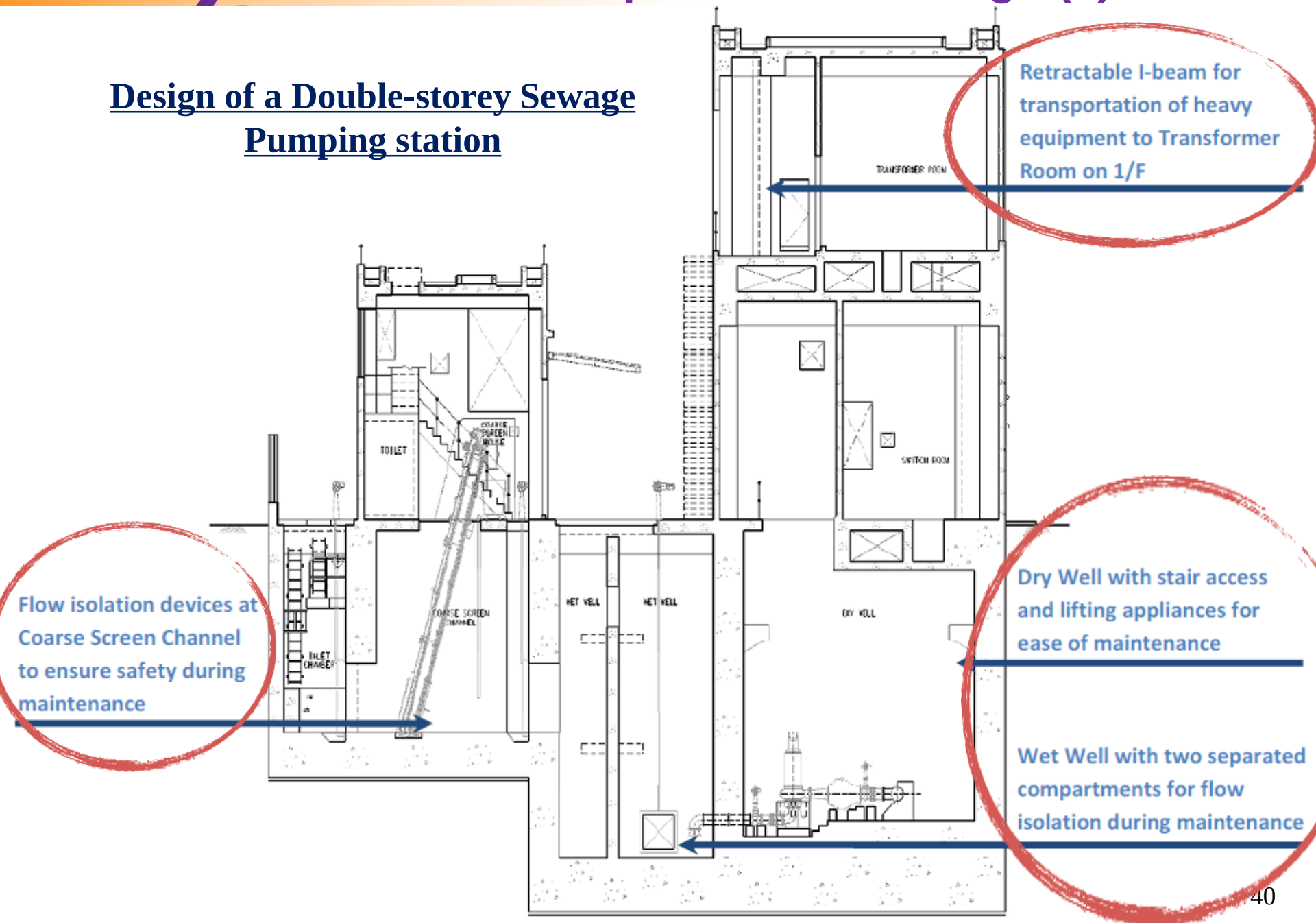


Brainstorming Sessions to Identify Potential Risk Items of Project (examples)

Hazard and Impact Summary						
Task	Hazards and Impacts	Risk Assessment Rating	Control Measures	Hazards Resolved (Yes/ No)	Necessity to Notify Contractor (Yes/ No)	Other relevant parties to be notified
Construction and Maintenance for Deep Sewer	• Ground water intrusion during construction • Work at height during construction • Risk of falling during access of manhole • Higher risk in confined space	4	- Alternative design scheme of a double-storey SPS was proposed and deep sewer was avoided at Kau To Shan - Alternative design scheme of steeper sewer with epoxy lining and grade 40 concrete manhole instead of relying on backdrop manholes	Yes	No	DSD
Maintenance In large Diameter Trunk Sewer	• Impractical to isolate large flow • Long-distance Pumping infeasible	4	- Provision of twin pipes	Yes	No	DSD

