CERAMAH TOPIK 4

UJIAN MUSNAH & UJIAN TANPA MUSNAH

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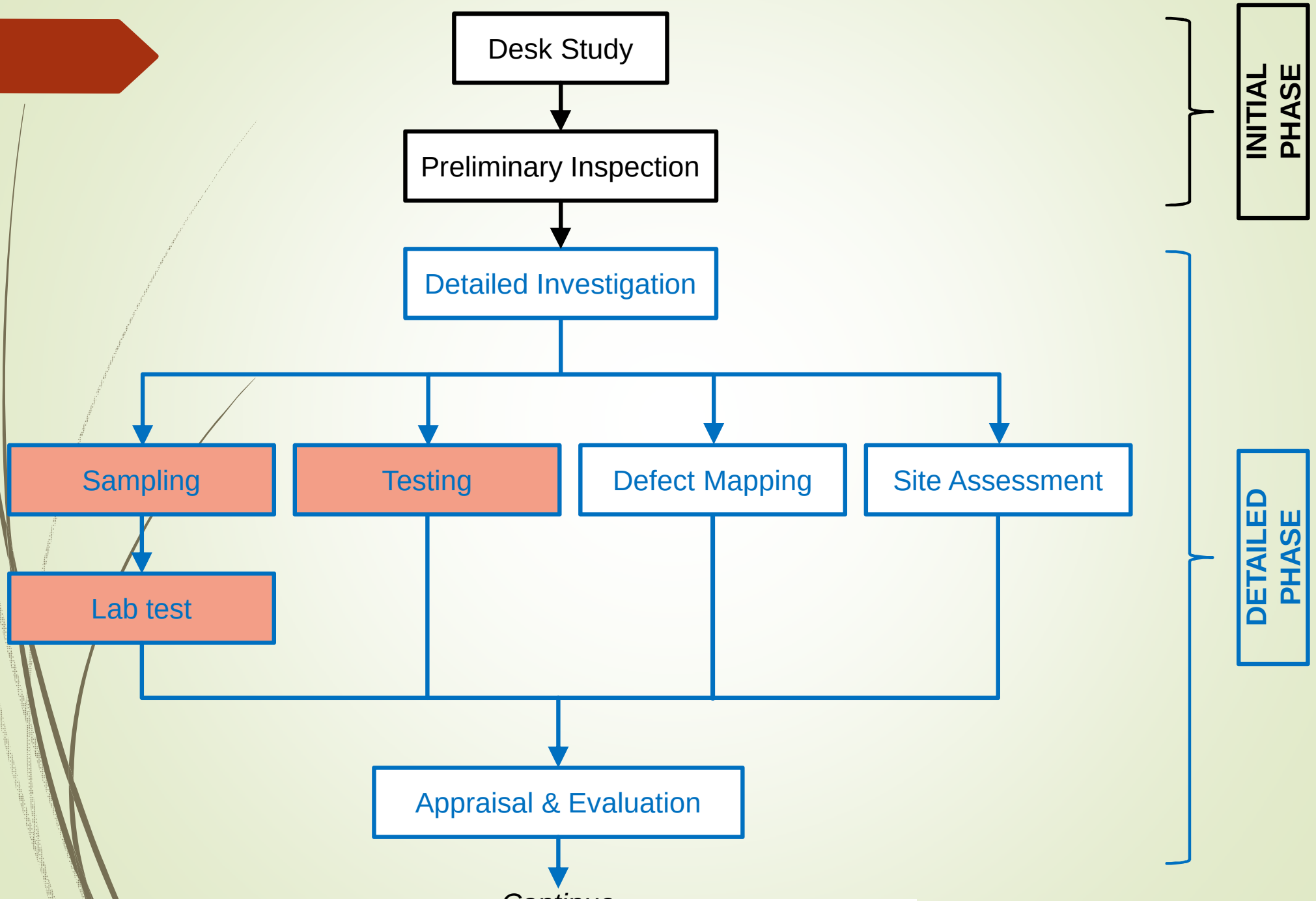
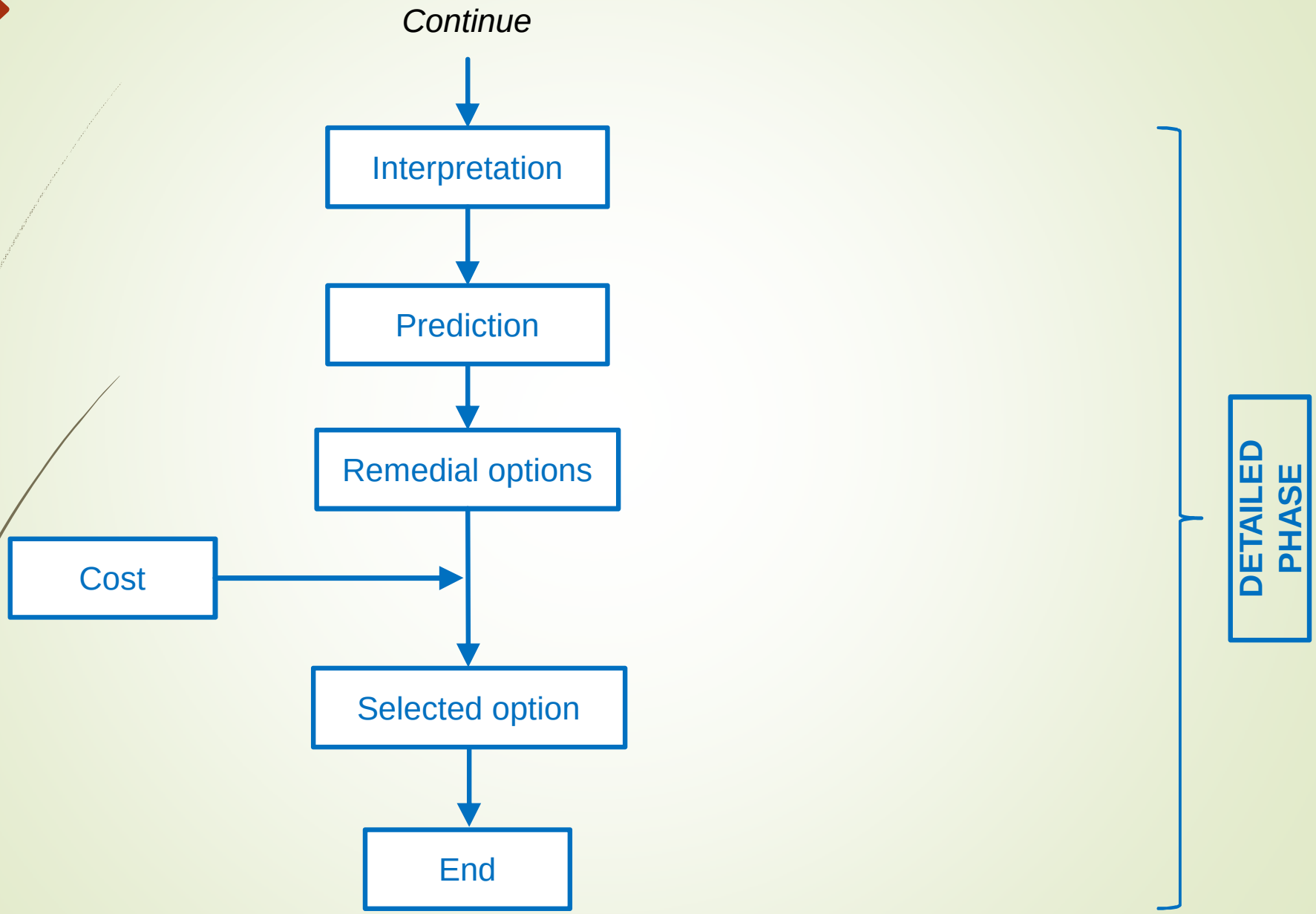
Bahagian Perkhidmatan Forensik Struktur
Cawangan Kejuruteraan Awam & Struktur
Ibu Pejabat JKR Malaysia

Structural Assessment Process (1)



Structural Assessment Process (2)



Structural Assessment Process (3)

DETAILED PHASE

Sampling & Testing

Sampling and testing ("Ujian")

- ✓ Core sampling
- ✓ Carbonation
- ✓ Petrographic analysis
- ✓ Half-cell potential
- ✓ Rebound hammer
- ✓ Ultrasonic pulse velocity
- ✓ Cover measurement
- ✓ Rebar size & location
- ✓ Chloride & sulphate tests

DETAILED PHASE

DESTRUCTIVE TEST (DT) & NON-DESTRUCTIVE TEST (NDT) FOR CONCRETE STRUCTURES

Keperluan Ujian Bahan (MS EN 13791 2014):

- ✓ Apabila struktur sedia ada diubahsuai
- ✓ Apabila timbul keraguan terhadap struktur akibat kualiti pembinaan yang tidak memuaskan, kes kebakaran dll.)
- ✓ Apabila penilaian konkrit diperlukan pada peringkat pembinaan
- ✓ Apabila ujian mampatan konkrit piawai tidak dipatuhi (non-conformance)
- ✓ Apabila penilaian pematuhan konkrit telah ditetapkan dalam spesifikasi atau piawaian sesuatu produk

Kaedah Ujian untuk Penilaian Konkrit

Sifat Mekanikal

- Kekuatan Mampatan
  - -Ujian Teras (1)
  - -Proba Windsor (3)
  - -Tukul Rebound(2)
- Kualiti Konkrit
  - -Ultrasonic Pulse Velocity (UPV) (4)
- Kekuatan Tegangan
  - - Ujian *Pull-Off*
  - -Kekuatan Tegangan *Splitting (5)*
- Kekuatan Lenturan (Flexural) (6) (7)
- Rintangan Lelasan (Abrasion Resistance) (8)
- Kekuatan Ikatan (Bond)
  - Ujian *Pull-Off*

Kandungan Kimia

- Aktiviti Elektrokimia
  - Half-Cell Potential (9)
  - Rintangan Elektrik (10)
- Kedalaman Karbonasi
  - Indikasi Fenolftalein
  - Analisa Petrografik (11)
  - Difraksi X-Ray
  - Spektroskopi Infrared
- Reaksi Alkali-Agregat
  - Analisa Petrografik
  - *Uranyl Acetate Fluorescense Method*
- Kandungan Klorida (12) (13) (14)

Keadaan Fizikal

- Keseragaman
- Sistem Air-Void
- Pelekangan/Ruang Udara
- Lokasi / Keadaan Besi Tertanam
- Kebolehtelapan Air
- Kebolehtelapan Udara
- Kebolehserapan Air (19)
- Rintangan Beku-Cair (16) (17)
- Rintangan Terhadap Garam Pencair

Tingkah – laku Disebabkan Manifestasi Luaran *(External Manifistation – Behaviour)*

*Keretakan / Pengelupasan

*Pesongan dari beban tambahan

*Kebocoran

*Suhu / kelembapan

*Geometri Luaran

Standard Penilaian Konkrit

NO	PIAWAI	TAJUK
1	MS EN 12504-2:2013	Rebound Number of hardened concrete
2	ASTM C 803	Penetration resistance of hardened concrete
3	MS EN 12504-4:2013	Pulse velocity through concrete
4	BS EN 12390-6:2009	Splitting tensile strength of cylindrical concrete specimens
5	BS EN 12390-5:2009	Flexural strength of concrete (using simple beam with third-point loading)
6	BS EN 12390-5:2009	Flexural strength of concrete (using simple beam with centre-point loading)
7	ASTM C 418	Abrasion resistance of concrete by sand-blasting
8	ASTM C 876 / BS 1881:PART 5:1987	Half cell potentials of uncoated reinforcing steel in concrete
9	BS 1881-124:2015	Standard practice for petrographic examination for hardened concrete

Standard Penilaian Konkrit

NO	PIAWAI	TAJUK
11	BS EN 12390-11:2015	Resistance of concrete to chloride ion penetration
12	AASHTO T 260	Sampling and testing for total chloride ion in concrete and concrete raw materials
13	AASHTO T 277	Rapid determination of the chloride permeability of concrete
14	ASTM C 642 / BS EN 12390-8:2009	Specific gravity, absorption and voids in hardened concrete
15	ASTM C 457 / BS EN 480-11:2005	Microscopical determination of parameters of the air-void system in hardened concrete
16	ASTM C 666	Resistance of concrete to rapid freezing and thawing
17	ASTM C 671	Critical dilation of concrete specimens subjected to freezing
18	ASTM C 672 / BS 8500	Scaling resistance of concrete surfaces exposed to deicing chemicals

Peranan Jurutera di Tapak

Memastikan ujian dijalankan mengikut piawaian dan spesifikasi ditetapkan	Menentukan lokasi sebenar ujian di tapak	Memastikan integriti sampel dihantar pihak kontraktor
Keputusan boleh diterimapakai	Lokasi di tapak mungkin berubah disebabkan akses dan lain-lain	Keputusan boleh diterimapakai
Analisis sebenar boleh dibuat berpandukan keadaan sebenar di tapak	Pertambahan atau pengurangan bilangan ujian tidak berlaku	Analisis sebenar boleh dibuat berpandukan keadaan sebenar di tapak

NON-DESTRUCTIVE TEST (NDT)

