مخططات الأبنية

Chapter

2

الأسس والمفاهيم العامة

Section

2.1

تعريف المخططات الهندسية وأهميتها

- من الناحية المفاهيمية ، المخططات الهندسية لغة المهندسين ويمكن تعريفها على أنها ترجمة لأفكار أو ابتكارات المهندس بشكل يسهل فهمه. بخصوص مشاريع الأبنية، هي وصف تخطيطي لكل مكونات البناية وتفاصيلها بالاعتماد على المعرفة الهندسية الأكاديمية للمهندس المصمم بما في ذلك الرياضيات والميكانيكا والهندسة الإنشائية وعلوم المواد والجيولوجيا والهندسة الجيوتقنية.
- **أهمية المخططات واستعمالاتها**

- المخططات هي دليل لأنشاء المبنى بالنسبة للفنين والعمال
- توضح كميات وأنواع المواد المراد استخدامها في البناء.
- وثيقة قانونيه وتعاقديه بين المالك والمهندس والمقاول في مراحل العطاء والتنفيذ والأشراف. كما أنها توثيق للمبنى يستعمل للصيانة والتوسعة المستقبلية.
- هي مصدر أو أساس لأعداد وثائق أخرى مثل المخططات التنفيذية وجدول الكميات والجدول الزمني للمشروع والأوامر التغيرية.

المهارات اللازمة لأعداد المخططات

تشمل المهارات والخبرات اللازمة للمهندس ليكون قادرا على إعداد مخططات هندسية جيدة ما يلي:

1. معرفة علمية كافيه بأصول وقواعد التصميم الهندسي بما في ذلك الأسس النظرية والكودات الناظمة.
2. معرفة جيدة بأسس وعناصر نظرية الرسم الهندسي بما في ذلك حسن اختيار واستخدام مقياس الرسم والمساقط و الخطوط بأنواعها وسماكتها المختلفة.
3. دراية جيدة بطرق الأنشاء المتبعة في المحيط المستقبل للمخططات وأدواتها، ذلك أن المخططات المقبولة يجب أن تكون قابله للفهم والتطبيق بسهولة من قبل المقاولين المستهدفين وطواقمهم.
4. القدرة على مراجعة المخططات لتحديد وتصحيح العيوب والأخطاء التي يمكن أن يقع بها المصممون والتي تتمثل في العادة بالأخطاء الفنية أو التنسيقية أو النقص في التفصيل أو سوء العرض الناتج عن معرفه غير كافية بأسس الرسم الهندسي المعروفة.

أنواع المخططات الهندسية

المخططات الهندسية

مخططات التصميم Design – Tender Drawings	مخططات التنفيذ Shop Drawings	مخططات التوثيق As-built Drawings
• تعد من قبل المصممين في مراحل التصميم المختلفة. • توسم نسختها بعبارة للعطاء فقط وتسمى مخططات العطاء. تستعمل من قبل المقاولين لفهم وتسعير المشروع. • بعد إرساء العطاء توسم بعبارة "للتنفيذ" وتصبح المخططات الرسمية للمشروع ويجري الأشراف وأعداد مخططات التنفيذ على أساسها.	• تفصيل لمخططات التصميم يعده طاقم المقاول قبل البدء بالتنفيذ وتخضع لمراجعة وموافقة المشرف. • تستخدم من قبل المشرف لفحص الأعمال المنجزة قبل استلامها. ويستعملها المقاول لأعداد طلبيات المواد. • تستخدم أيضا لأعداد الدفعات المالية الجارية للمقاول أثناء العمل.	• تفصيل للأعمال المنفذة في الواقع ومرجع للمسؤولية القانونية. • يتم أعدادها من قبل طاقم المقاول وتسلم لاعتماد وموافقة المشرف عند اكتمال أعمال المشروع. • تبين تفاصيل التغيرات التي تم تنفيذها في المشروع. • تستعمل لأعداد الدفعة النهائية للمقاول وكمرجع للصيانة وأعمال التوسعة المستقبلية.