Examples of Safe Design (1)

Design of a Double-storey Sewage Pumping station





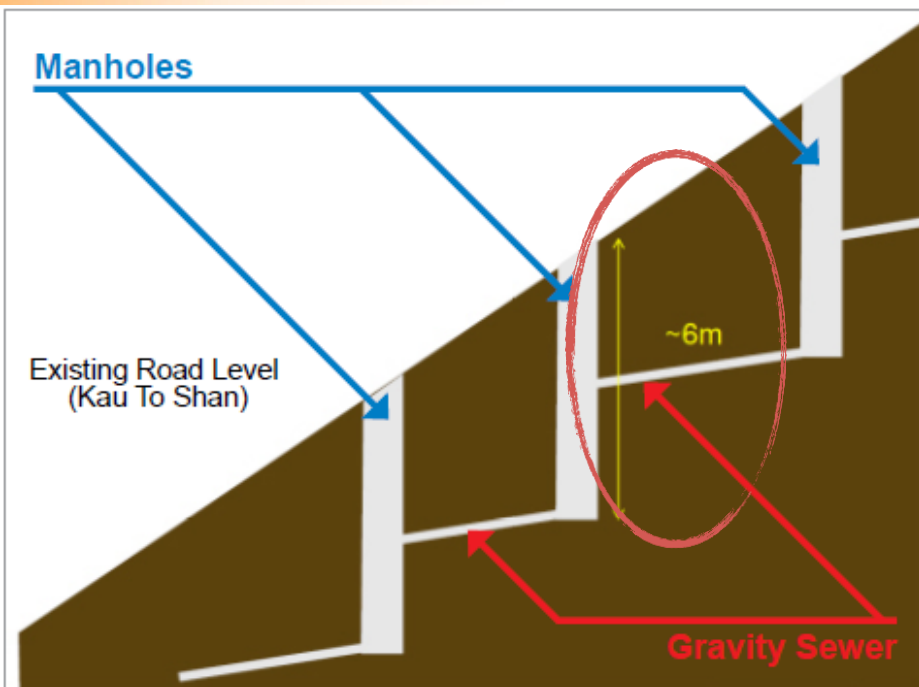
Examples of Safe Design (2)

DESIGN FOR SAFETY

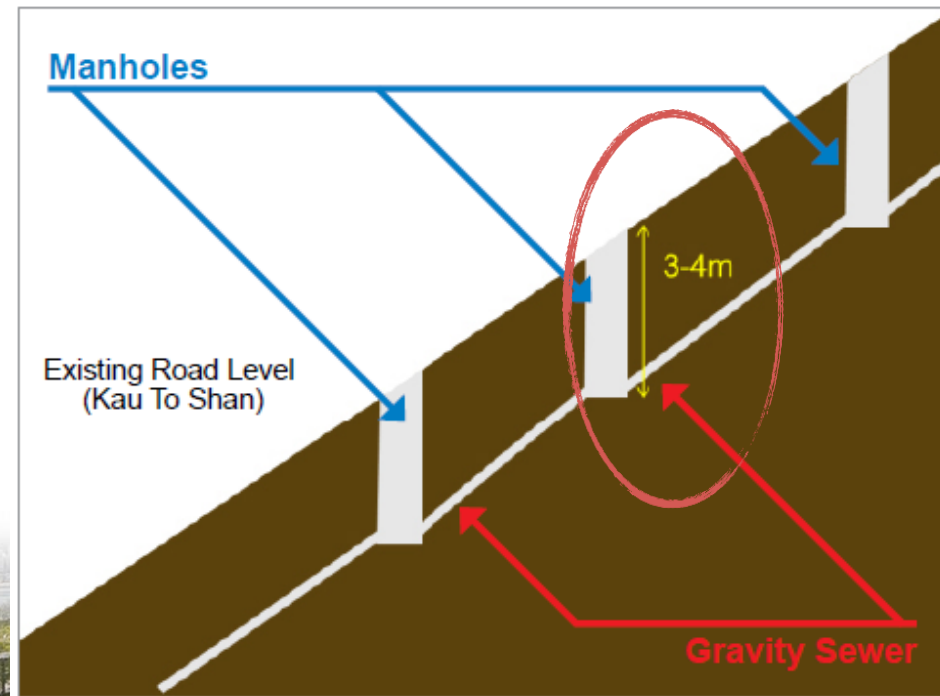
Improvement in Design of Sewers at Steep slope