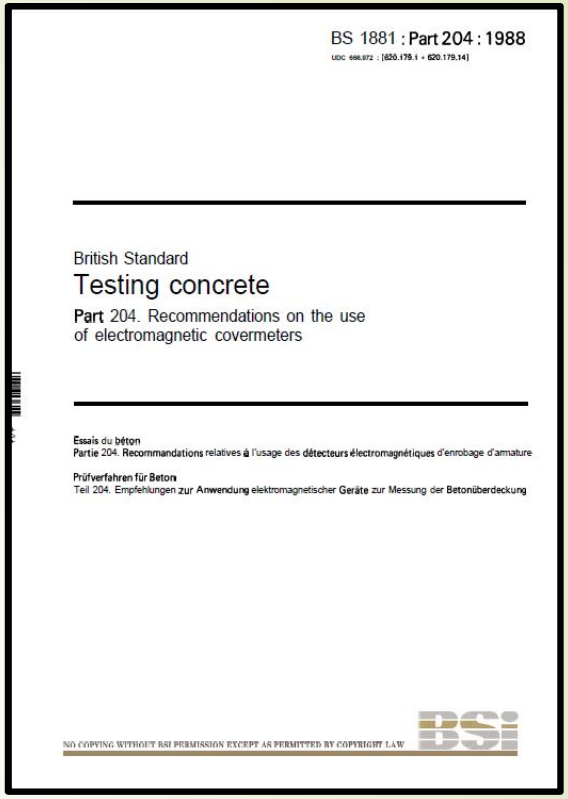
NON-DESTRUCTIVE TEST (NDT)

1. Cover-meter Survey
2. Rebound Hammer
3. Windsor Probe
4. Carbonation
5. Hall-cell Potential
6. Ultrasonic Pulse Velocity (UPV)

COVER-METER SURVEY

BS 1881 Part 204 : 1988

- Juga dipanggil rebar detector / rebar scanner
- Tujuan:
  - ✓ Semak perincian sebenar komponen struktur i.e. concrete cover,bar spacing, bar diameter
  - ✓ Semak kedudukan tetulang keluli sebelum rebound hammer atau ‘coring’


BS 1881 : Part 204 : 1988

British Standard
Testing concrete
Part 204. Recommendations on the use of electromagnetic covermeters

Essais du béton
Partie 204. Recommandations relatives à l'usage des détecteurs électromagnétiques d'enrobage d'armature

Prüfverfahren für Beton
Teil 204. Empfehlungen zur Anwendung elektromagnetischer Geräte zur Messung der Betonüberdeckung

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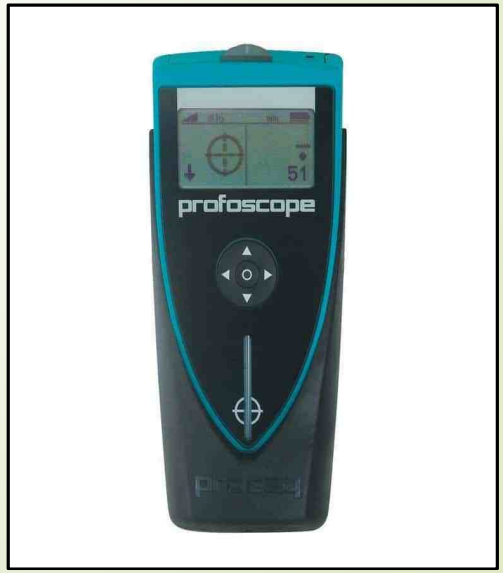
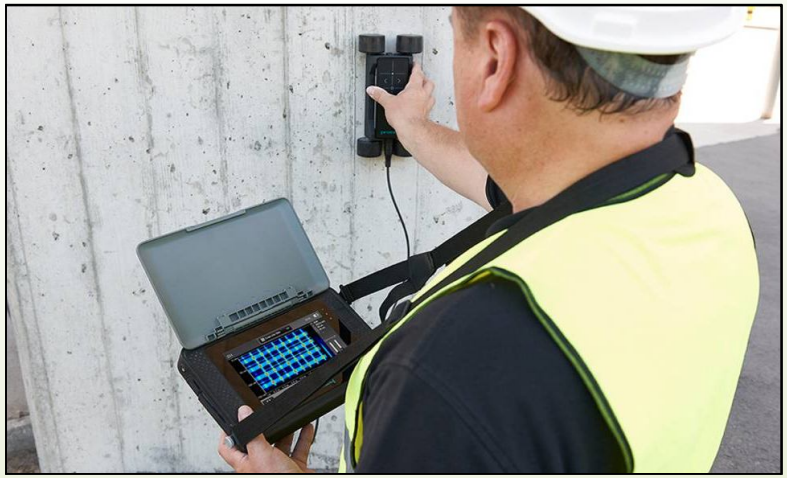
BSI



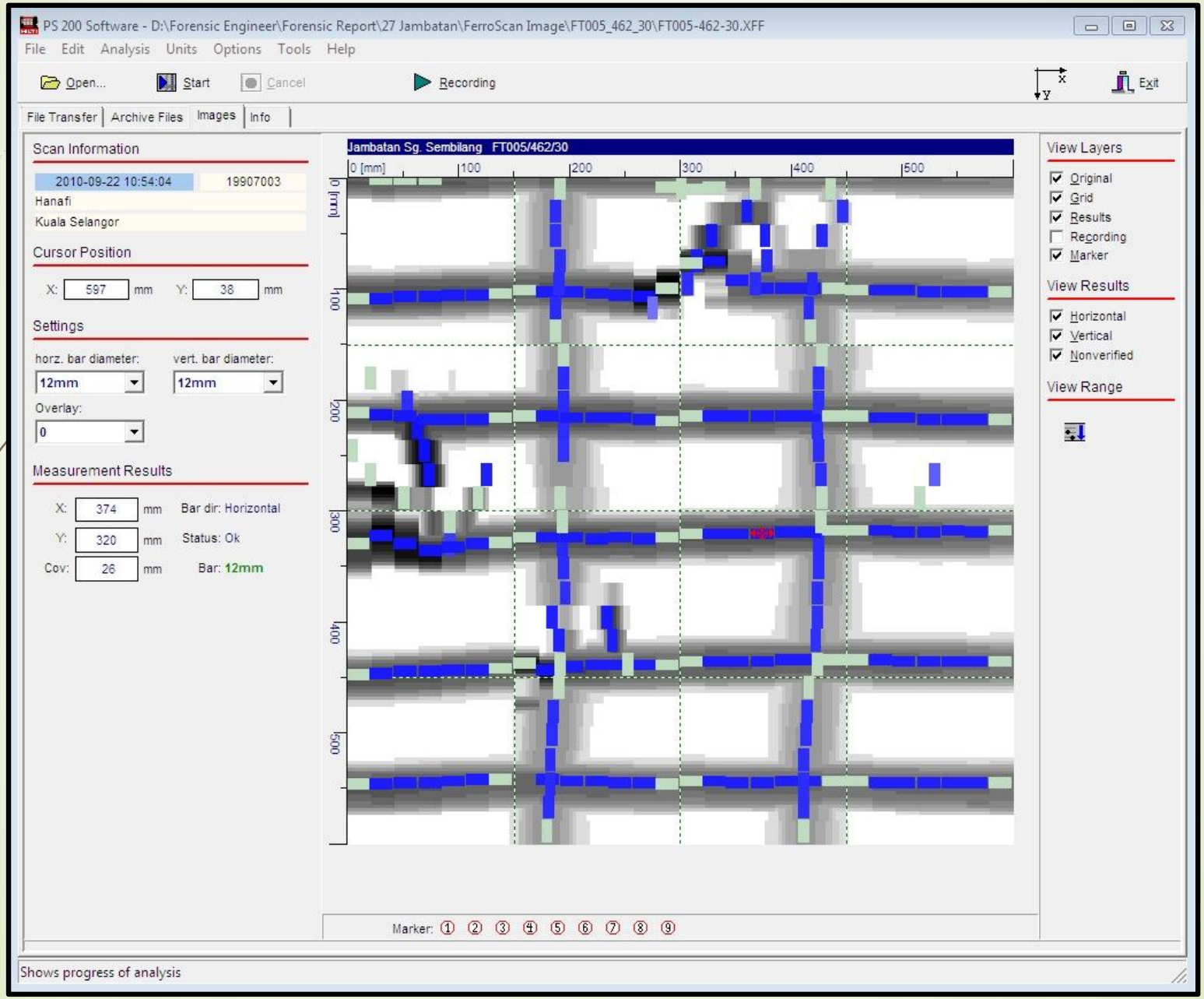
COVER-METER SURVEY

Hilti Ferro Scan



Proceq Profometer

COVER-METER SURVEY



COVER-METER SURVEY

Kekurangan:

1. Keputusan dipengaruhi oleh kehadiran lebih dari satu jenis keluli seperti kawasan tindihan, lapisan kedua, dawai pengikat & penyokong keluli

2. Tidak sesuai pada struktur dengan pemasangan keluli yang rapat

3. Keputusan dipengaruhi oleh tahap pengaratan tetulang keluli (scaling)

4. Gangguan berlaku di kawasan paip besi, conduit elektrik, bingkai pintu & tingkap besi

5. Untuk ketepatan maksimum, peralatan perlu dikalibrasi bagi menghapuskan kesan kandungan besi (iron) dalam agregat dan simen

6. Ketepatan bacaan berkurangan sekiranya permukaan konkrit kasar atau tidak rata

REBOUND HAMMER

- Alat paling popular
- Ujian berdasarkan prinsip kekuatan pantulan (elasticity) terhadap kekerasan permukaan konkrit
- Kekuatan diekspresikan dalam “rebound number”

Tujuan:

- ✓ Menilai tahap keseragaman in-situ konkrit dengan mengasingkan zon/kawasan yang lemah atau bermasalah.
- ✓ Boleh memberikan anggaran kekuatan mampatan konkrit menggunakan proses korelasi yang sesuai.

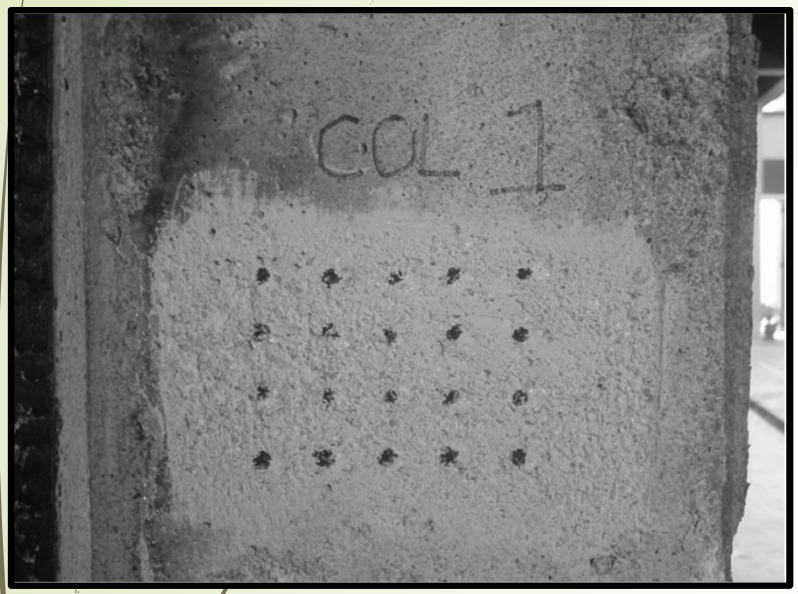
MS EN 12504 Part 2: 2013

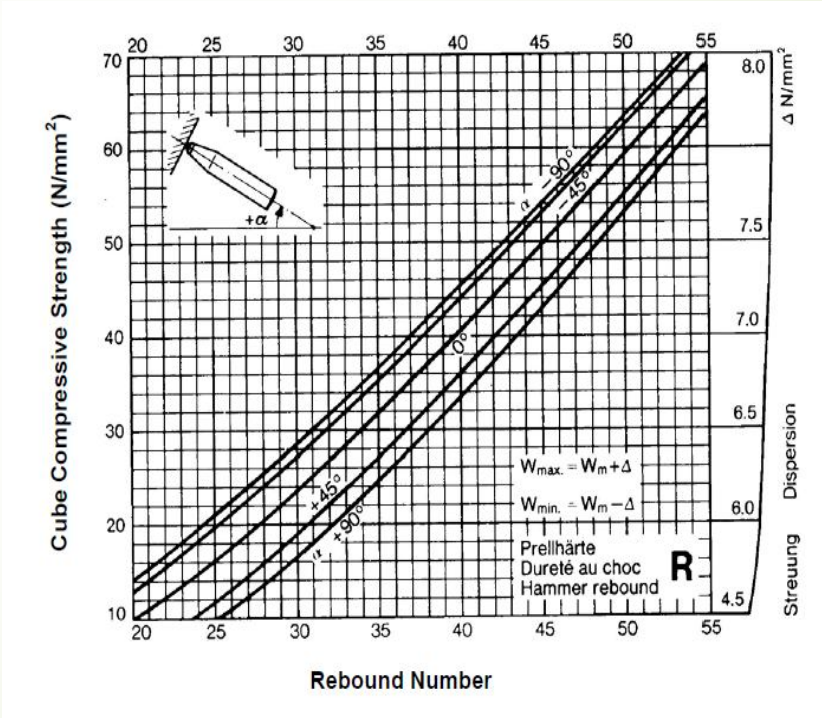
REBOUND HAMMER

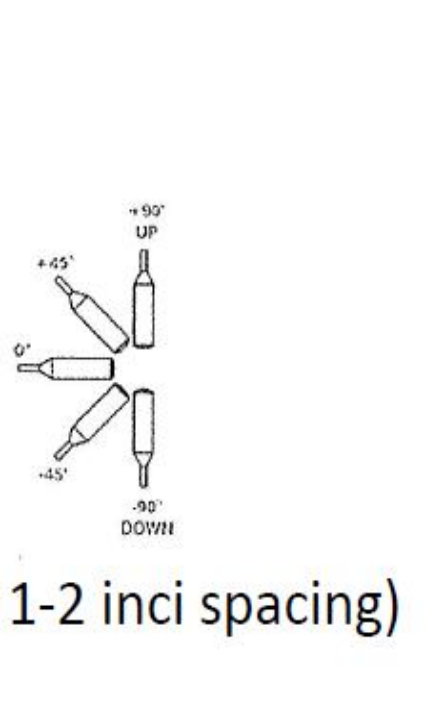
Jumlah bacaan disyorkan:

- 9 atau 12 bacaan setiap lokasi
- Average or median?

