LESSONS LEARNED:
Best Practice for Quality Architecture

A Chapter on Ceiling System:
What Went Wrong,
What Can Be Learned and What Can Be Done

6th November 2019 :: Dewan Memorial Tun Hussein Onn, Kuala Lumpur

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| Objective

The objective of this presentation is to:

1. **Identify the source of problems** associated with installation failure or damage to the ceiling system

2. **Find and provide the best technical advice** in solving the root causes of installation failure or damage to the ceiling system

3. **Establish best practices** in installing the ceiling system based on the findings of lesson learned

4. **Create** a **knowledge-sharing platform** for designers

List of Content

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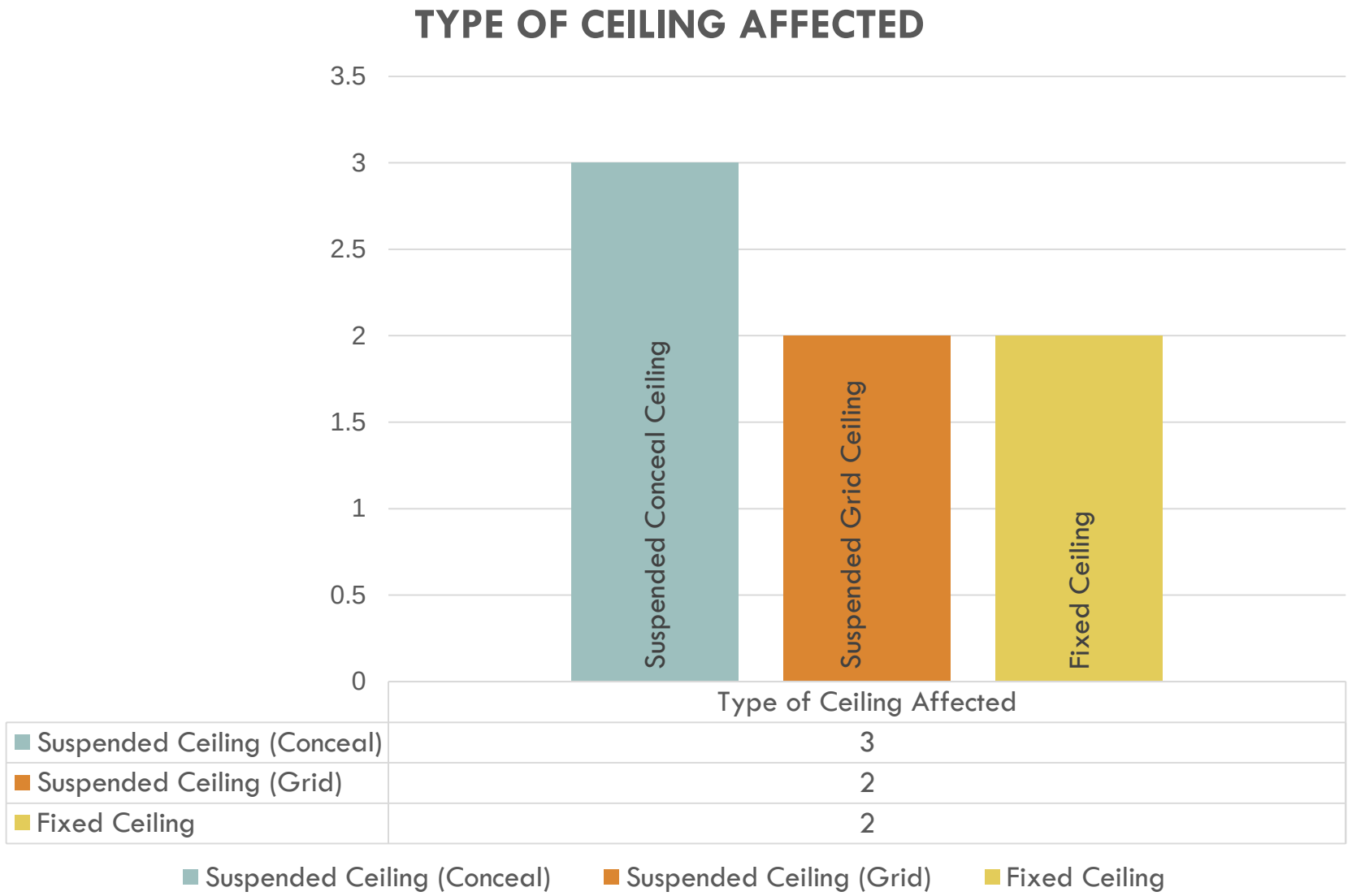
Background:

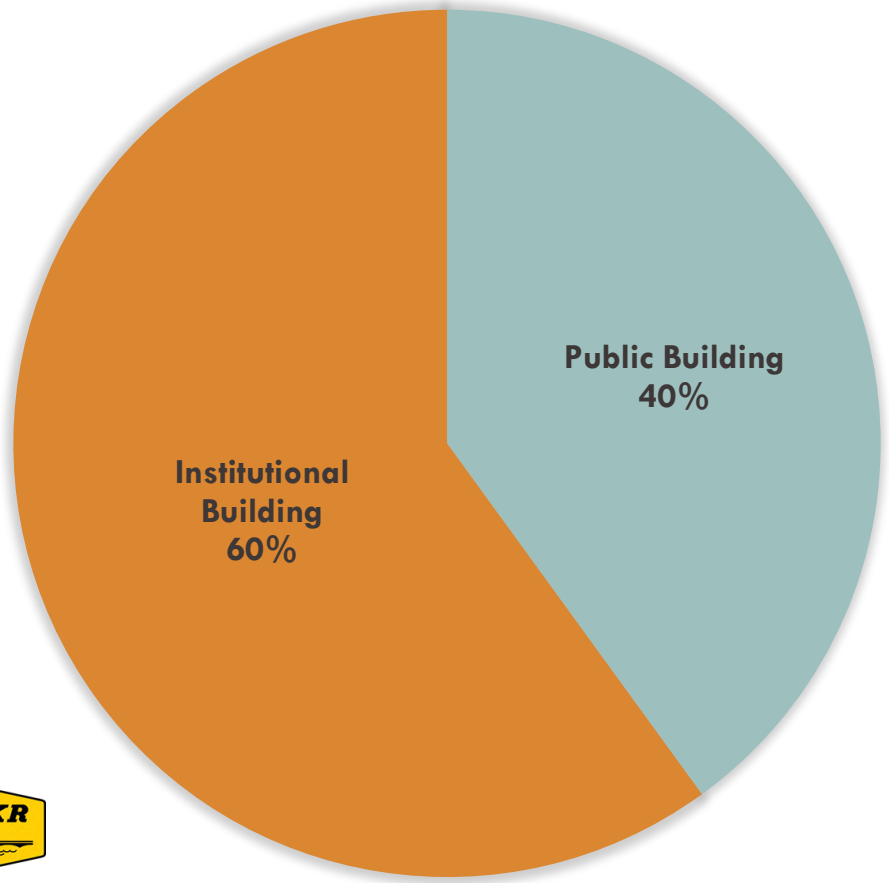
1. Ceiling Failures Stastistic Report 2017