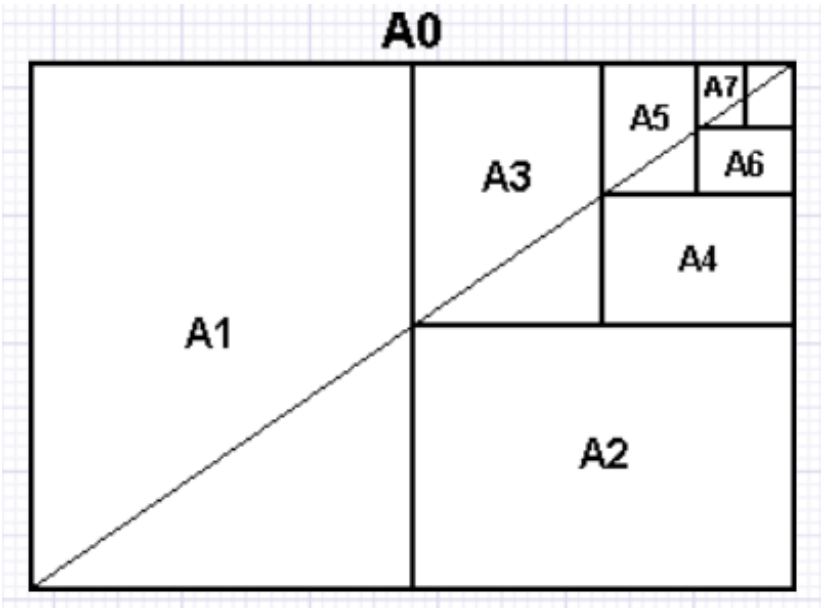
قواعد واصطلاحات المخططات الهندسية

- تعني قواعد واصطلاحات المخططات الطرق والممارسات المتفق عليها في أعداد المخططات الهندسية بما في ذلك:

1. اللوحات (Drawing sheet)
2. مقياس الرسم (Scale)
3. الخطوط (Lines)
4. الكتابة والرموز والمختصرات (Littering, symbols and abbreviations)
5. الأبعاد (Dimensioning)

وذلك لاعتبار أن المخططات لغة عالمية يجب أن يستطيع المهندسين والمعنين قراءتها دون الحاجة لتفسير من اعدها.