REBOUND HAMMER







1-2 inci spacing)

Guna graf untuk dapatkan anggaran kekuatan mampatan konkrit

REBOUND HAMMER

Electronic Concrete Test (ECT)
@ Electronic Rebound Hammer

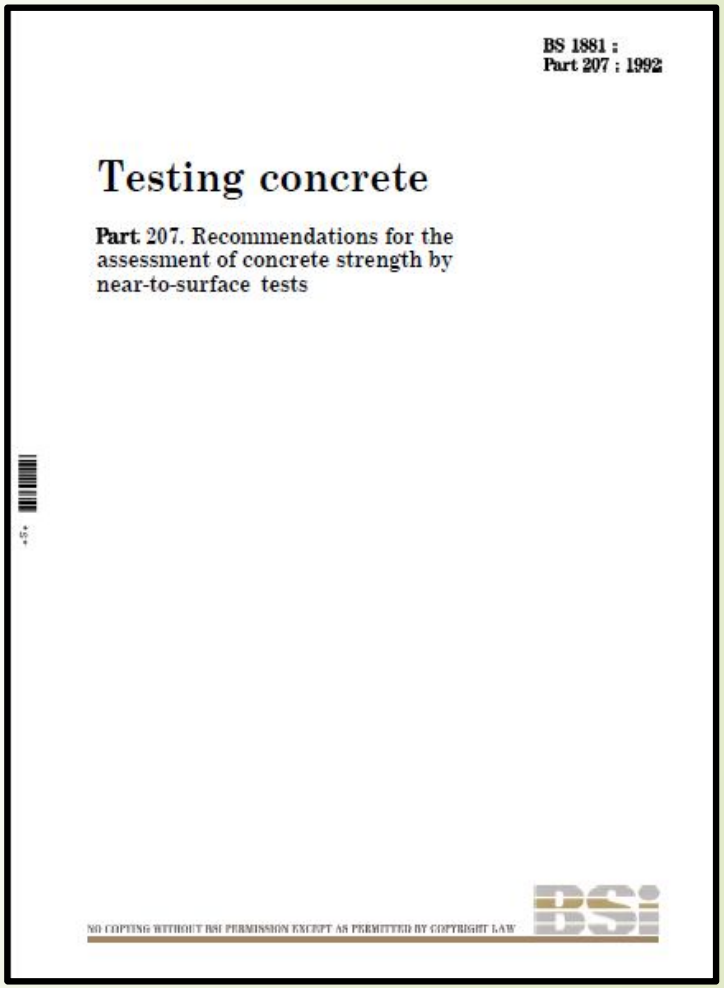
* Bacaan kekuatan mampatan konkrit boleh diambil terus dari ‘display’. Tak perlu rujuk graf.

WINDSOR PROBE

- Penetration Resistance Test atau Windsor Probe Test (komersial)
- Ukur rintangan konkrit terhadap tusukan proba (rod keluli)

- Tujuan:
  - ✓ Menilai tahap tahap keseragaman in-situ konkrit dengan mengasingkan zon/kawasan yang lemah atau bermasalah.
  - ✓ Boleh memberikan anggaran kekuatan mampatan konkrit menggunakan proses korelasi yang sesuai.

BS 1881 Part 207: 1992


BS 1881 :
Part 207 : 1992

Testing concrete

Part 207. Recommendations for the assessment of concrete strength by near-to-surface tests

WINDSOR PROBE

WINDSOR PROBE

Driver Unit: Powder-actuated device that capable of driving the probe into the concrete with an accurately controlled energy

Probe: Bolt of hardened steel alloy. Generally 6.35mm in diameter and 79.5mm in length and can penetrate up to 40mm into concrete

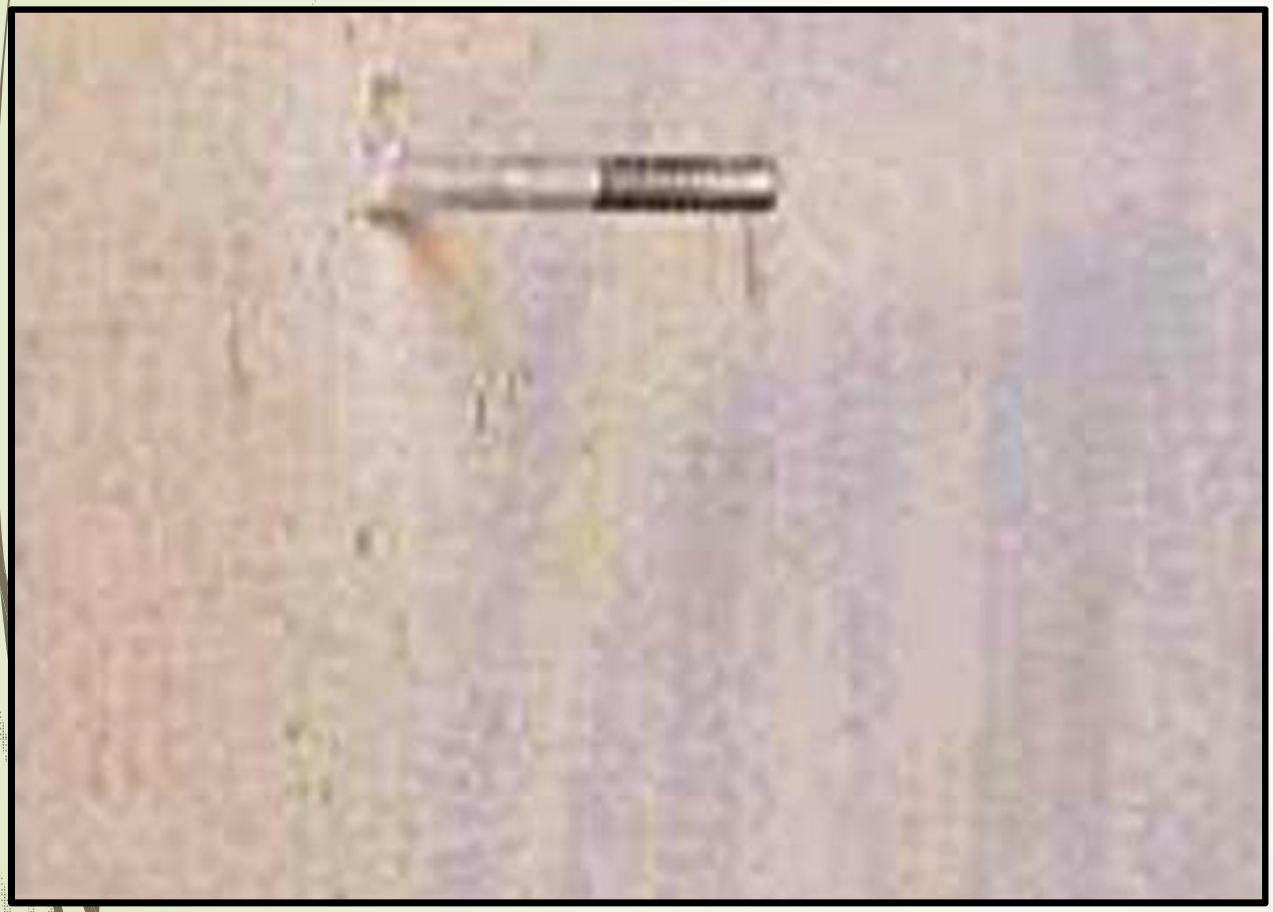
Measuring Unit: To measure and record the exposed length (above original surface) of probe to the nearest 0.5mm

WINDSOR PROBE

Positioning the driving unit with probe before fire into the concrete

* LESEN:
Sama seperti lesen memiliki senjata api

WINDSOR PROBE

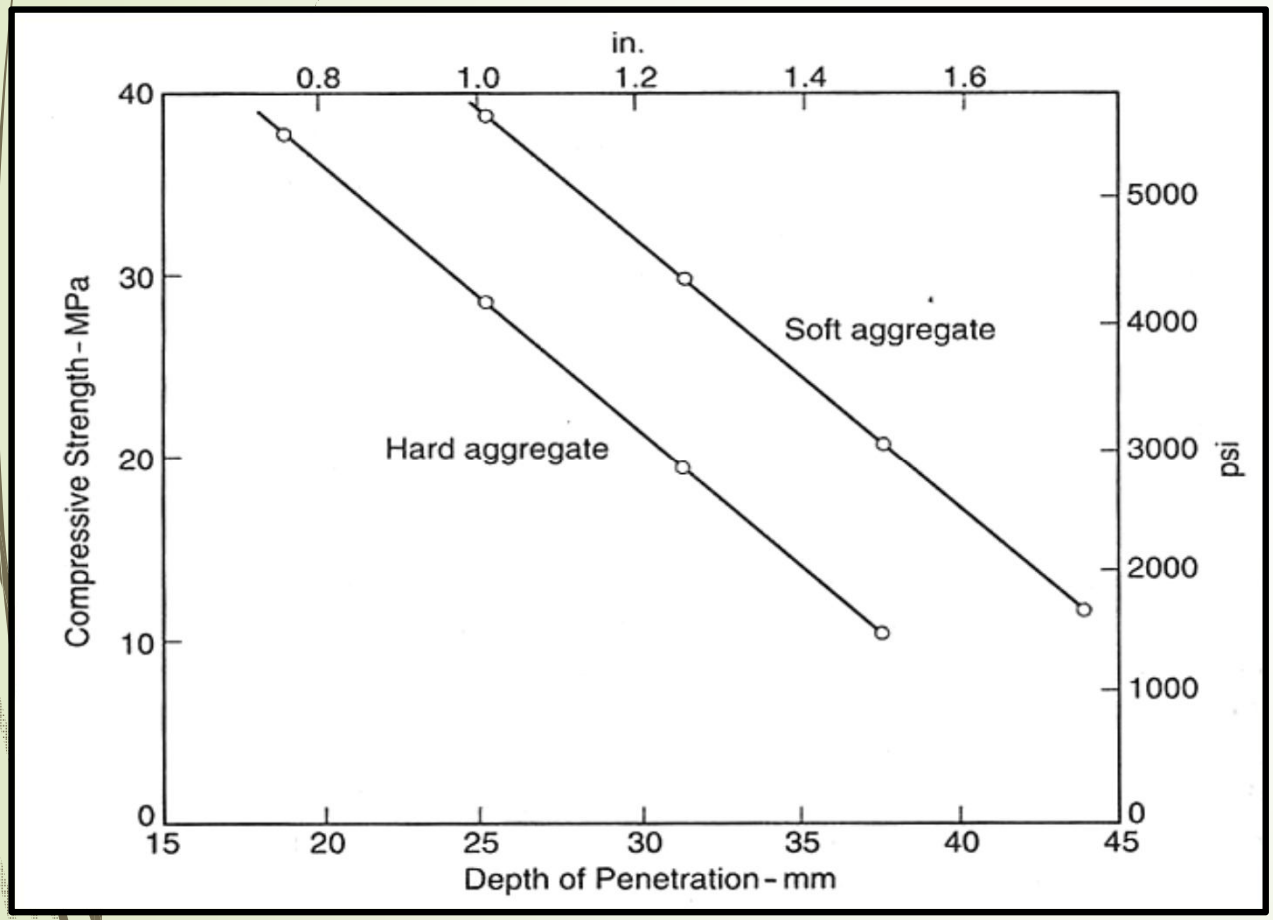


Exposed probe embedded in concrete structure

WINDSOR PROBE

Measuring the exposed probe length

WINDSOR PROBE



Typical Windsor Probe correlation

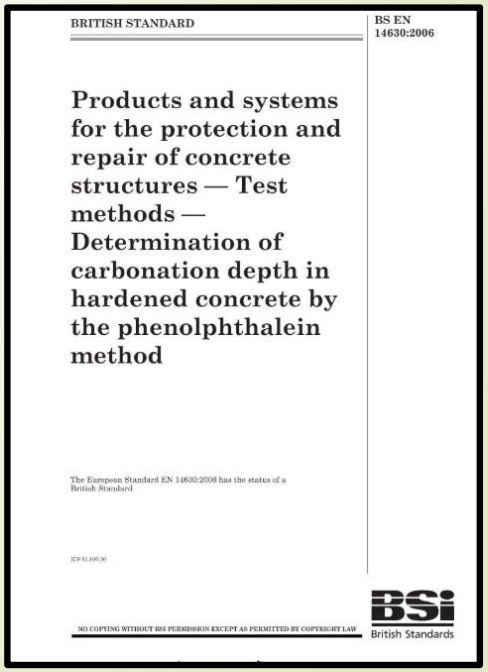
CARBONATION TEST

CARBONATION IS ONE OF THE MAIN CAUSES OF CORROSION OF STEEL IN CONCRETE, THE OTHER IS CHLORIDE ATTACK

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

Calcium hydroxide

Calcium carbonate
(from cement paste)