Statistics for Architectural Forensic Inspection that Involve Ceiling System Failure For Year 2017



Statistics for Architectural Forensic Inspection that Involve Ceiling Failure For Year 2017

BUILDING CATEGORIES EXPERIENCE CEILING FAILURE /DEFECTS



TOTAL:

5 PROJECT/BUILDINGS

Public Building: **2** building	Hospital Besar Terengganu
	Masjid Bandar Springhill NS
Institutional Building: **3** building	SPRM Melaka
	INTAN Sarawak
	Pusat Islam UMT Terengganu

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CASE STUDIES:

Ceiling Failure (Inspection & Findings)

Case Study are about:

Investigating the problems caused by poor specification or poor quality of workmanship.

The case studies will discuss on:

Different types of ceiling systems and materials used, various building typology and site conditions that represent different conditions in which ceiling failure and defects occur

Inspection Methodology

1

DOCUMENT REVIEW (DRAWING/CONTRACT)

Review all related drawing/document: As-Built dwg./ Construction dwg./ Contract doc./ specifications/ standards

SITE INSPECTION

2

Conduct site inspection and investigation to identify causes and to determine the degree of failure or defects

3

INTERVIEW

Carry out interview with the parties involved to gather the case chronology and related information

RECORD OF FINDINGS

4

Record all findings and observation in written form and by photos

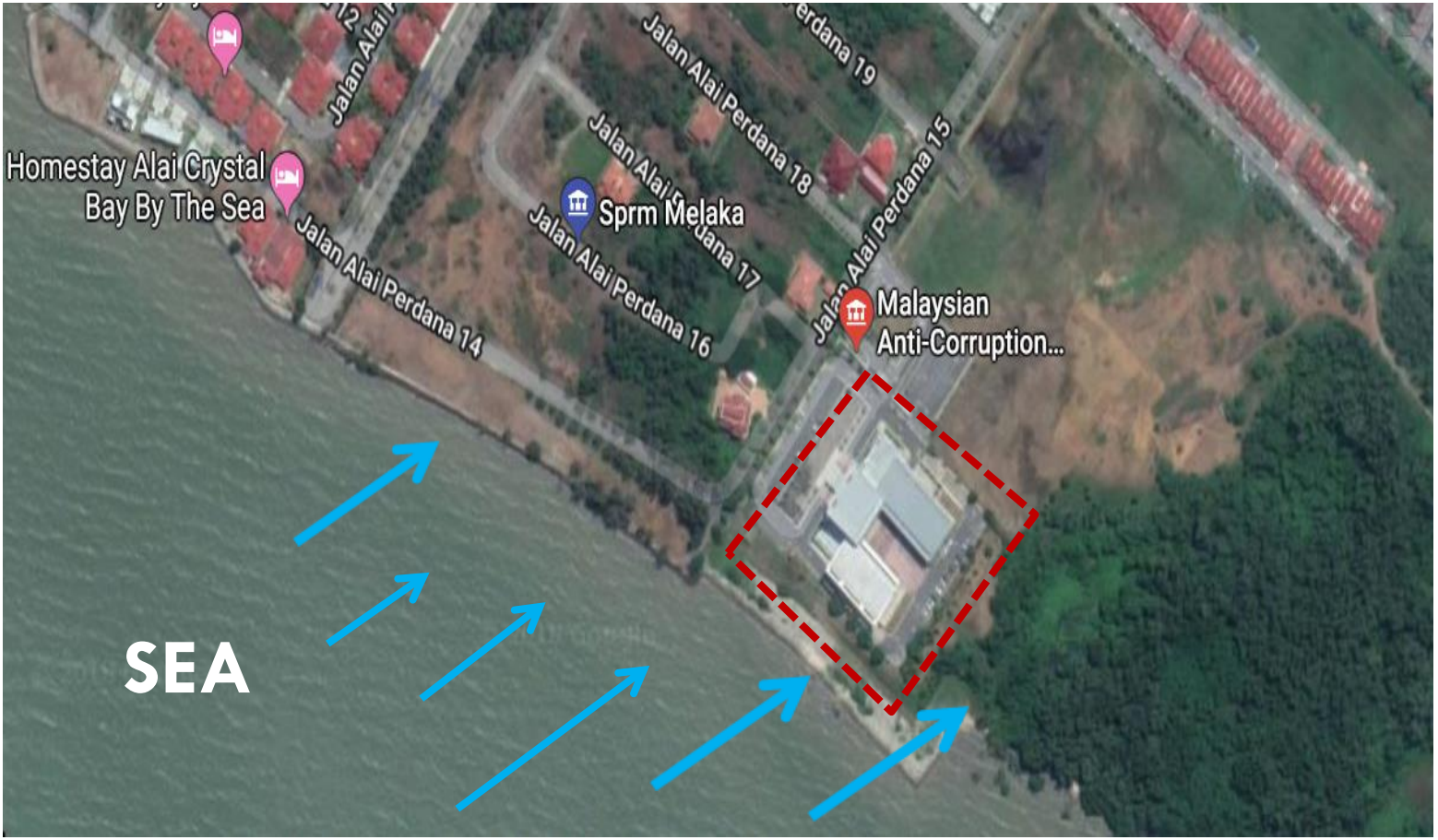
2 Case Study 1: Pusat Islam Universiti Malaysia Terengganu