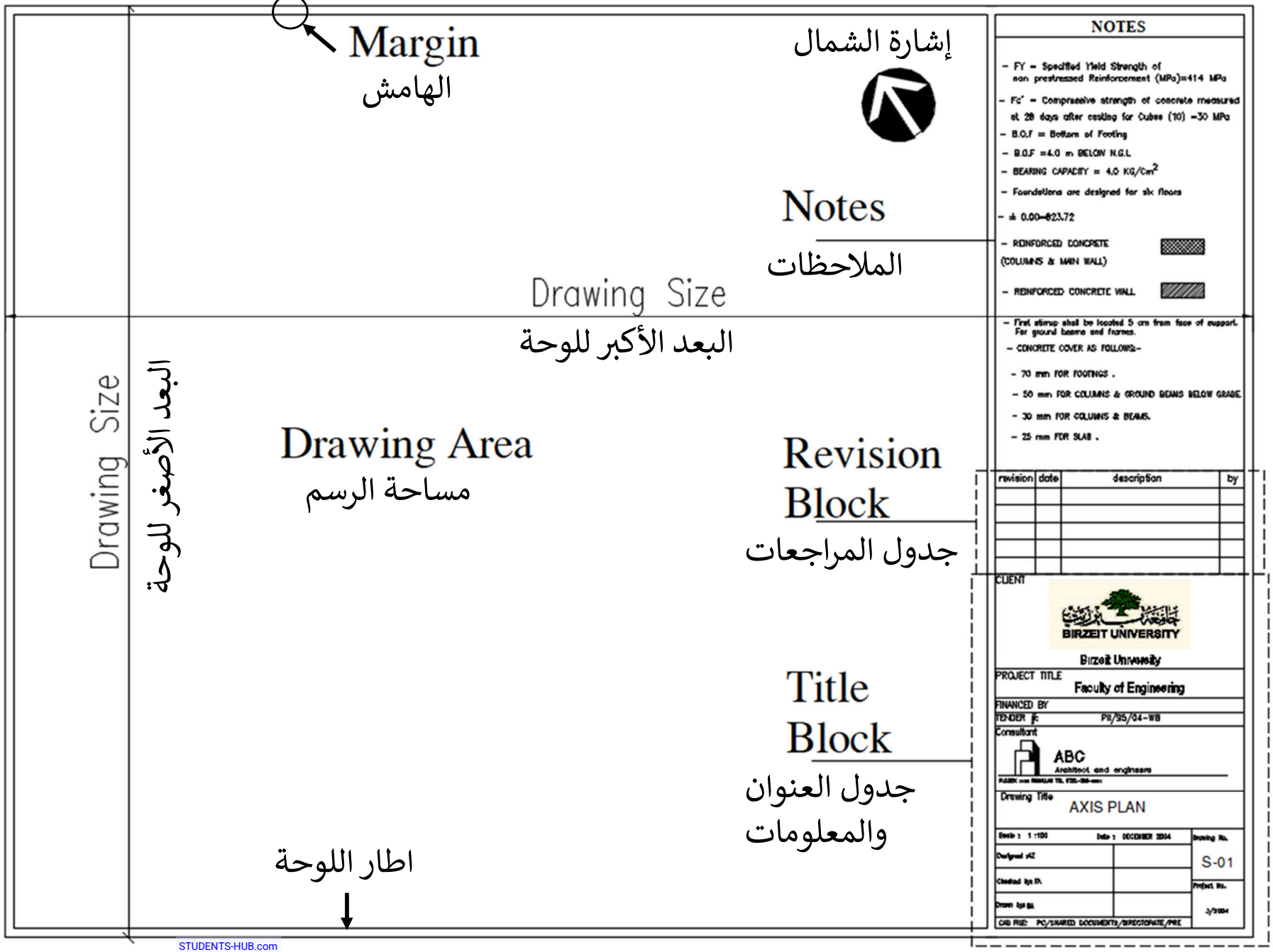
اللوحات



- **حجم اللوحة**
- تتوافر في الأسواق لوحات بأسماء وأبعاد مختلفة أهمها وأكثرها استخداما السلسة القياسية "A" كما في الشكل. وتتميز هذه بان البعد الأكبر للوحة يساوي البعد الاصغر $\times \sqrt{2}$.
- تبدء السلسلة بالحجم A0 وتكون مساحه اللوحة الأصغر في السلسلة تساوي نصف مساحة اللوحة الأكبر منها مباشرة.
- يختار المهندس لوحته التي يرغب بإخراج مخططاته عليها منذ البدء بالتصميم اعتمادا بالأساس على حجم المشروع ومقياس الرسم المستخدم.

Designation	Dimensions
A0	841 mm x 1189 mm
A1	594 mm x 841 mm
A2	420 mm x 594 mm
A3	297 mm x 420 mm
A4	210 mm x 297 mm
A5	149 mm x 210 mm