BRITISH STANDARD

BS EN 14630:2006

Products and systems for the protection and repair of concrete structures — Test methods — Determination of carbonation depth in hardened concrete by the phenolphthalein method

The European Standard EN 14630:2006 has the status of a British Standard

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BSi British Standards

BS EN 14630: 2006

CARBONATION TEST

TUJUAN:

Sebagai petunjuk bagi mengesan kehilangan sifat kealkalian pada konkrit (pHdrop from 13 to below 9). Konkrit akan menjadi berasid dan ia akan menyebabkan pengaratan tetulang keluli

2 Kaedah ujian dijalankan:

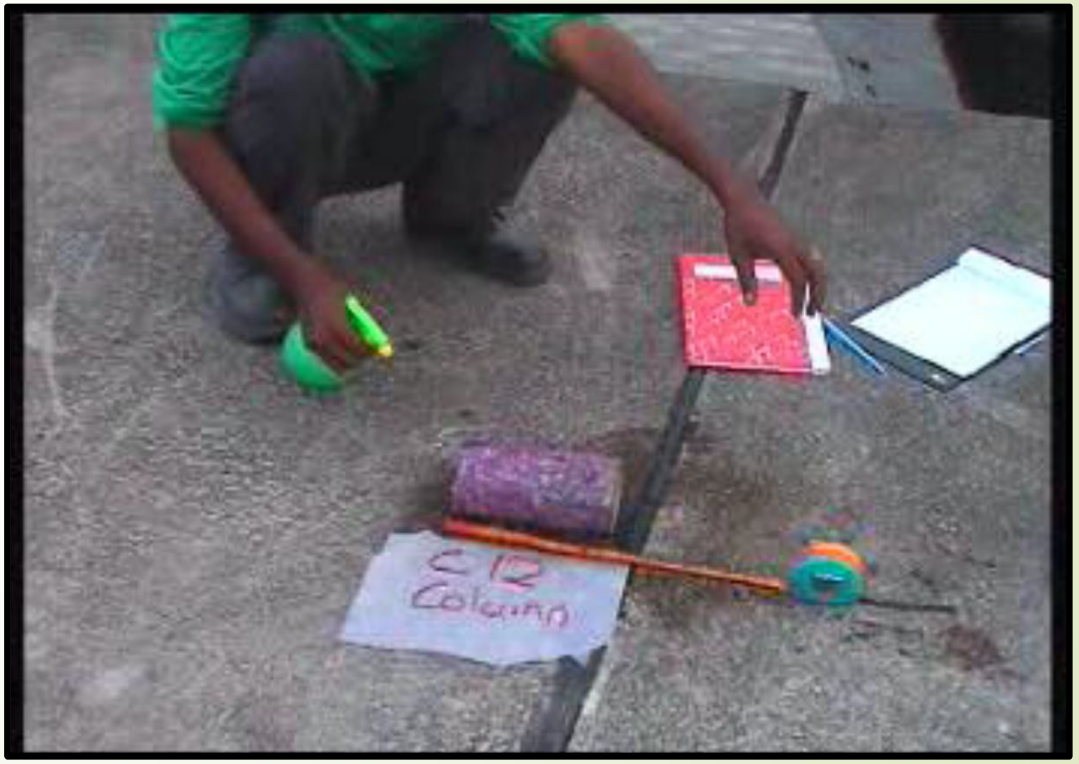
(a) Menggunakan ujian teras (core)

(b) Mengunakan kaedah ‘drill’ (concrete dust sample)

CARBONATION TEST

1. Kaedah core

Core specimen ready for carbonation test

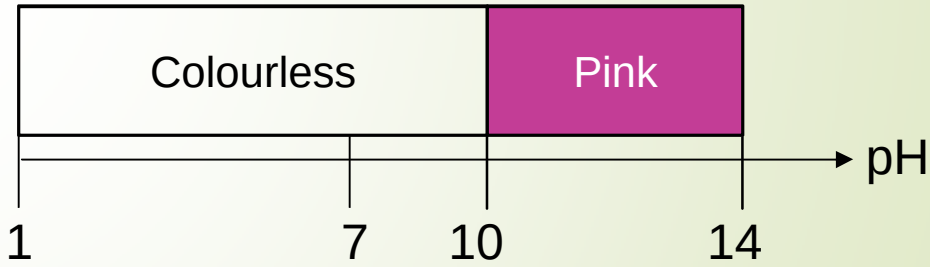


Spraying **phenolphthalein** solution on a core sample

CARBONATION TEST

1. Kaedah core

Measuring the carbonation depth of a core sample



CARBONATION TEST

2.Kaedah concrete dust

Drill dan ambil sampel pada setiap kedalaman 10mm, 20mm, 30mm, 40mm, 50mm

Sampel pada setiap kedalaman akan disembur dengan phenolphthalein.

Contoh:

- Jika pada kedalaman 10mm, serbuk (dust) tidak bertukar pink, pengkarbonatan telah berlaku.
- Jika pada kedalaman 20mm, dust tidak bertukar pink, pengkarbonatan telah berlaku
- Jika pada kedalaman 30mm, dust bertukar pink, tiada pengkarbonatan.

✓ Oleh itu, kita boleh simpulkan ‘carbonation depth’ = 20mm

CARBONATION TEST

2.Kaedah concrete dust

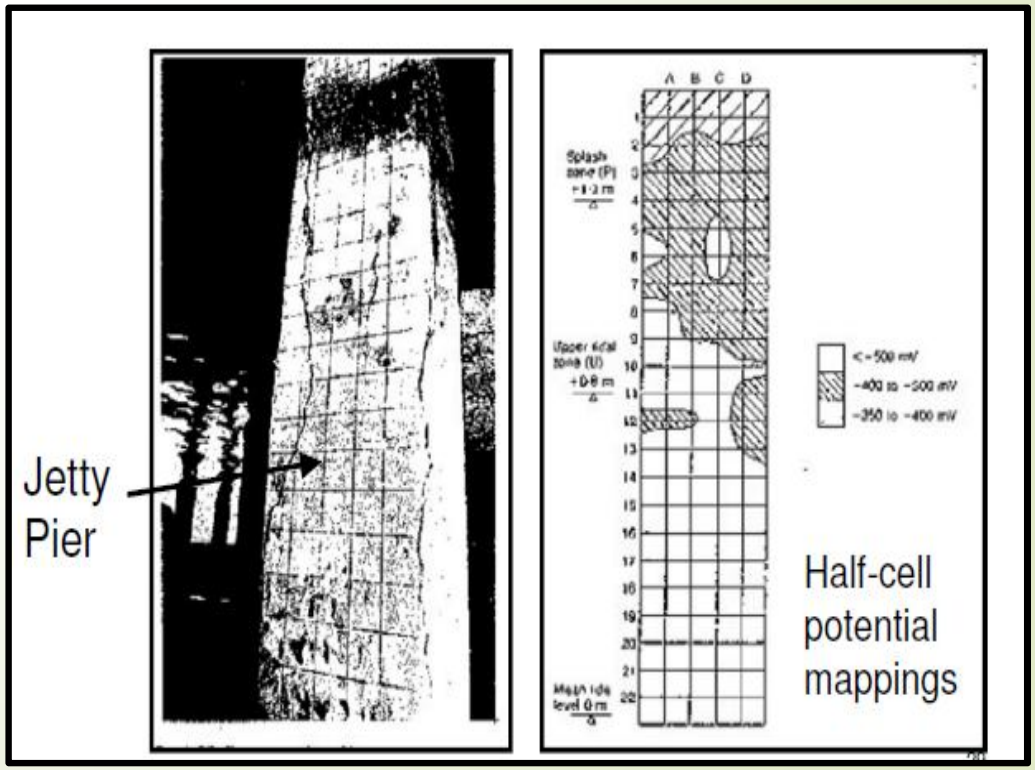
Bandingkan dengan tebal penutup konkrit

- **Penutup = 35mm**
- **Carbonation depth = 20mm**

✓ **Keluli tetulang masih selamat dan tidak berkarat (belum bertindak balas)**

HALF-CELL POTENTIAL

- Virtually non-destructive techniques to determine the **probability** of rebar corrosion
- Able to estimate the corrosion risk of steels even if there are no signs of corrosion on the concrete surface.

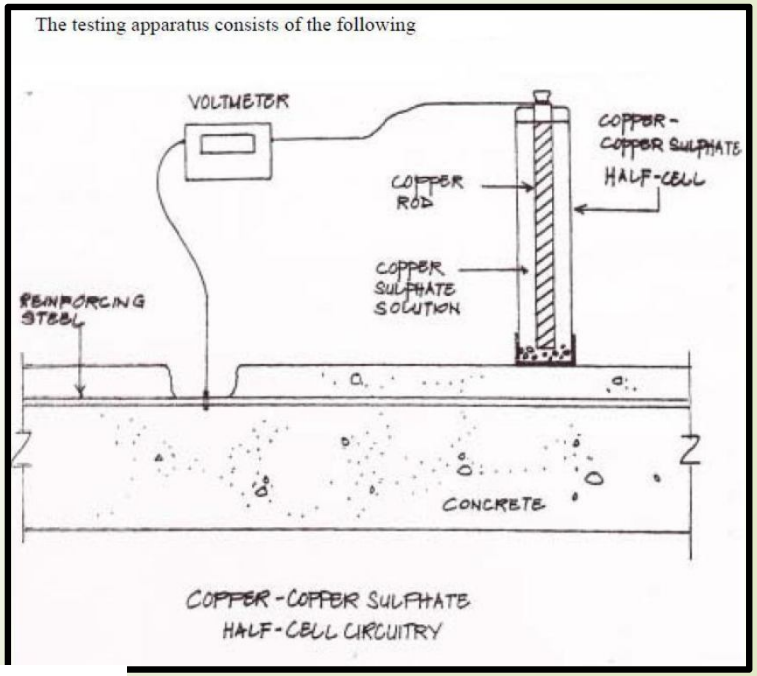


HALF-CELL POTENTIAL

- Identify areas with corrosion activity for further analysis (chloride test, carbonation, flaws or permeation) to establish the cause of corrosion and estimate remaining service life.

- Copper / copper sulphate half cell as per ASTM C-876

- Corrosion survey of suspected concrete structure such as:
  - ✓ Bridge decks
  - ✓ Parking basement / garage
  - ✓ Concrete piers & docks
  - ✓ Substructure
  - ✓ Tunnel lining
  - ✓ Foundations



HALF-CELL POTENTIAL

- **Half cell probe**
  – move about on surface to measure potential of reinforcing steel at various location

- **Half cell voltmeter**
  – measure and record electrical potential

- **Crocodile clip**
  – to connect the steel rebar to voltmeter

- **Rod**
  – to support half cell probe for testing on soffit at high level e.g slab

HALF-CELL POTENTIAL

Prosedur Ujian

Scanning the rebar

HALF-CELL POTENTIAL

Prosedur Ujian

Marking the testing grid

HALF-CELL POTENTIAL

Prosedur Ujian

Chip off coating / plaster and clean the surface of test location by wire brush

HALF-CELL POTENTIAL

Prosedur Ujian

Hacking of concrete surface to expose the reinforcement to make a direct electrical connection

HALF-CELL POTENTIAL

Prosedur Ujian

Spray water to the testing grid to moisten the concrete surface

HALF-CELL POTENTIAL

Prosedur Ujian

Measure and record the reading as showed on voltmeter (in mV)

HALF-CELL POTENTIAL

Range (mV)	Probability of Corrosion (%)
< -350	95%
-200 to -350	50%
> -200	5%

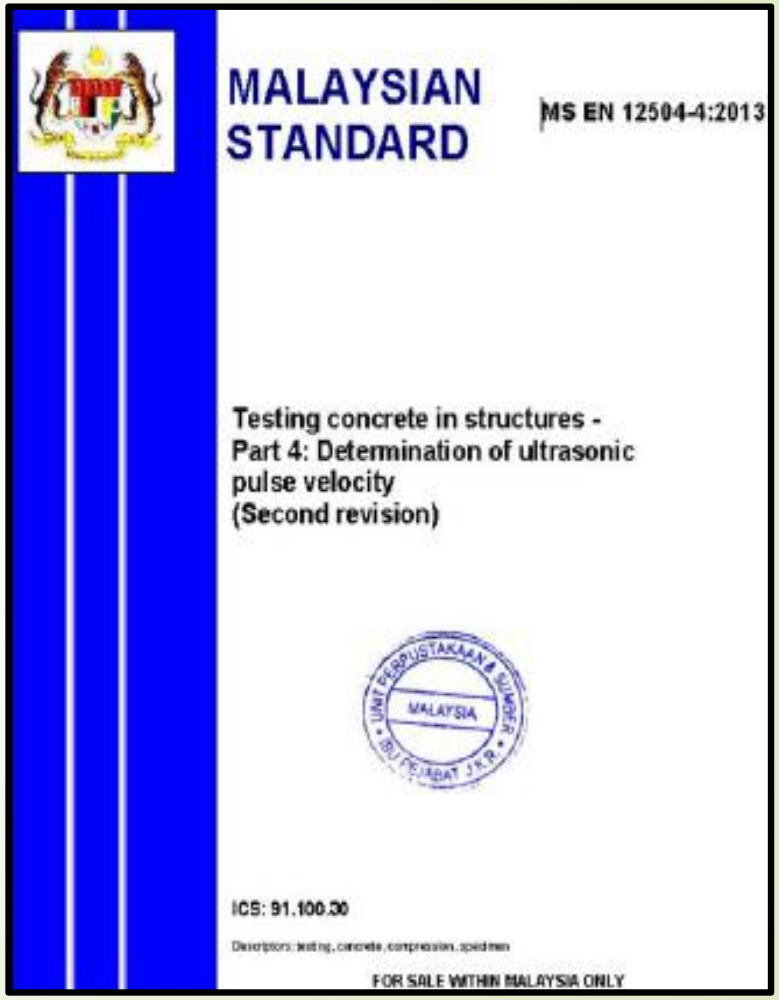
Interpretation of test result

ULTRASONIC PULSE VELOCITY

- Mengukur masa transit gelombang ultrasonic menerusi jarak laluan yang diketahui dalam sesuatu komponen konkrit.
- Kaedah yang cepat & mudah tanpa merosakkan struktur konkrit

- Tujuan:
  - ✓ Menilai tahap keseragaman in-situ konkrit dengan mengasingkan zon/kawasan yang lemah atau bermasalah.
  - ✓ Boleh memberikan anggaran kekuatan mampatan konkrit menggunakan proses korelasi yang sesuai.