LOCATION	**KUALA TERENGGANU, TERENGGANU**
SITE TOPOGRPAHY /GEOGRAPHICAL	▪ Coastal area ▪ Expose to direct wind and weather ▪ Mangrove area
BUILDING FUNCTION	▪ Mosque ▪ Lecture Hall ▪ Lecture Room

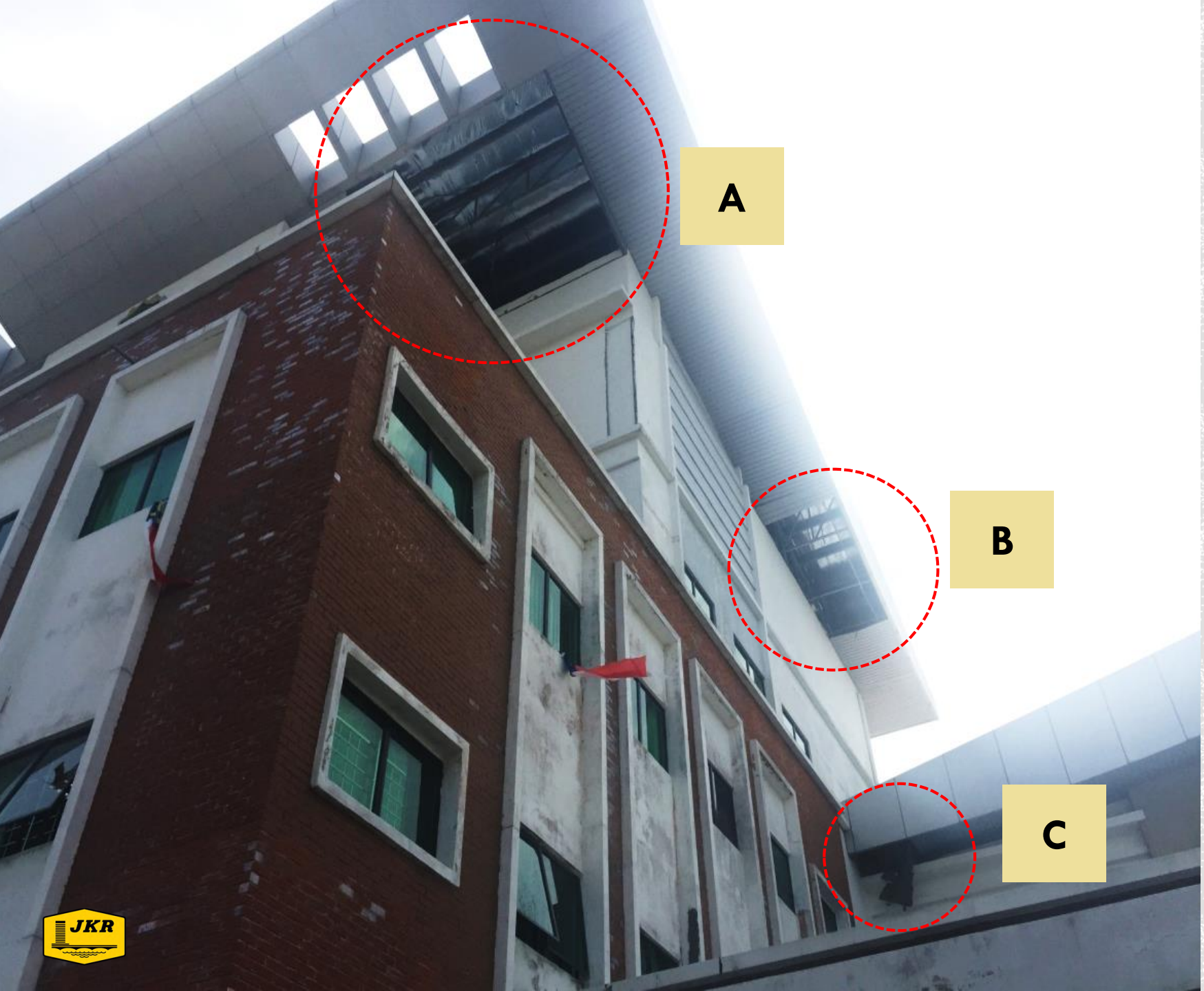
Type of Ceiling: Aluminium Strip Ceiling

- **Failure/Defects:** Aluminium Strip Ceiling Collapsed
- **Location:** Mosque's Verandah

2 Case Study 2: Bangunan Ibu Pejabat SPRM Melaka



LOCATION	**TELOK MAS, MELAKA**
SITE TOPOGRPAHY /GEOGRAPHICAL	▪ Coastal area ▪ Expose to direct wind and weather
BUILDING FUNCTION	▪ Regional Headquarter Office



Type of Ceiling: Aluminium Strip Ceiling

- **Failure/Defects:**
  External aluminium strip ceiling plunge into the balcony area
- **Location:**
  Roof Top Floor
  (Main office building)
  Third Floor
  (Balcony Area)