- The Project Team explored the way for constructing the sewers with a steeper gradient and hence shallower depth from road level

Conventional Design



Alternative Safe Design



Examples of Safe Design (3)

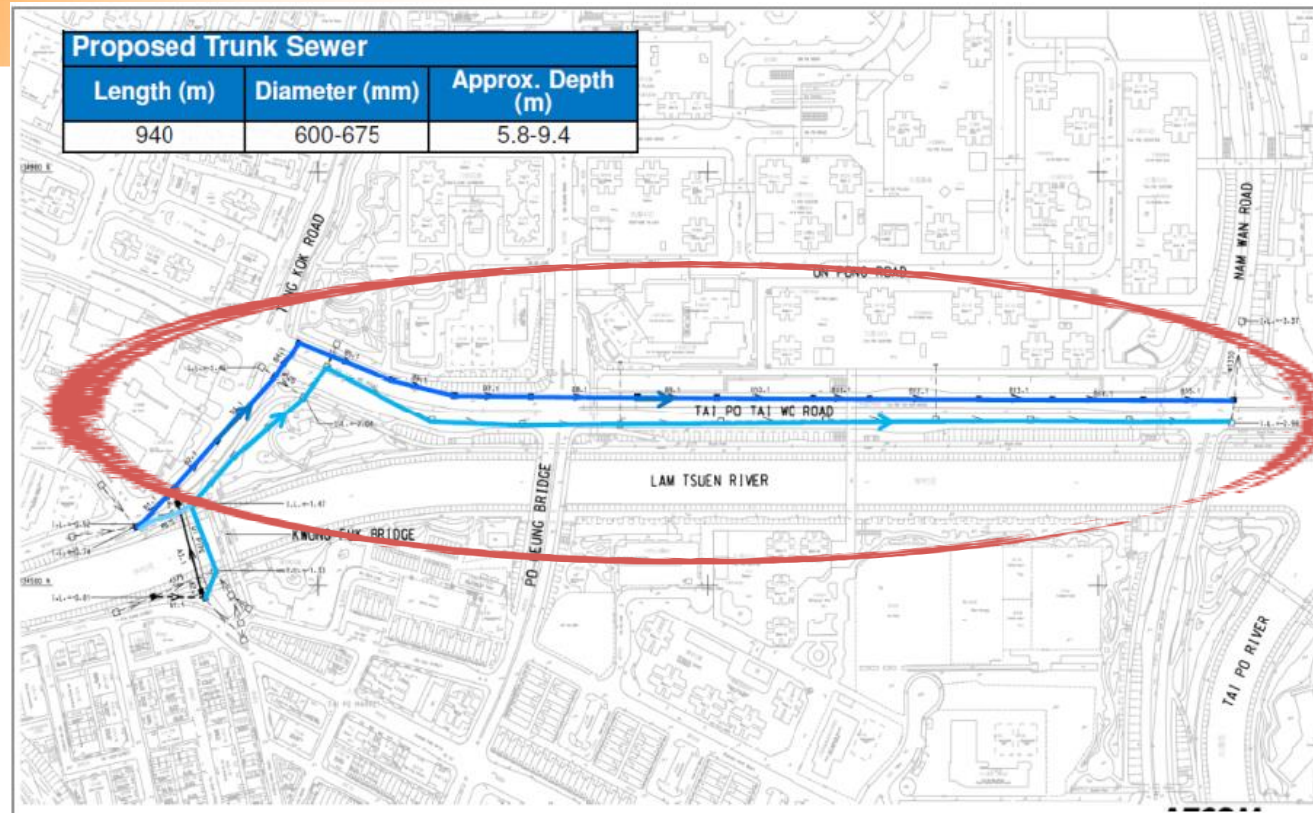
DESIGN FOR SAFETY

Design a New Twin Pipe System with Diversion Switch Arrangement

- In case of inspection and maintenance, one of the twin pipes could be shut and the sewage could be temporary conveyed by the other one
- Safety hazard was therefore eliminated by allowing workers to work in dry condition



Proposed Trunk Sewer		
Length (m)	Diameter (mm)	Approx. Depth (m)
940	600-675	5.8-9.4





DESIGN FOR SAFETY

魯班 - 中國土木工匠的祖師，
古代最出色的建築師、木匠和發明家

Lo Pan - the Patron Saint of Chinese Builders and Constructors, the
genius builder, carpenter and inventor in ancient China

「準繩分曲直，規矩定方圓」

“Thread regulates Criteria, Compass regulates Radii”

時至今日，安全更正正是其中一個決定設計的考慮因素，
劃定方圓的規矩！



Today, Safety is one of the important considerations that
regulates the Design!



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