MS EN 12504 Part 4: 2013


MALAYSIAN STANDARD

MS EN 12504-4:2013

Testing concrete in structures - Part 4: Determination of ultrasonic pulse velocity (Second revision)

ICS: 91.100.30

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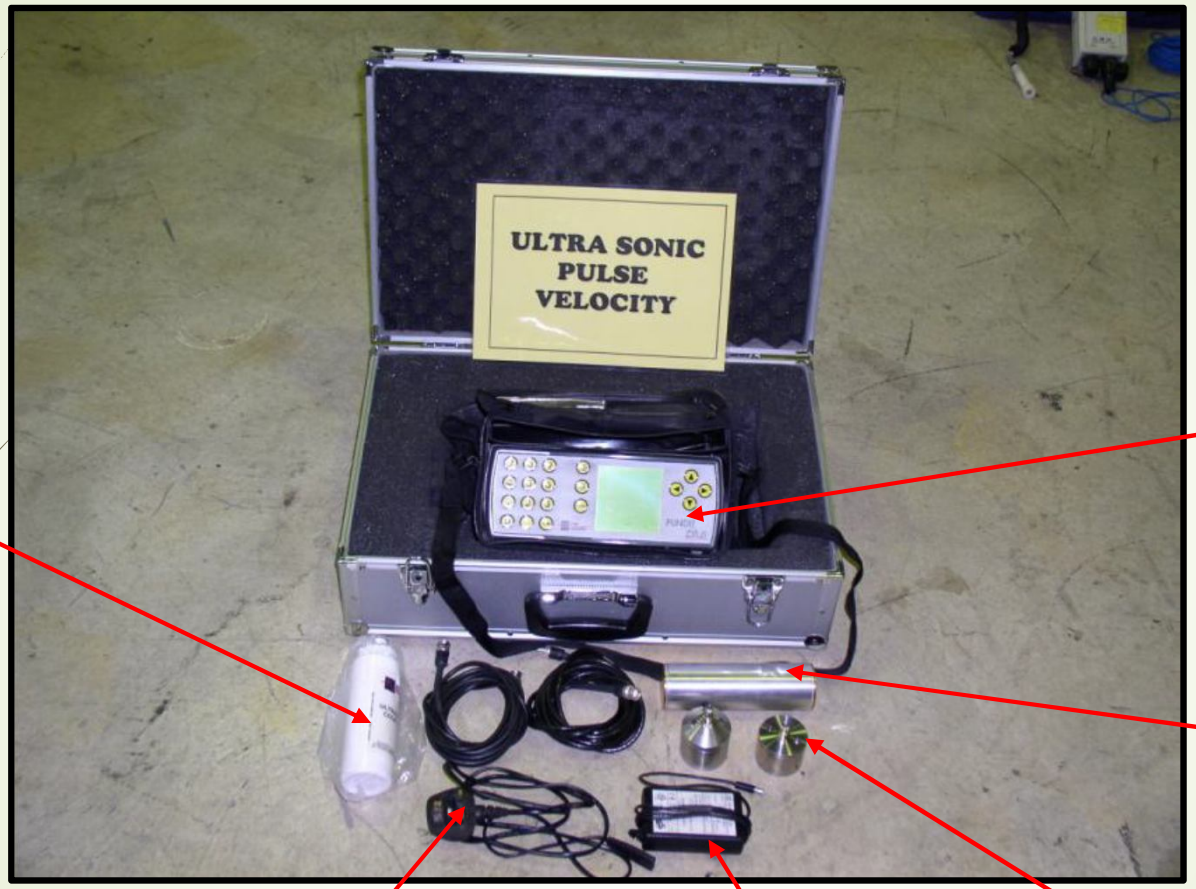
ULTRASONIC PULSE VELOCITY



Grease oil

Voltmeter

Calibrator block

Connecting wire

Battery charger

Transducer (transmitter & receiver)

ULTRASONIC PULSE VELOCITY

Transducers

Direct method

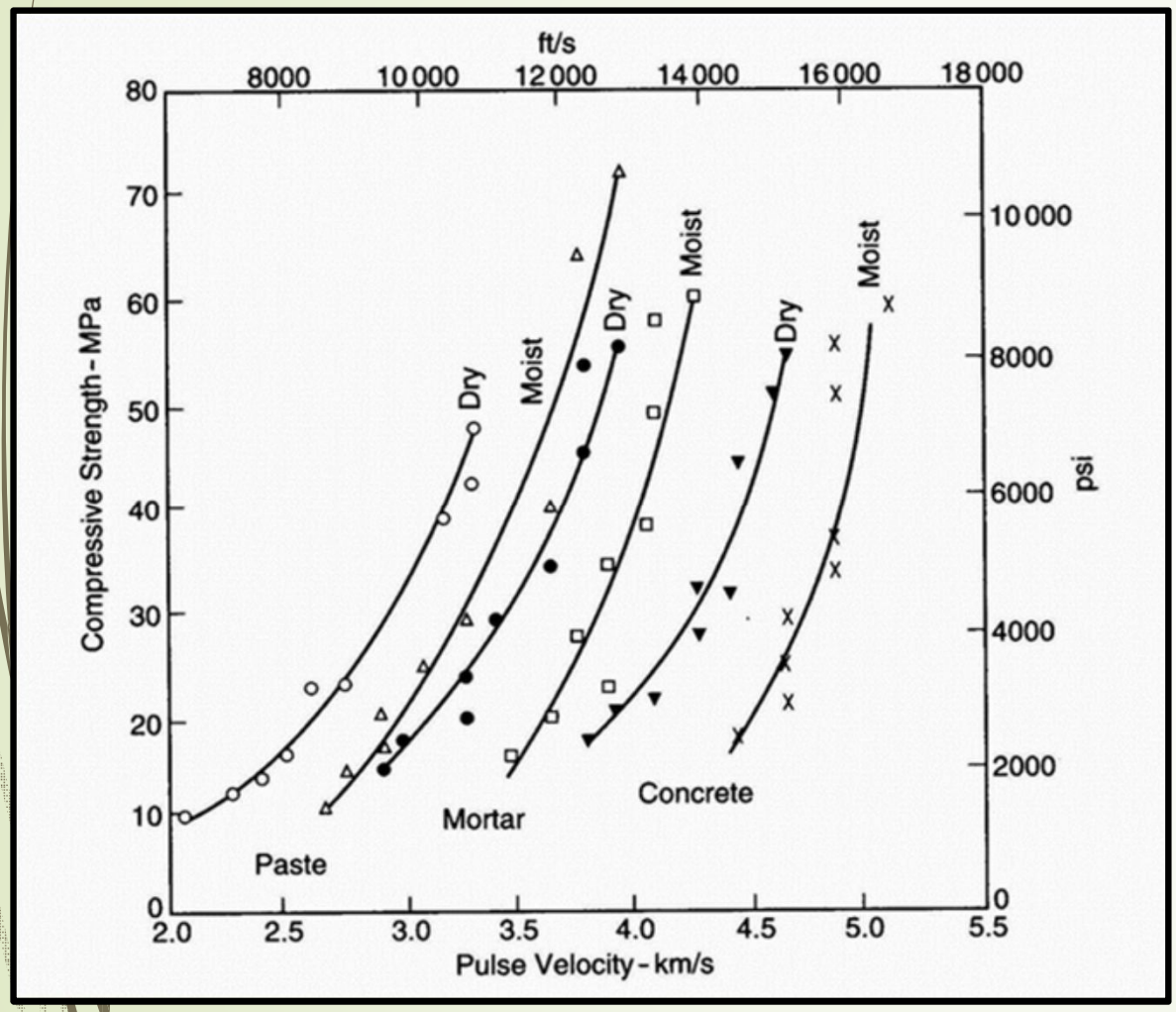
ULTRASONIC PULSE VELOCITY

Semi Direct Method

Indirect method

$$UPV = \frac{\text{Path Length}}{\text{Transit Time}} \quad km/s$$

ULTRASONIC PULSE VELOCITY



Relationship between compressive strength and UPV

i) Dapatkan nilai pulse velocity daripada formula
ii) Tentukan jenis struktur atau bahan yang diuji
iii) Dapatkan anggaran kekuatan mampatan konkrit daripada graf

High pulse velocity readings are generally indicate a good quality of concrete

The presence of reinforcement can influence the measurement

ULTRASONIC PULSE VELOCITY

Pulse velocity (km/s)	Indication
> 4.50	Very good to excellent
3.50 – 4.50	Good to very good – porosity slightly may exist
3.00 – 3.50	Satisfactory - loss of integrity is suspected
< 3.00	Poor – loss of integrity exist

Interpretation of test result

DESTRUCTIVE TEST (DT)

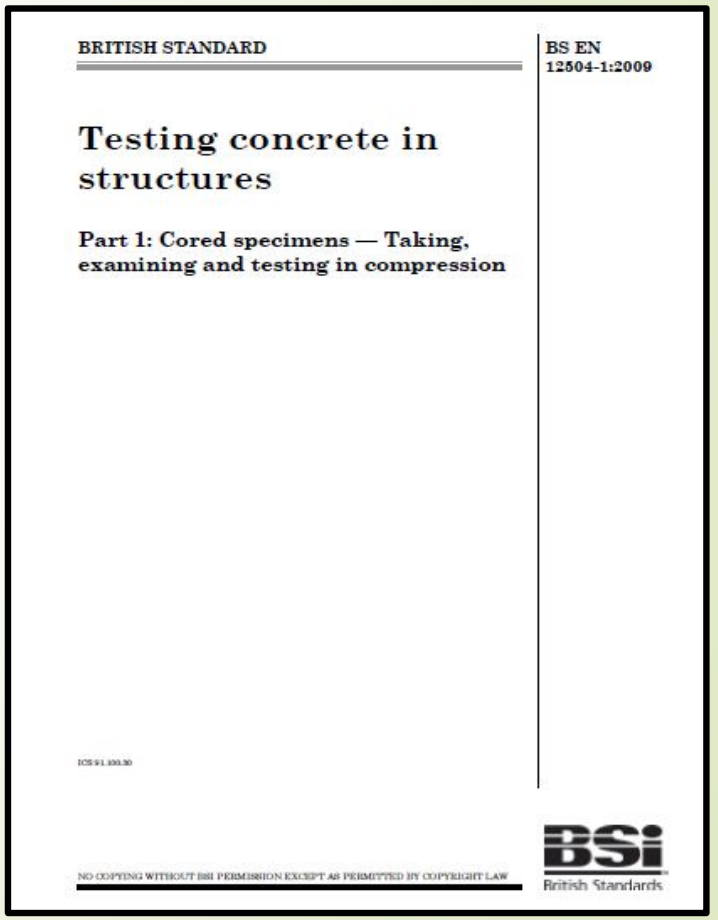
DESTRUCTIVE TEST (DT)

1. Concrete Core
2. Steel Tensile Strength Test
3. Petrographic Analysis
4. Verification of Steel
5. Pull-off Test

CONCRETE CORE

- Paling popular dan kaedah yang paling tepat
- Kaedah secara langsung

BS EN 12504 Part 1: 2009


BRITISH STANDARD

BS EN 12504-1:2009

Testing concrete in structures

Part 1: Cored specimens — Taking, examining and testing in compression

BSi British Standards

- Tujuan:

  - ✓ Mendapatkan anggaran kekuatan mampatan konkrit
  - ✓ Sampel teras juga boleh digunakan untuk:
    - penyerapan air (water absorption)
    - ketumpatan konkrit
    - kedalaman keretakan
    - pemerhatian visual (honeycomb, agg.distribution, segregation etc.)

CONCRETE CORE

L/d > 1 (decrease strength)
L/d < 1 (increase strength)

Specimen size

- Core diameter: 50mm, 75mm, **100mm, 150mm**
- Diameter/max agg. size ratio > 3
  - ✓ 100mm (max. aggregate 20mm)
  - ✓ 150mm (max. aggregate 40mm)
- Length: 1.0 ~ 1.2 x diameter (extract)
- Length/diameter ratio
  - ✓ 2.0 (compare with cylinder strength)
  - ✓ 1.0 (compare to cube strength)
- Core with transverse / longitudinal steel???

CONCRETE CORE

Coring machine stand

Drill equipment

Coring machine

Anchor bolt

Core bit

Water pump

Safety socket

Screw driver, chisel & hammer

CONCRETE CORE

Coring & extracting core from the structure

CONCRETE CORE

Trimming & capping of core

- High alumina cement + fine sand > 50Mpa
- Sulphur + fine sand < 50Mpa

CONCRETE CORE

Store the specimen in water

Testing for core comp.strength

When???