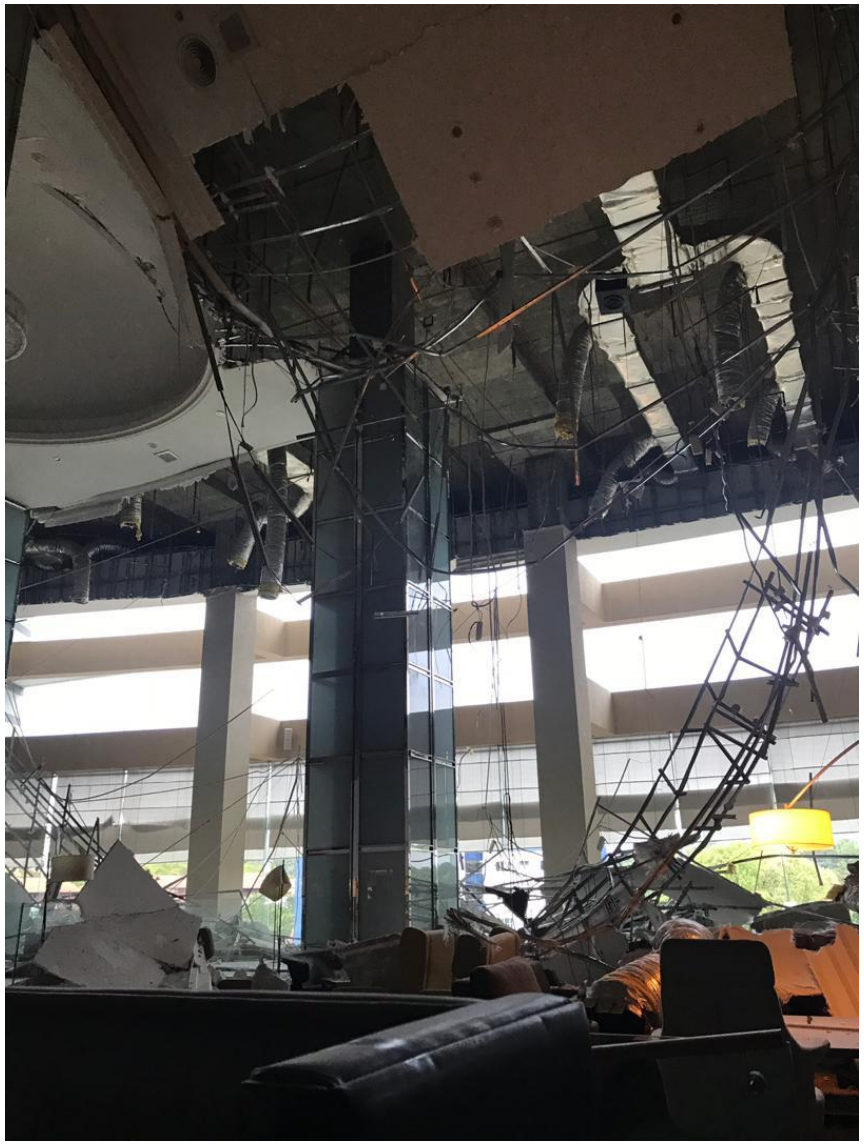
Ceiling failure is not a problem exclusive to government buildings. It affects buildings in the private sector too

Concorde Hotel Shah Alam

13th March 2014

A portion of the ceiling of the Concorde Hotel here collapsed but no casualties or injuries were reported.

It is learnt that the hotel was undergoing upgrading works but it is not known if the ceiling collapsed due to construction work.



KL Hilton

14th October 2018

KUALA LUMPUR: A foreign worker suffered head injuries after falling some 40 feet, when the plaster ceiling of the lobby at the Hilton Kuala Lumpur in KL Sentral came crashing down early this morning.

According to a report from the KL Fire and Rescue Department, the ceiling collapsed just before 3.40am. At the time, repairs were being carried out on the electrical wiring.

Some 1,500 square feet of the ceiling collapsed, causing the foreign worker from Bangladesh to fall.

He was treated at the site by emergency services before being sent to the Universiti Hospital in Petaling Jaya.

A Hilton Kuala Lumpur spokesman said during an overnight routine maintenance work on the ceiling lobby by an approved maintenance contractor, an incident occurred causing a part of the ceiling to give way. The area will be temporarily closed to the public

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JKR's Standard Ceiling Specification for Building Works

ATTACHMENT ASSEMBLY - UNIVERSAL

Manufacturing Standard: ASTM C635
Number of components to form system: Three (3)
Compatible system: Universal Acoustical Ceiling Grids

Component 1)

M6 x 30mm zink plated proprietary anchor fastener with matching nut and washer for reinforced concrete sockets along with soffit cleat made of galvanized steel min. 25mm x 25mm x 2mm thk. With a galvanization of 80g/sq.m for suspending the pre-straightened hanger rod.

Component 2)

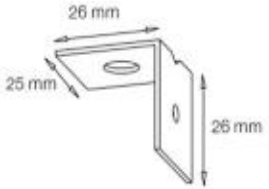
Pre-straightened hanger wire: Machine straightened wire of 4mm diameter with a galvanization of 80g/sq.m with min tensile strength of 350MPa. The wire rod should be used in conjunction with adjustable rod joiner (hook clip) or directly to main beam.

Component 3)

Adjustable rod joiner (hook clip) shall be butterfly type proprietary system. –connected to 4mm diameter straightened hanger wire 2 nos. with minimum pull-out strength of 100kgs.

Component 1a & 1b

M6 Anchor Fastener
Used to secure the ceiling suspension hanger wire to the structural soffit/deck



SOFFIT CLEAT
Connects Anchor Fastener and steel wire - 26x26x25x1.2mm

Component 2

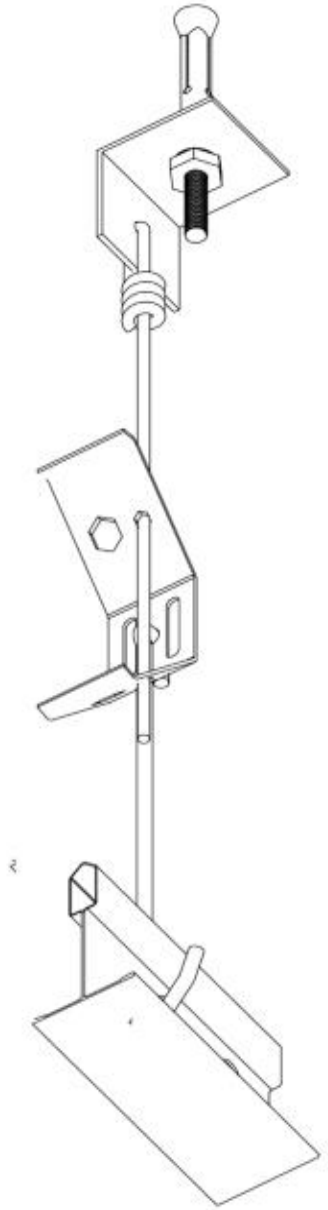
Hanger Rod
(∅4.0mm)
Used to hang suspended ceilings from structural deck