تقسيم اللوحة – ترتيب نموذجي للأجزاء

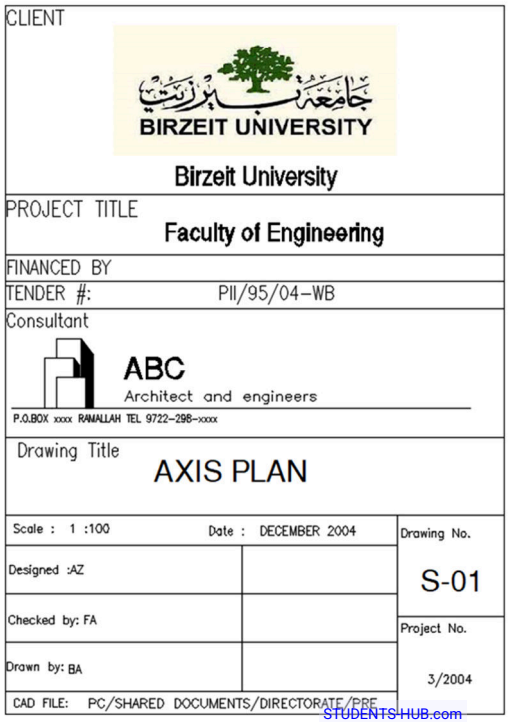


أجزاء اللوحة الأساسية

Paper Size	Border Width (mm)	
	Left & Right	Top & Bottom
A0	28	20
A1	20	14
A2	14	10
A3	10	7
A4	7	5

- **الهامش :** فراغ بعرض كافي بين حواف اللوحة وإطارها يهدف لحماية معلومات اللوحة من التلف أثناء الاستخدام ولتوفير مكان لتثبيت اللوحات معا دون التسبب بحجب بعض المعلومات. يختلف عرض الهامش حسب حجم اللوحة كما في الجدول المرفق.

- **جدول العنوان والمعلومات (Title block) ويشمل**
  - اسم المالك والمشروع والاستشاري
  - اسم اللوحة أو عنوانها
  - رقم المشروع ورقم اللوحة
  - تاريخ إعداد اللوحة وأسماء المهندسين المشاركين
  - مقياس الرسم المستخدم
  - اسم ملف اللوحة الإلكتروني


CLIENT

BIRZEIT UNIVERSITY

Birzeit University

PROJECT TITLE

Faculty of Engineering

FINANCED BY

TENDER #: PII/95/04-WB

Consultant

ABC

Architect and engineers

P.O.BOX xxxx RAMALLAH TEL 9722-298-xxxx

Drawing Title

AXIS PLAN

Scale : 1 :100 Date : DECEMBER 2004 Drawing No. S-01

Designed :AZ

Checked by: FA

Drawn by: BA

Project No. 3/2004

CAD FILE: PC/SHARED DOCUMENTS/DIRECTORATE/PRE

أجزاء اللوحة

revision	date	description	by

- **جدول المراجعات (Revision or amendments table).** وهو جدول يوضح التغيرات والإضافات التي أجريت على اللوحة خلال مراحل إعدادها المختلفة، أي انه سجل لتاريخ اللوحة والقرارات التصميمية ذات العلاقة قبل إصدار النسخة النهائية.

NOTES :

* REFERENCE POINT LEVEL : 843.57
* DESIGN REFERENCE LEVEL : ±00.00 = 843.57
* GROUND FLOOR LEVEL : +00.75 = 844.32
* USE MESH REINFORCEMENT OF Y25@150(T&B) EW, ONLY ADDITIONAL REINFORCEMENT ARE SHOWN ON PLAN.

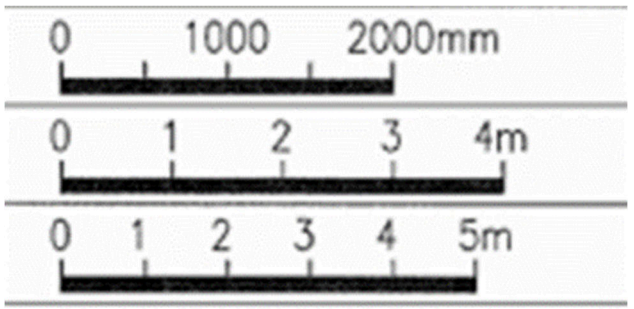
- **مساحة الملاحظات (Notes).** وهي مساحه تسجل فيها ملاحظات تصميمية خاصة باللوحة أو أي تعليمات عامة مهمة يرى المصمم ضرورة لذكرها والتأكيد عليها. إضافة لذلك يمكن أن تحتوي المساحة على رموز أو اختصارات خاصة باللوحة تساعد على قراءتها وفهمها بشكل جيد.