Constant rate of loading

= 0.6 ± 0.2 Mpa/s

CONCRETE CORE

Result:

- Core compressive strength
- Convert to estimated in-situ cube strength as per BS 6089: 1981 Clause 5

CONCRETE CORE

- Pemerhatian - kedalaman keretakan (crack depth)

STEEL TENSILE STRENGTH TEST

- Juga dipanggil rebar test
- Biasanya dijalankan pada struktur yang terdedah kepada kebakaran (mikrostruktur keluli mungkin berubah kesan daripada suhu kebakaran
- Juga dijalankan pada struktur yang disyaki gagal aspek rekabentuk / pembinaan
- Tujuan:
  - ✓ Untuk mendapatkan ‘tensile strength’ bagi tetulang keluli dan BRC

STEEL TENSILE STRENGTH TEST

i) Pecahkan konkrit di sekeliling tetulang keluli
ii) Potong sampel keluli sekurang-kurangnya 300mm
iii) Ujian dengan tensile test machine

STEEL TENSILE STRENGTH TEST

- Bandingkan f_y yang diperolehi dengan tensile strength asal keluli.
- Analisis semula struktur
- Jika gagal, struktur tersebut perlu diperkukuhkan

STEEL TENSILE STRENGTH TEST

Summary of Tensile Strength Test

No	Test Ref	Structural Element	Type of Bar	Nominal Size	Yield Stress (N/mm^2)	Tensile Stress (N/mm^2)
1	S1	Slab	R	12	342.9	469.2
2	S2	Slab	R	12	327.1	451.6
3	S3	Slab	R	12	342.0	468.3
4	B3	Beam	Y	25	420.6	690.2
5	B5	Beam	Y	25	416.2	672.0
6	B6	Beam	Y	25	368.5	638.6
7	B7	Beam	Y	25	417.9	677.1
8	B9	Beam	Y	25	383.8	672.9

Not OK

OK

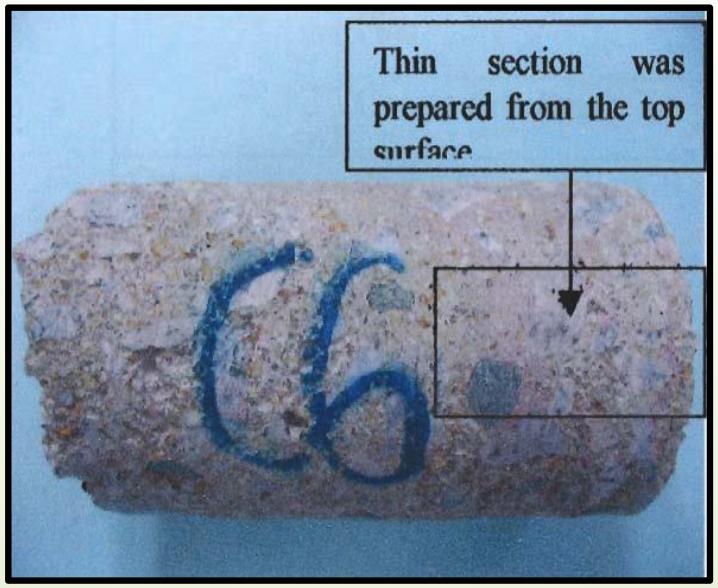
High Yield Steel	SD	23.73	Mean	401.40	Characteristic strength of reinforcement, fy	362.49
Mild Steel	SD	8.87	Mean	337.33	Characteristic strength of reinforcement, fy	322.78

None of elements tested below the acceptable limit 356.7 N/mm2 (410x0.87) for high yield steel and 217.5 N/mm2 (250x0.87) for mild steel.

PETROGRAPHIC ANALYSIS

- Detailed study carried out by visual and optical microscopy
- Can provide unique and valuable information regarding the ingredients, properties and condition of hardened concrete samples

BS 1881 Part 211:2016



PETROGRAPHIC ANALYSIS

Sample reference	**C6**
Cement content (kg/m^3)	262
Fine aggregate content (kg/m^3)	925
Coarse aggregate content (kg/m^3)	945
Ratio of cement, sand and coarse aggregate (by mass)	1 : 3.53 : 3.61

PETROGRAPHIC ANALYSIS

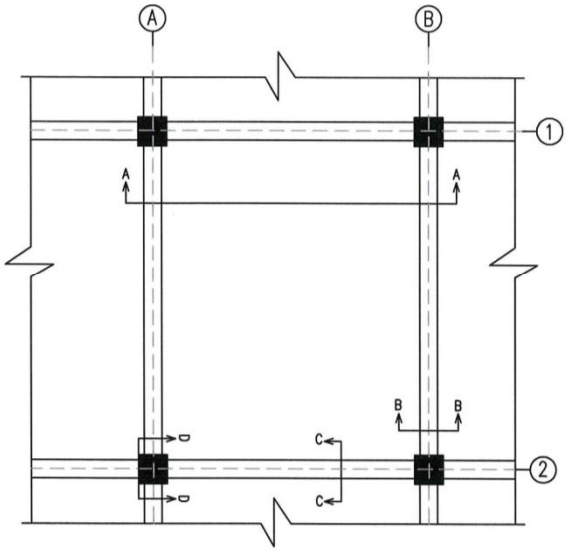
Sample reference		**C6**
Aggregate	Coarse aggregate	Mostly granite + one piece diorite
	Fine aggregate	Quartz
Cement paste	Type	Portland cement + silica fume
	Homogeneity	Good
	Degree of hydration	High
	Apparent w/c ratio	0.60 – 0.65
Paste cracks	Micro (<0.01 mm)	High amount
	Fine	-
	Coarse (>0.1 mm)	-
Others	Secondary reaction	-
	$Ca(OH)_2$	Some in the paste
	Compaction pores (%)	4.2
Carbonation	Outer surface	5 mm
	Crack	-

PETROGRAPHIC ANALYSIS

Sample reference	C6
Cement matrix	Ordinary Portland Cement is used. The cement is observed to be well hydrated with presence of hydration zone of cement grain (Alites)
Homogeneity of the mix	Under the fluorescent light, sample paste shows poor homogeneity
Others	- Estimated w/c ratio: 0.45 – 0.55 - There was no gel (reaction product) observed on the aggregates and cement matrix, hence there was no likely of any major **ASR or ACR** occurred in the core sample at this point - There was also no Ettringite crystal observed, hence there was unlikely of **DEF** in the core sample at this point

VERIFICATION OF STEEL

VERIFICATION OF STEEL REINFORCEMENT

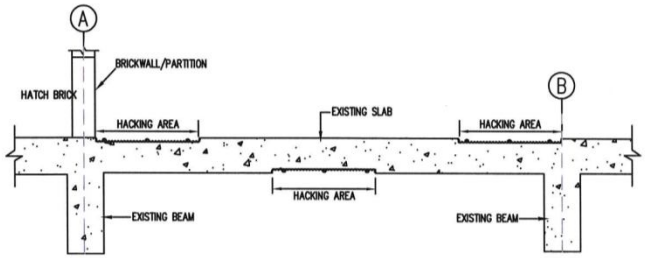


PLAN VIEW

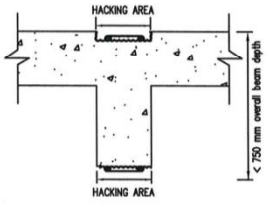
Element		Concrete Hacking Location	Concrete Hacking Dimensions (m x m)
Beam	< 750 mm overall depth	Top beam	0.40 x 0.40
		Soffit beam	0.30 x 0.30
	≥ 750 mm overall depth	Top beam	0.40 x 0.40
		Soffit beam	0.30 x 0.30
		Side beam	0.20 x 0.30
Column	size < 300 mm	Side of column	0.20 x 0.20
	size > 300 mm	Side of column	0.30 x 0.30
Slab		Soffit slab	0.50 x 0.50
		Top slab	0.50 x 0.50

NOTES :

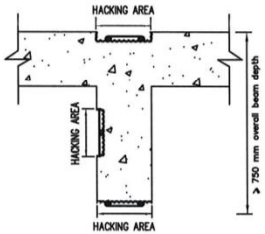
1. Concrete hacking dimensions (m x m) are to be in rectangular/square shapes. The longer dimension of rectangular concrete hacking at side of deep beam/column shall be perpendicular to the beam/column directions.
2. For top and soffit beam opening should within 1/3 from support distance.
3. The maximum rectangular concrete hacking area must not greater than 0.5 m^2.
4. Hacking concrete to a depth not exceeding 50 mm to expose and measure the reinforcement bars.
5. The actual location of concrete hacking area at site shall be referred to JKR for confirmation.
6. Reinstatement works for all concrete hacked shall be referred to the drawing CKASJ/UFS2/2012/M/02/006. (masukkan no lukisan reinstatement works)
7. All dimensions are in milimetres.



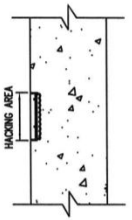
SECTION A–A



SECTION C–C (< 750 MM OVERALL BEAM DEPTH)



SECTION B–B (> 750 MM OVERALL BEAM DEPTH)



SECTION D–D (FOR COLUMN)

JABATAN KERJA RAYA MALAYSIA

CAWANGAN KEJURUTERAAN AWAM & STRUKTUR
BAHAGIAN PERKHIDMATAN FORENSIK STRUKTUR
IBU PEJABAT JKR MALAYSIA
TINGKAT 4–10, MENARA KERJA RAYA(BLOK G),
No. 6, JALAN SULTAN SALAHUDDIN
50480 KUALA LUMPUR
NO TEL: 03-26189171 & NO. FAKS: 03-26189155

DIREKABENTUK : NAMA PENUH PEREKABENTUK	PENGARAH KANAN : KAMALUDDIN BIN HJ. ABDUL RASHID	HURUF PETUNJUK	PINDAAN
DISEMAK : NAMA PENUH PENYEMAK	PENGARAH KHIDMAT REKABENTUK :		
DILUKIS : NAMA PENUH PELUKIS	JURUTERA AWAM PENGUASA KANAN : Ir. HJ. AZHARI BIN SHAHARUDDIN		
SKALA : NTS	JURUTERA AWAM KANAN/PENGUASA : NAMA PENUH KETUA UNIT		
NO FAIL PROJEK : JKR.CKASJ/09.500/010/12 JId.18 (rujuk fail negeri/projek)	TARIKH : MAC 2015 (bulan & tahun)		

NAMA PROJEK :
CADANGAN UJIAN BAHAN DI
NAMA BANGUNAN YANG DIPERIKSA
DAERAH, NEGERI

TAJUK LUKISAN :
VERIFICATION OF STEEL REINFORCEMENT

NO. LUKISAN : JKR/CKAS/08/14/B16/40/01 (rujuk fail daftar untuk lukisan)

VERIFICATION OF STEEL

Marking & hacking works

VERIFICATION OF STEEL

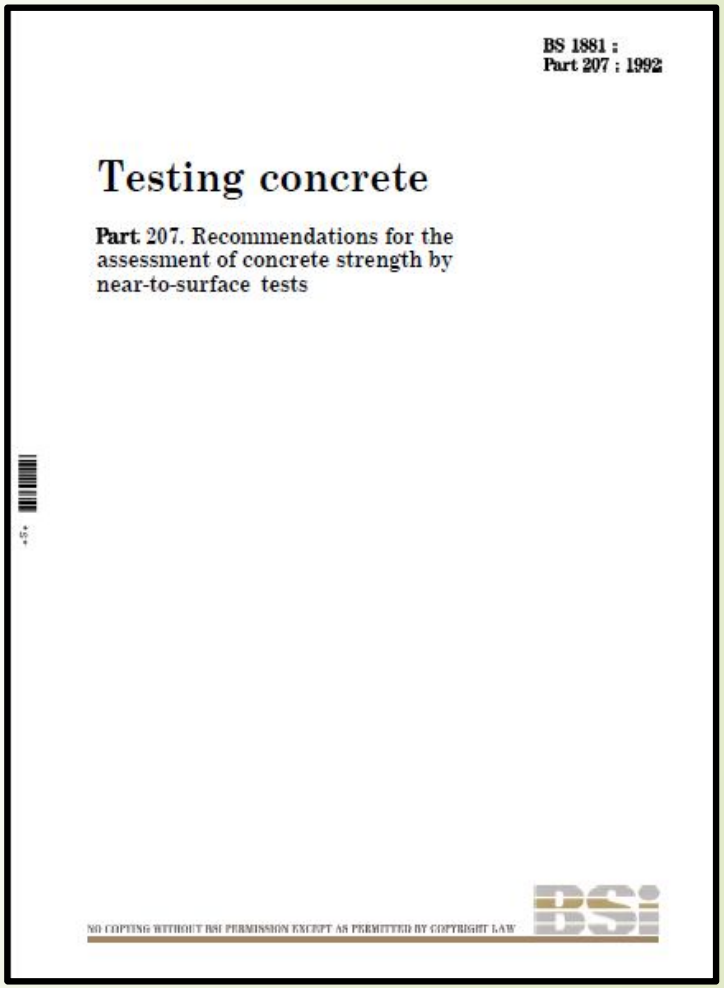
Measure and record the reading

PULL-OFF TEST

MS 26 Part 3: Cl 1.2.20

BS 1881 Part 207: 1992

- Assessment of concrete surface strength
- Near-to-surface test
- Dry & flat concrete surface
- Correlation should be established to get estimate strength