Hanger Wire Specification

Description	Specification
Diameter	**4.00mm**
Length	1828.80 mm
Galvanized Coating	80g/m²
Tensile Strength	**Min. 350** MPa

Component 3

Hook Clip
Connects **4.0mm** hanger wire to the main runner; recommended for renovation & fast track applications; provides easy adjustment of ceiling height.
Min. Pull-out strength: 110kgs



Typical Proprietary Suspended Ceiling System Components

6.16 Suspended Ceiling Exposed to Wind (Outside Building).

6.16.1 Wind Load

6.16.1.1 The minimum basic wind speed shall be 35 m/s. However, the minimum basic wind speed shall be increased to 41 m/s for lightweight covering.

6.16.1.2 The requirement of wind load shall be as stated in the MS 1553 – Code of Practice on Wind Loading for Building Structures. The minimum basic wind speed shall be as specified above or as per the value stated in MS 1553 whichever higher.

6.16.1.3 Load combinations shall be clearly identified (as per MS EN 1993 Part 1 to Part 3 or other equivalent standards recognised internationally) and itemised to enable design checking to be carried out upon the most adverse conditions or the effect (e.g. effect of uplift) under consideration.

6.16.1.4 Where grid ceilings system is installed to areas exposed to wind condition (outside buildings), all lay-in ceiling panels/boards shall be secured to the suspension system with minimum two proprietary `hold-down clip' for each tile as recommended by the manufacturer and approved by the S.O. Installation shall refer to manufacturer's method statement.

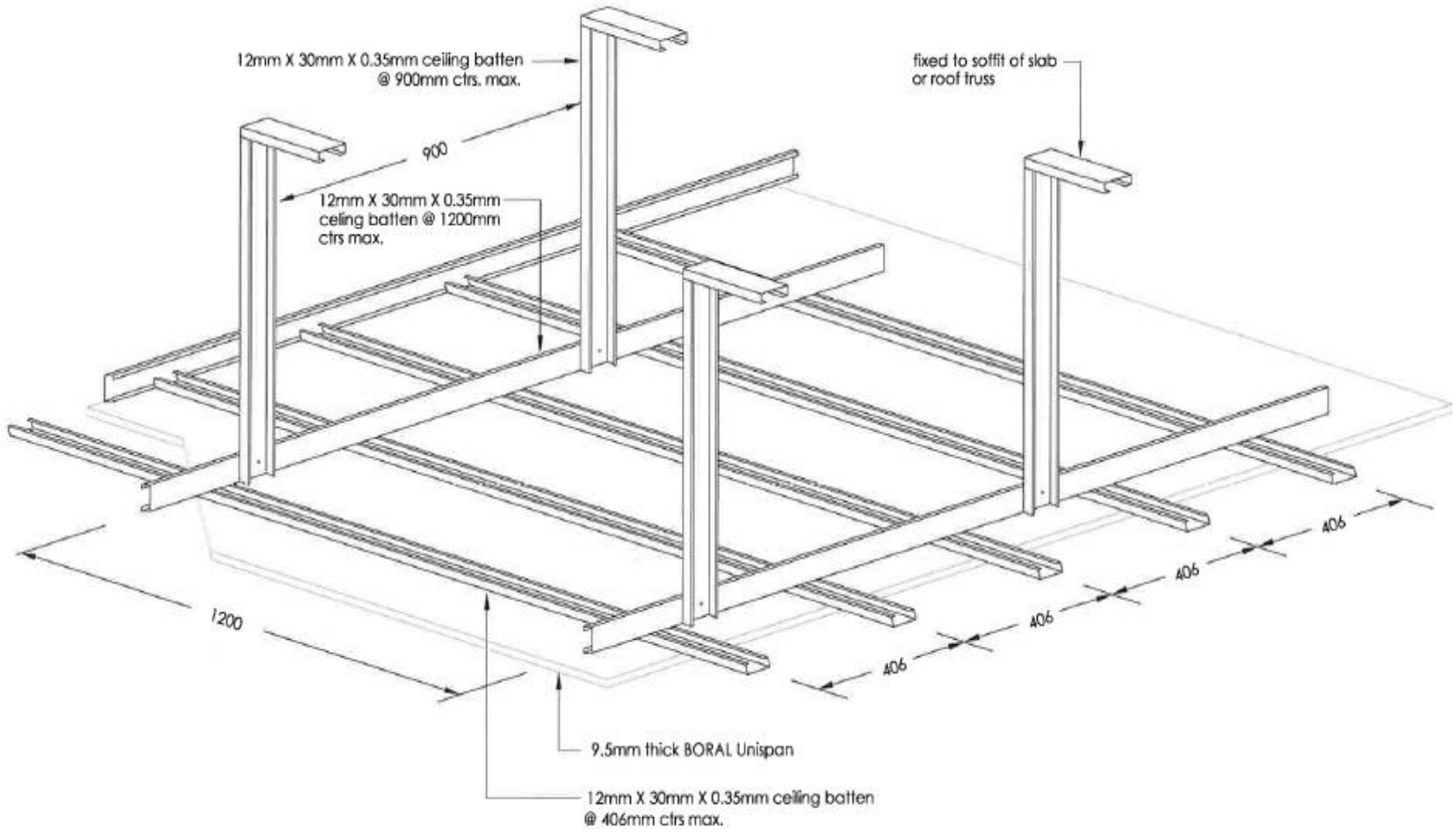
6.16.1.5 The Contractor shall submit manufacturer's shop drawings and design calculations for the complete proprietary ceiling system showing compliance to all specifications including the method of installation of the ceiling board/panels, hangers, fittings and all accessories duly certified by a P.E. with practising certificate registered with the Board of Engineers Malaysia.