مقياس الرسم (Scale)

- مقياس الرسم هو النسبة بين البعد على اللوحة لعنصر معين والبعد الحقيقي لهذا العنصر في الواقع.
- يعبر عن مقياس الرسم على المخططات عادة كما يلي:

SCALE 1:100

- في بعض الأحيان يعبر عن المقياس بالرسم كما هو موضح وذلك عندما يخشى من تشوه المخطط بالتصوير



- يستعمل المقياس لتكبير الأشياء او تصغيرها أو رسمها بالبعد الحقيقي كما في الجدول أدناه.

الوصف	مقياس الرسم باللوحة			
التكبير	١/ ٥٠	١/ ٣٠	١/ ١٠	
	١/ ٥	١/ ٢		
مقاس حقيقي	١/ ١			
تصغير	١/ ٢			١/ ٥
	١/ ١٠	١/ ٢٠		١/ ٥٠
	١/ ١٠٠	١/ ٣٠٠		١/ ٥٠٠
	١/ ١٠٠٠	١/ ٣٠٠٠		١/ ٥٠٠٠

مقياس الرسم ١/ ٥٠ يعني كل ١ سم بالرسم= ٥٠ سم بالطبيعة
مقياس الرسم ١/ ١٠٠ يعني كل ١ سم بالرسم= ١٠٠ سم بالطبيعة= ١ متر
مقياس الرسم ١/ ٥٠٠ يعني كل ١ سم بالرسم= ٥٠٠ سم بالطبيعة= ٥ متر
مقياس الرسم ٢/ ١ يعني كل ٢ سم بالرسم= ١ سم بالطبيعة .

مقياس الرسم

- يعتبر الاستخدام الموفق لمقياس الرسم من اهم عوامل الجودة في المخططات ويعتمد ذلك على:
  - درجة تعقيد المخطط أو التفصيلة المراد رسمها.
  - الحاجة لإظهار اكبر كم من المعلومات المرتبطة على نفس اللوحة.
  - الوضوح وسهولة قراءة التفاصيل.
- يوضح الجدول أدناه مقياس الرسم الموصى به لرسم تفاصيل ومخططات هندسية مدنية مختلفة

Type of Drawing	**Recommended Scale**
Location Maps	1:50 000, 1:10 000, 1:5000
Site Plan	1:2500, 1:1250, 1:500
Road and sewage longitudinal sections	Vertical - 1:5, 1:10, 1:20, 1:50
	Horizontal – 1:1250, 1:500, 1:200, 1:100
Building plans, elevations and sections	1:100, 1:50
Details	1:25, 1:20, 1:10,1:5, 1:1

الخطوط وأنواعها (Lines and line types)

- لكل لغة حروف وحروف الرسم الخطوط، وهي أنواع مختلفة ولكل نوع منها دلالته الخاصة في الرسم الهندسي. إن الاستعمال الخاطئ لأنواع الخطوط قد يؤدي الى إرباك قارئ المخطط وإيصال معلومات مشوشه له.
- **أنواع الخطوط واستخداماتها**