PULL-OFF TEST

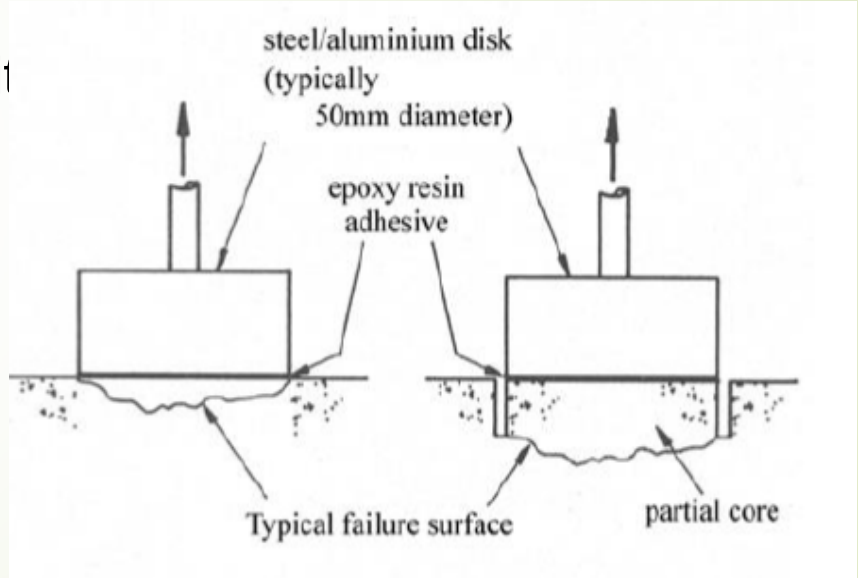
PULL-OFF TEST

Kaedah ujian

Terdapat dua (2) kaedah ujian:

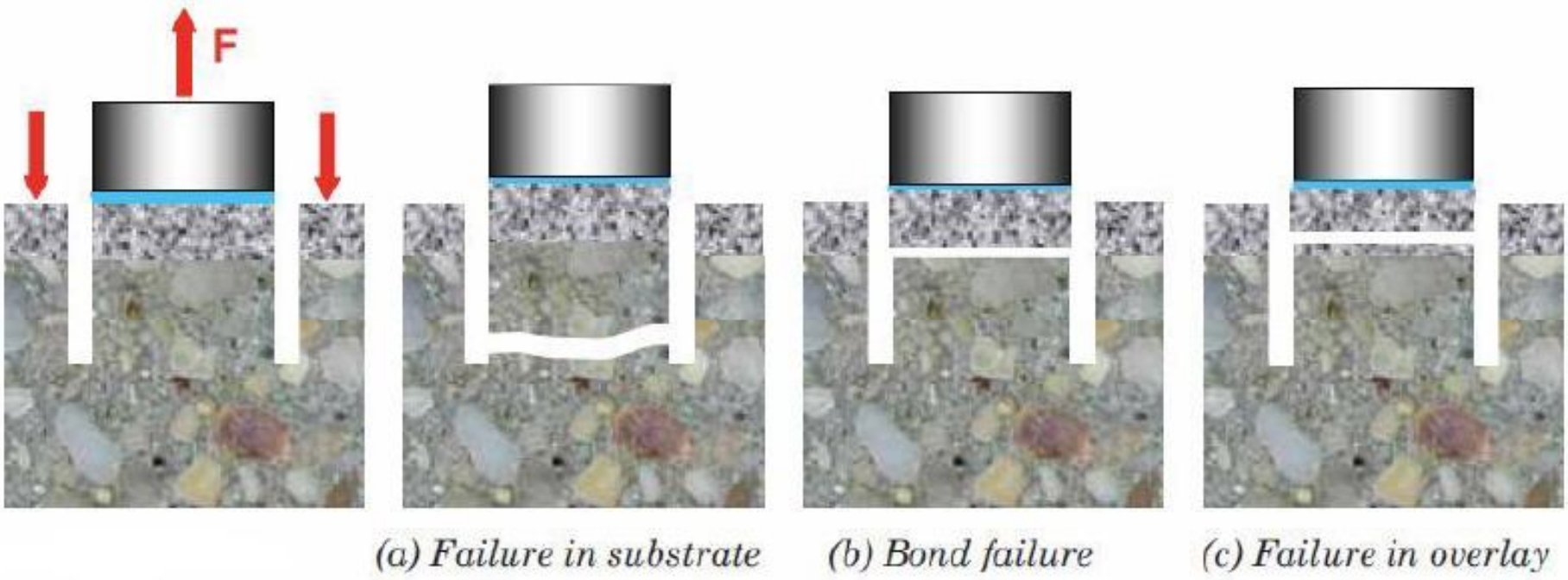
i) Test disc dilekatkan pada permukaan konkrit
- digunakan apabila tiada keraguan bahawa konkrit di permukaan adalah seragam pada keseluruhan konkrit

ii) Test disc dilekatkan pada permukaan konkrit yang ditebuk
- digunakan untuk mendapatkan kekuatan lapisan konkrit yang lebih dalam



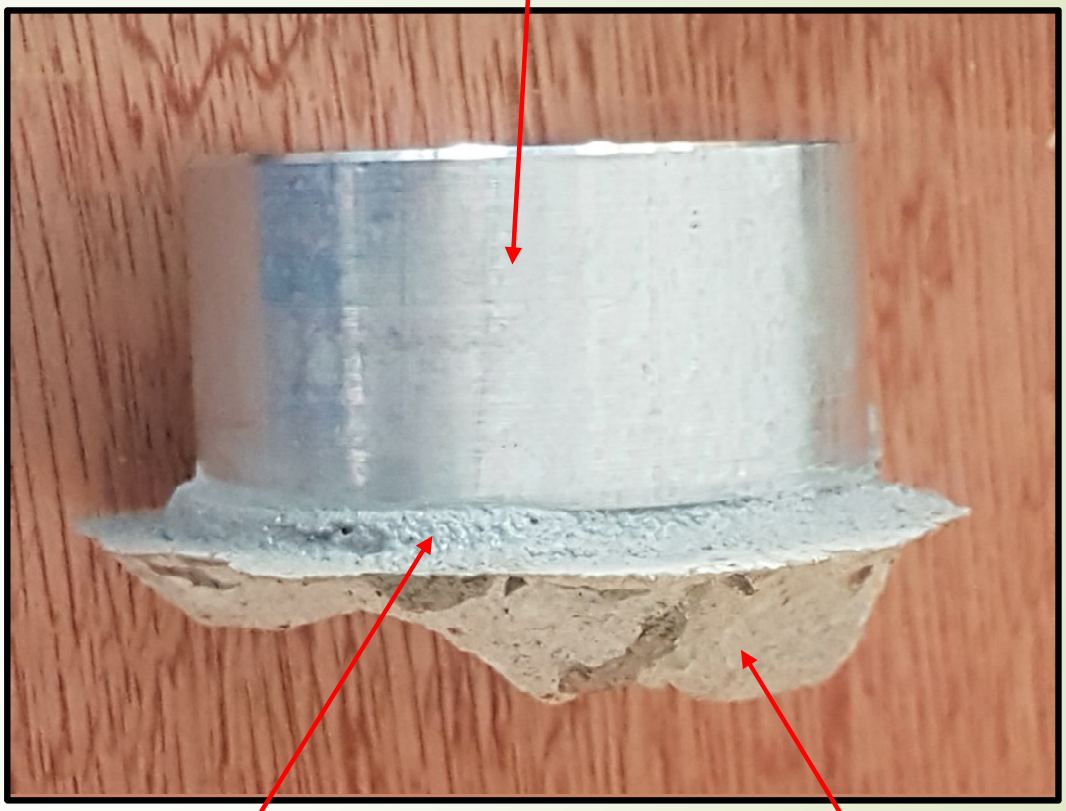
*** A thin uniform layer of adhesive (recommended 2.0 – 3.0 mm) & allow to cure 1.5h – 24h)**

PULL-OFF TEST



(a) Failure in substrate (b) Bond failure (c) Failure in overlay

PULL-OFF TEST



Measure and record the reading & failure mode (concrete or adhesive)

$$\textbf{Tensile strength} = \frac{\textbf{failure stress}}{\textbf{area}} \text{ N/mm2}$$

DETAILED PHASE

MATERIAL TESTING PLAN

MATERIAL TESTING PLAN

1. Scope of Works
2. Test Methodology
3. Drawing
4. Bill of Quantities

SKOP KERJA

1. Sedia jadual perancangan kerja
2. Laksana ujian bahan mengikut jenis, lokasi & bilangan yang ditetapkan atau seperti arahan PP
3. Pastikan keselamatan penguji / pengguna bangunan sepanjang tempoh ujian
4. Baikpulih struktur di lokasi yang terlibat (reinstatement works)
5. Sedia laporan yang komprehensif

METODOLOGI UJIAN

1. Mengimbas komponen struktur bagi mengelakkan terkena tetulang keluli

2. Lakaran grid pada komponen struktur yang diuji

3. Membuang lapisan lepaan / kemasan sebelum ujian

4. Mengikut prosedur dan piawaian seperti ditetapkan dalam Malaysian Standard atau Bristih Standard

5. Memastikan sampel tidak terjejas

METODOLOGI UJIAN

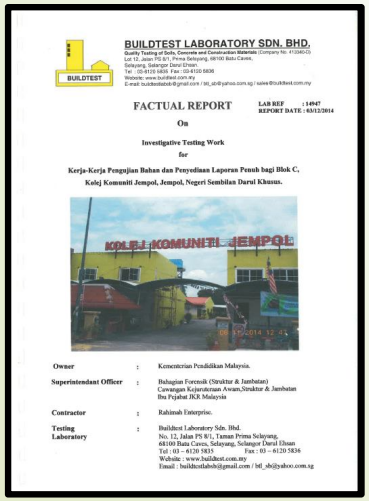
6. Sebarang perubahan lokasi ujian perlu dimaklumkan kepada PP atau pihak Forensik

7. Memastikan semua peralatan dikalibrasi dan berkeadaan baik

Laporan Ujian Bahan

- ✓ 4 set Laporan Ujian Bahan mengandungi:
  - maklumat ujian
  - kaedah kerja yang dijalankan
  - lokasi sebenar ujian
  - keputusan lengkap ujian
  - gambar sampel

- ✓ Laporan dan lukisan hendaklah disahkan oleh Jurutera Profesional yang berdaftar dengan BEM


BUILDTEST LABORATORY SDN. BHD.

FACTUAL REPORT

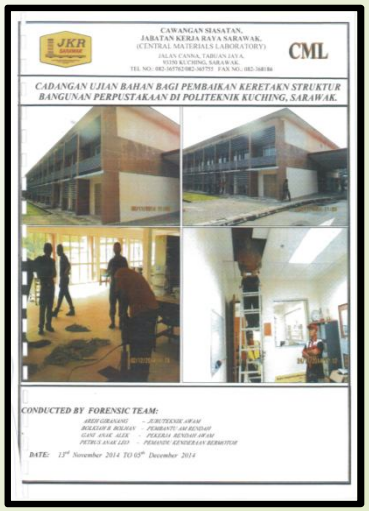
On

Investigative Testing Work

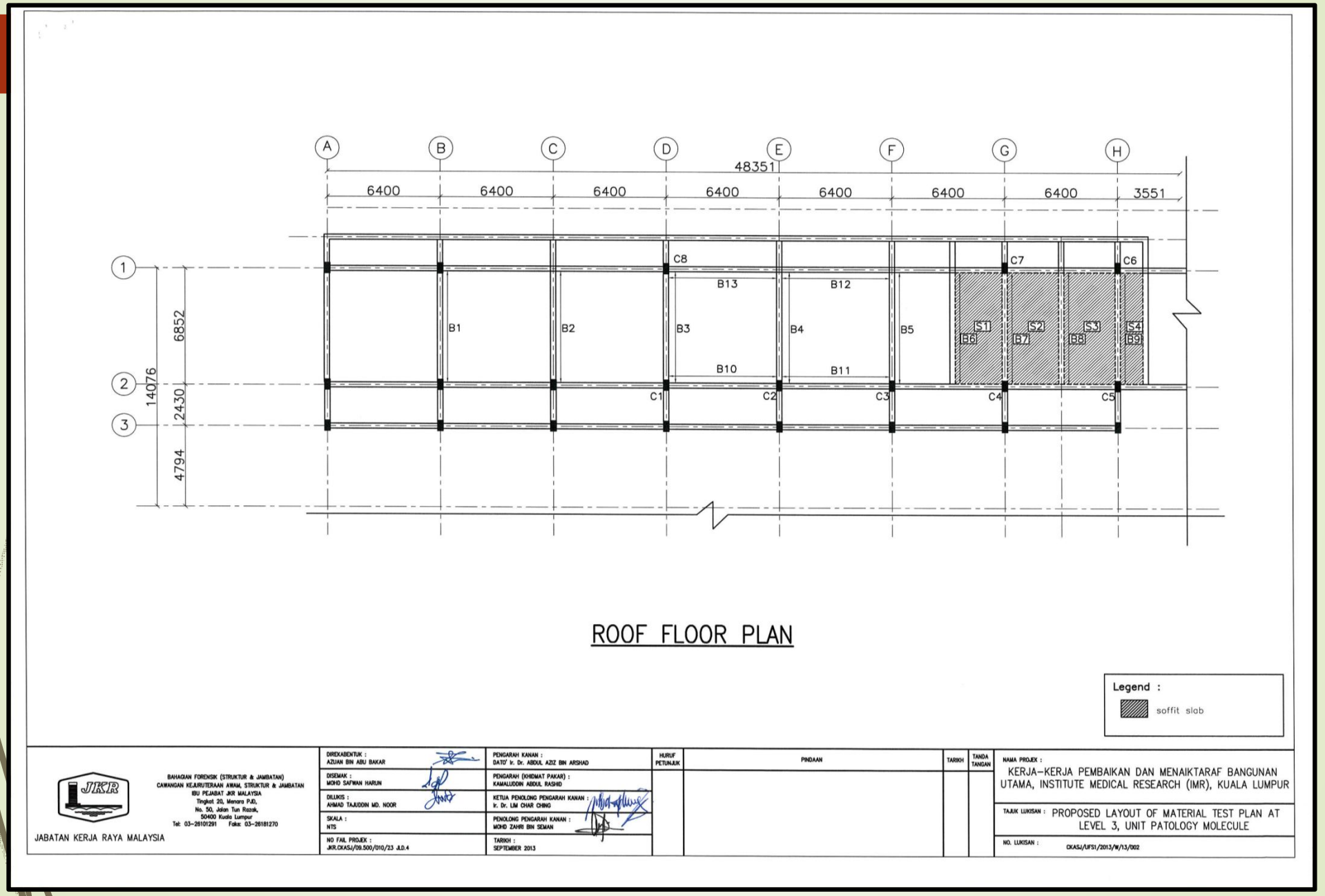
for

Kerja-Kerja Pengujian Bahan dan Penyediaan Laporan Penuh bagi Blok C, Kolej Komuniti Jempol, Jempol, Negeri Sembilan Darul Khusus.