Description on tender drawings:

- refer to engineer's detail
  (rujuk butiran/perincian Jurutera)
- refer manufacturer's specification/shop drawings
  (rujuk butiran pengeluar)
- Installation refer to Method Statement

Ceiling Specification

On Detail Drawings



Suspended Seamless / Concealed Grid Ceiling

600mm X 600mm X 9.5mm thk UniSpan Gypsum PlasterBoard with Plaster & Paint (PC1)

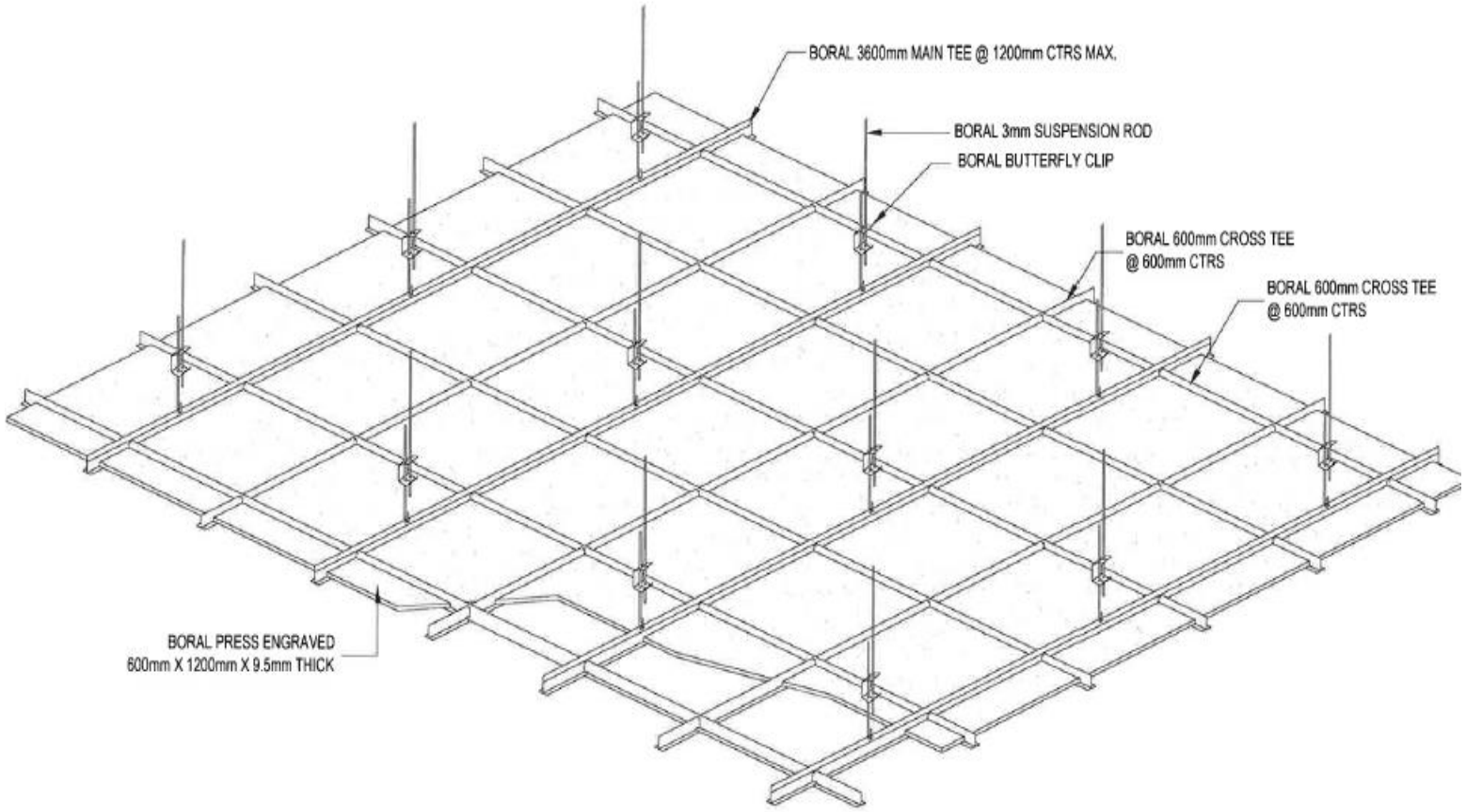
CONCEAL CEILING

Specifications for
Hospital Parit Buntar (76 Beds)

- Ceiling batten system
  12mm x 30mm x 0.35mm thk.
- Distance of hanger 900 x 1200 mm
- Plasterboard thickness 9.5mm

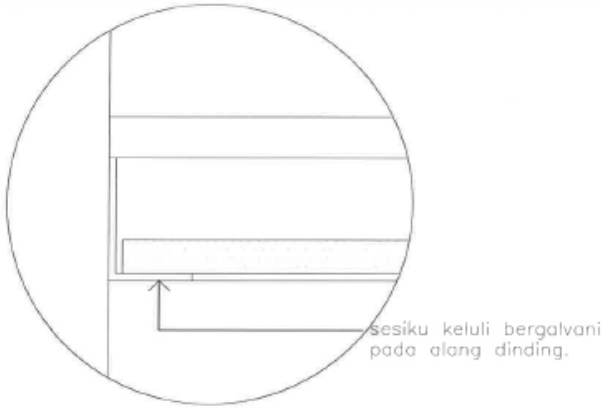
GRID CEILING

Specifications for
Hospital Parit Buntar (76 Beds)