Owner	:	Kementerian Pendidikan Malaysia.
Superintendant Officer	:	Bahagian Forensik (Struktur & Jambatan) Cawangan Kejuruteraan Awam,Struktur & Jambatan Ibu Pejabat JKR Malaysia
Contractor	:	Rahimah Enterprise.
Testing Laboratory	:	Buildtest Laboratory Sdn. Bhd. No. 12, Jalan PS 8/1, Taman Prima Selayang, 68100 Batu Caves, Selayang, Selangor Darul Ehsan Tel : 03 – 6120 5835 Fax : 03 – 6120 5836 Website : www.buildtest.com.my Email : buildtestlabsb@gmail.com / btl_sb@yahoo.com.sg



Material Testing Plan



Material test location

Material Testing Plan

LIST MATERIAL OF TEST				
Member	Sampling No.	Type of Test	Quantity of Test	Remaks
Slab	S1, S2	Tensile	2 Nos./slab	Refer to the Drawing No: CKASJ/UFS1/2014/W/26/002
		Rebound Hammer + Coring	4 Nos./slab (12 Reading/test) 1 Nos./slab	
		Rebound Hammer	2 Nos./slab (12 Reading/test)	
Beam	B1, B2, B3, B4, B5, B6	Tensile	2 Nos./beam	
		Rebound Hammer + Coring	2 Nos./beam (12 Reading/test) 1 Nos./beam	
		Rebound Hammer	1 Nos./beam (12 Reading/test)	
	B7, B8, B9, B10, B11, B12, B13	Rebound Hammer	2 Nos./beam (12 Reading/test)	
	B14	Petrography Examination	1 Nos./beam	
Column	C1, C2, C3, C4	Rebound Hammer + Coring	2 Nos./column (12 Reading/test) 1 Nos./column	
		Rebound Hammer	1 Nos./column (12 Reading/test)	
	C5, C6, C7, C8	Rebound Hammer	2 Nos./column (12 Reading/test)	
	C9	Petrography Examination	1 Nos./column	

In-situ & laboratory material test

Material Testing Plan

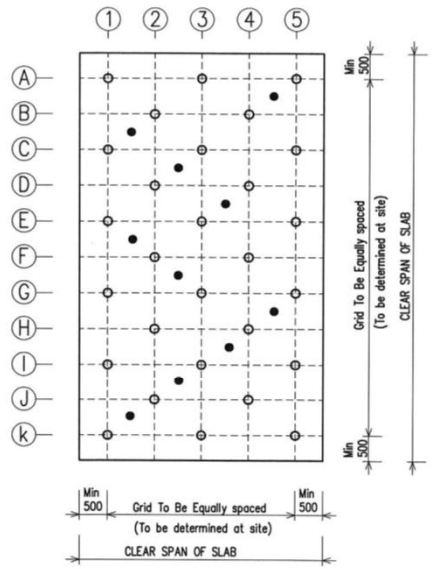


FIGURE 1 : TYPICAL MATERIAL TEST AT SOFFIT SLAB / WALL

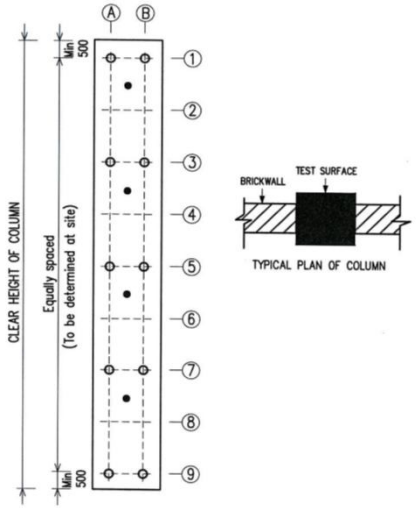


FIGURE 2: TYPICAL MATERIAL TEST AT COLUMN

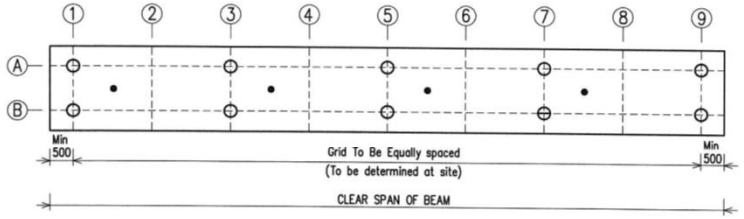


FIGURE 3: TYPICAL MATERIAL TEST PLAN AT BEAM SOFFIT

NOTES :

1. This drawing shall be read in conjunction with other structural plans indicating locations of structural components to be sampled for tests.
2. Actual test locations to be confirmed at site by JKR.
3. All gridlines shall coincide with the position of rebar in structure and shall be determined at site using rebar locator and to the approval of JKR.
4. The minimum number of tests listed in the Drawing No. CKASJ/UFS1/2013/W/13/003 shall be maintained and adjusted on a regular grid to suit a non-typical size member.
5. The location for Rebound Hammer Test to be determined at site. The test points were marked according to a grid of 50 mm apart. Twelve (12) points for an area of 200 mm x 300 mm are recommended.
6. All tests shall conform to the Malaysian Standards or British Standard. Where a test is not prescribed in any such standard, the procedure shall be agreed upon by JKR.
7. All reports and test results submitted to JKR shall be endorsed by a Professional Engineer, registered with the Board of Engineers Malaysia (BEM).
8. Drill a hole of 25mm of slab, beam & column using 25mm diameter drill bit for carbonation test.
9. Drill a hole of 100mm of slab, beam & column using 100mm diameter drill bit for coring test.
10. All cored and drilled holes must be grouted back using polymer-modified cementitious repair mortar.
11. All dimensions are in milimetres.
12. All plaster shall be removed prior to the test.

LEGEND :

- Cover measurement
- Carbonation testing
- Reinforcement Bar
- Coring sample
- Rebound hammer test (12 readings/test)

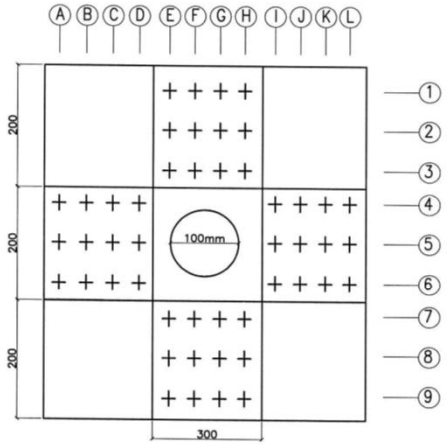


FIGURE 4: CORING AND REBOUND HAMMER TEST PLAN AT SOFFIT SLAB

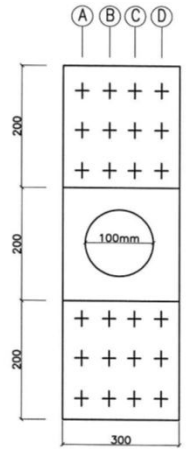


FIGURE 5: CORING AND REBOUND HAMMER TEST PLAN AT SIDE BEAM/SIDE COLUMN

JABATAN KERJA RAYA MALAYSIA

BAHAGIAN FORENSIK (STRUKTUR & JAMBATAN)
CAWANGAN KEJURUTERAAN AWAM, STRUKTUR & JAMBATAN
IBU PEJABAT JKR MALAYSIA
Tingkat 20, Menara PJD,
No. 50, Jalan Tun Razak,
50400 Kuala Lumpur
Tel: 03-26181291 Faks: 03-26181270

DIREKABENTUK : AZUAN BIN ABU BAKAR	PENGARAH KANAN : DATO' Ir. Dr. ABDUL AZIZ BIN ARSHAD	HURUF PETUNJUK	PINDAAN	TARIKH / TANDA TANGAN
DISEMAK : MOHD SAFWAN HARUN	PENGARAH (KHIDMAT PAKAR) : KAMALUDDIN ABDUL RASHID			
DILUKIS : RAJA KHAIRUL ZAKI BIN RAJA DAUD	KETUA PENOLONG PENGARAH KANAN : Ir. Dr. LIM CHAR CHING			
SKALA : NTS	PENOLONG PENGARAH KANAN : MOHD ZAHRI BIN SEMAN			
NO FAIL PROJEK : JKR.CKASJ/09.500/010/23 JLD.4	TARIKH : SEPTEMBER 2013			

NAMA PROJEK : KERJA-KERJA PEMBAIKAN DAN MENAIKTARAF BANGUNAN UTAMA, INSTITUTE MEDICAL RESEARCH (IMR), KUALA LUMPUR

TAJUK LUKISAN : MATERIAL TEST PLAN

NO. LUKISAN : CKASJ/UFS1/2013/W/13/004

Procedure of material test / sampling

Material Testing Plan

Bill of Quantities for Material Test At Patology Molekul Unit, 3rd Floor, Institute Of Medical Research (IMR), Jalan Pahang, Kuala Lumpur.

ITEM	DESCRIPTION	QTY	UNIT	RATE (RM)	AMOUNT (RM)
1.0	**Preliminaries**				
1.1	Allow for insurances (CAR, WC, PL), SOCSO, site communication, temporary access, temporary support, working platform, temporary water and electrical supply, clearance of site upon completion, etc for the total amount of work carried out exceed RM 15,000.00	-	L/S		
2.0	**Site Mobilisation and Demobilisation**				
2.1	Site mobilisation and demobilisation for the concrete sampling team and equipments.	-	L/S		
3.0	**Material Testing and Sampling**				
3.1	Electromagnetic Cover Measurement Test				
3.1.1	Identify depth and location of rebars in concrete using electromagnetic cover meter.	156	Nos		
3.2	Carbonation Test				
3.2.1	Drilling of 25 mm diameter hole for depths not exceeding 75mm for concrete carbonation test, include patching back hole with shrinkage compensated mortar, but exclude reinstatement of finishes or re-painting, if any.	60	Nos		
3.2.2	Measurement of carbonation depth for concrete by spraying 1% solution of phenolphthalein to drillled hole.	60	Nos		
3.3	Steel Tensile Strength Test				
3.3.1	Sampling of rebar for steel tensile test, including replacing with new similar rebar using full penetrating butt weld and all patching works with shrinkage compensated grout, but exclude reinstatement of finishes and re-painting, if any.	16	nos		
3.3.2	Tensile test on steel bar not exceeding 25mm diameter.	16	nos		
3.4	Rebound Hammer Test				
3.4.1	Removing plaster and surface preparation for rebound hammer test include patching back plaster, but exclude reinstatement of finishes or re-painting, if any.	41	nos		
3.4.2	Measurement of concrete surface hardness (12 readings per test).	41	nos		
3.5	Concrete Coring Test				
3.5.1	Identify location of rebars in concrete using cover meter prior coring (4 bars per location).	12	Nos		
3.5.2	Concrete coring of 100 mm diameter core using thin wall diamond bits up to 150 mm depth to collect cored sample of beam for laboratory testing.	12	Nos		
3.5.3	Patch back cored hole with shrinkage compensated mortar, but exclude reinstatement of finishes or re-painting, if any.	12	Nos		
3.5.4	Laboratory concrete compressive strength test including trimming and capping on cored sample.	12	Nos		
	Total				

Bill of Quantities for Material Test At Patology Molekul Unit, 3rd Floor, Institute Of Medical Research (IMR), Jalan Pahang, Kuala Lumpur.

ITEM	DESCRIPTION	QTY	UNIT	RATE (RM)	AMOUNT (RM)
	Amount from page 1				
4.0	**Deliverables and Reporting**				
4.1	Scope including: (a) project coordination and planning of testing schedule; (b) compilation of test data; (c) statistical analysis of test data; and (d) writing of factual testing report, 4 original copies of report certified by PE will be submitted upon completion of all agreed scope.	4	L/S		
	Grand Total				0.00

Bill of quantities for material test

TERIMA KASIH