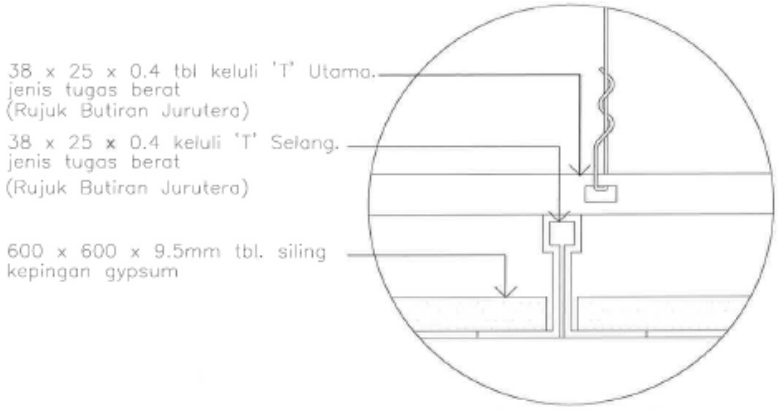


Suspended Exposed Grid Ceiling
600mm X 600mm X 9.5mm thk Press Engraved Gypsum Board with Anti-Fungus Paint (GB1)

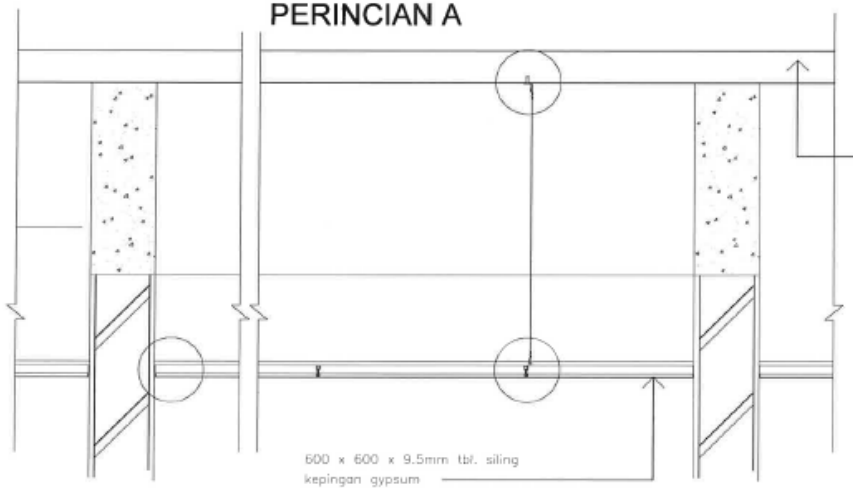
- BRAND : Boral Main & Cross Tee
- Distance of hanger 1200 x 1200 mm
- Plasterboard thickness 9.5mm
- Boral 3mm suspension rod



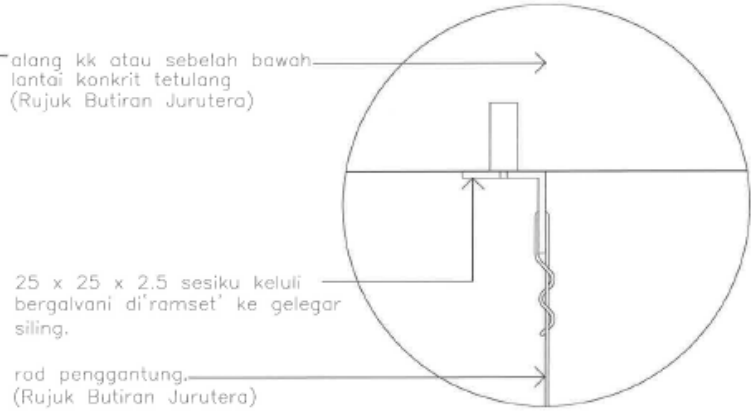
PERINCIAN A



PERINCIAN C



KERATAN TIPIKAL



PERINCIAN B

PENGARAH KANAN CAWANGAN ARKITEK: Ar. ZAINUL AZIDIN BIN BADRI	ARKITEK PENGUASA KANAN: Ar. YONG RAZIDAH BINTI RASHID	PROJEK: CADANGAN MEMBINA DAN MENYIAPKAN HOSPITAL PARIT BUNTAR (76 KATIL) PARIT BUNTAR. PERAK DARUL RIDZUAN	TAJUK LUKISAN: SUSPENDED CEILING BOARD
ARKITEK KANAN: Ar. HANI YULIATI MOHD LASA	ARKITEK: SITI NOR FAIZAH BT OMAR		NO. LUKISAN: JKR/CA/10/26/A14/024/A-B/SL/2
			PINDAAN / DILUKIS: RAD / DISEMAK: MAR / SKALA: NTS / TARIKH: 2017

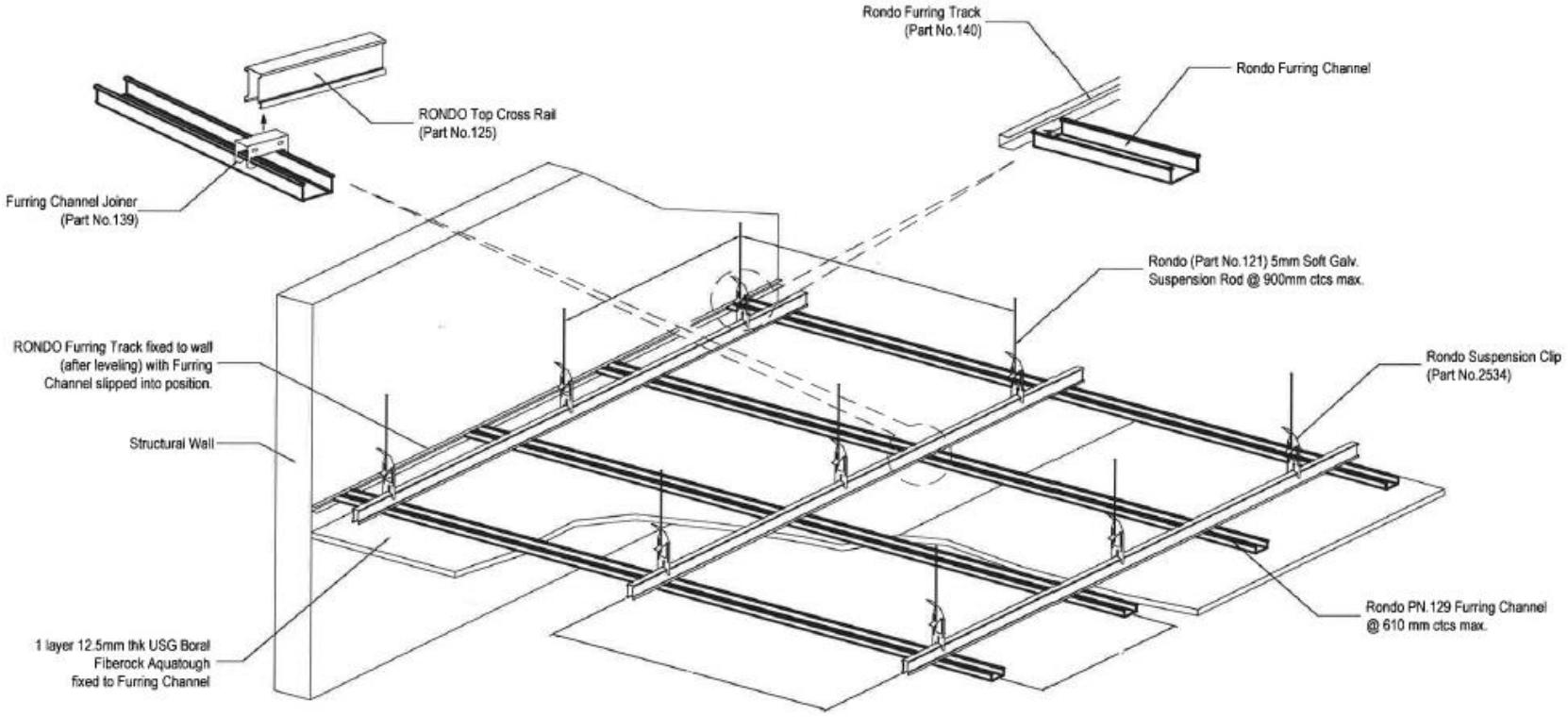
CAWANGAN ARKITEK

JKR

GRID CEILING

Specifications for
Hospital Parit Buntar (76 Beds)

- Main & Cross Tee to engineer's detail
- Fixed to soffit slab or truss to engineer's detail
- 25 x 25 x 2.5 galvanized angle attached ramset fixing to ceiling joist Plasterboard thickness 9.5mm
- Suspension vertical rod refer to engineer's detail
- Plasterboard thickness 9.5mm



Suspended Seamless / Concealed Grid Ceiling
600mm X 600mm X 12.5mm thk Fiberock Aquatough Gypsum PlasterBoard
with Plaster & Hygienic & Anti-Fungus PU Paint (PC3)

Note:
Assumed Ceiling Drop Height = 3300mm
External Ceiling with ultimate Wind Pressure
P = 1.2kPa ; Uplift = 0.90kPa

CONCEAL CEILING

Specifications for
Hospital Parit Buntar (76 Beds)

- ❑ Ceiling Type
- ❑ Brand Specified
- ❑ Fixed to soffit slab or truss to engineer's detail
- ❑ Vertical hangers at 900mm c/c grid
- ❑ Suspension vertical rod 5mm diameter
- ❑ Plasterboard thickness 12.5mm

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Conclusion

1. Highlighted Issues
2. What Went Wrong,What Can Be Learned and What Can Be Done
3. Way forward

Highlighted Issues

A Safety Issue

- Occupant safety must be a priority in designing strong and secure the architectural components
- Majority of the building that affected by ceiling installation failures are public buildings such as hospitals, mosques and institutional buildings.

B Structural And Building Integrity

- Failures is closely related to structural integrity of all the building components;
- Root cause of the problem should be identified and resolved in advance before any remedial action can be done.
- In most cases the structural integrity of the building components had been compromised. For instance; the ceiling installation are not in accordance with the specification or method statement

C Inter Disciplinary Scope

- Design and installation of the ceiling system involves a wide scope of various discipline such as structural roof systems, electrical and mechanical system.
- Coordination between disciplines is critical and crucial especially during the design process up until the construction stage to ensure there are no modification made to give way to any scope of work.

D Method Statement And Specification

- The materials shall comply with JKR standard /specification and the installation must be in accordance with the system provider method statement.

E Appropriate And Practical Design Solution

- Ceiling system must be a proprietary system that includes both product and installation warranty.
- Design consideration should take into account the condition/ function/location of buildings and surrounding (site context) for present and future purpose

What Went Wrong
What Can Be Learned
What Need To Be Done

WHAT WENT WRONG?

- Non-compliance with technical specifications and method statement
- Use of non-proprietary type ceiling system,
- Inadequate design consideration and analysis and;
- Lack of coordination and supervision on site

WHAT CAN BE LEARNED?

- Design considerations for the selection of ceiling designs should take into account the function of the building (technically and aesthetically),
- Site environmental conditions and;
- Coordination with other disciplines should ideally start during the design stage and should be followed by regular monitoring on site.

WHAT NEED TO BE DONE?

- Adequate design consideration is given during the design stage
- Compliance to technical requirements, standards and specifications.
- The ceiling system shall be of a proprietary system and with product warranty
- Coordination and supervision on site between all disciplines/SO/ contractors/suppliers/installers.

Way Forward

1 Not all method fits all condition

- Designer must be sensitive in selection of ceiling system for the right built environment

2 Better knowledge and understanding on the specification and performance of the ceiling system

- Project and design team must familiarize with contract document and construction drawing.
- If any shortfall in the information, should request for information (RFI) from design office

3 Better coordination of ceiling installation work

- Coordination of works between various discipline should be carried out frequently.
- Training to JKR's site supervision team

Thank you