LINE TYPE	LINE CHARACTER & WIDTH	USES
VISIBLE LINE	Width 0.15 - 0.7 mm	PHYSICAL BOUNDARY OF A FEATURE DIRECTLY VISIBLE OR EXPOSED IN A PARTICULAR VIEW
CENTERLINE	Width 0.1 - 0.2 mm	CENTER OF SYMMETRY OF A PARTICULAR FEATURE OR OBJECT IN A GIVEN DIRECTION
DIMENSION LINE	3.0' Width 0.1 - 0.2 mm	LINE FOR DEFINING A DIMENSION OR LIMITS OF A PARTICULAR FEATURE, WITH ARROW HEAD AT EACH END.
EXTENSION LINE	Width 0.1 - 0.2 mm	LINES EXTENDING THE LIMITS OF A PARTICULAR FEATURE TO WHERE THEY CAN BE CLEARLY DIMENSIONED
LEADER	Width 0.1 - 0.2 mm	LINE CONNECTING A CALL–OUT TO THE FEATURE SHOWN, WITH ARROWHEAD ON THE FEATURE SIDE
HIDDEN LINE	Width 0.15 - 0.25 mm	PHYSICAL BOUNDARY OF A FEATURE NOT DIRECTLY VISIBLE OR COVERED IN A PARTICULAR VIEW

الخطوط وأنواعها (Lines and line types

LINE TYPE	LINE CHARACTER & WIDTH	USES
LONG BREAK LINE	 Width 0.3- 0.7 mm	ISOLATES ONLY PORTION OF A FEATURE INSTEAD OF SHOWING THE ENTIRE FEATURE
SECTION CUT LINE	 Width 0.5- 0.7 mm	SHOWS A PLANE ACROSS WHICH A SECTION IS CUT

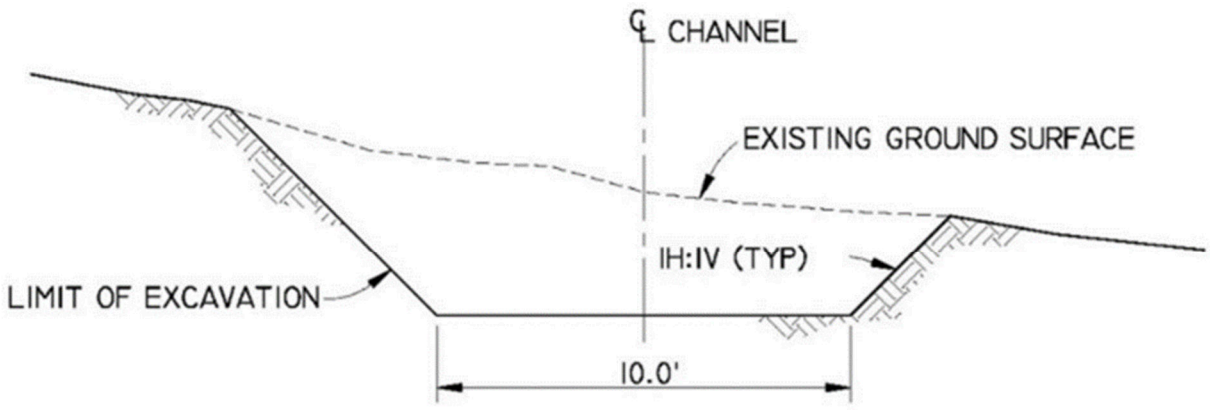
- **سماكة الخطوط**

- يرجع اختيار السماكات المختلفة للخطوط لاختيار المصمم، فقط يلزم أن يعطي الخيار صورة مجسمه للرسم وان يوصل المعلومات الأساسية بوضوح.
- عموما تزداد السماكات كلما زاد حجم اللوحة ويميز الخط العريض بان سمكه عادة ما يكون ضعفي الى ثلاثة أضعاف سمك الخط الرفيع.

الكتابة على اللوحات (Lettering)

- الخط المستخدم (Font) يجب أن يكون سهلا ومباشرا من أنواع الخطوط البسيطة مثل simplex or Arial وان يكون موحدا لكل اللوحات في المجموعة.
- أن لا يقل حجم الخط (Font size) عن 2.5 ملم. يوضح الجدول التالي أحجام الخط الموصى بها وفقا لأحجام اللوحات.

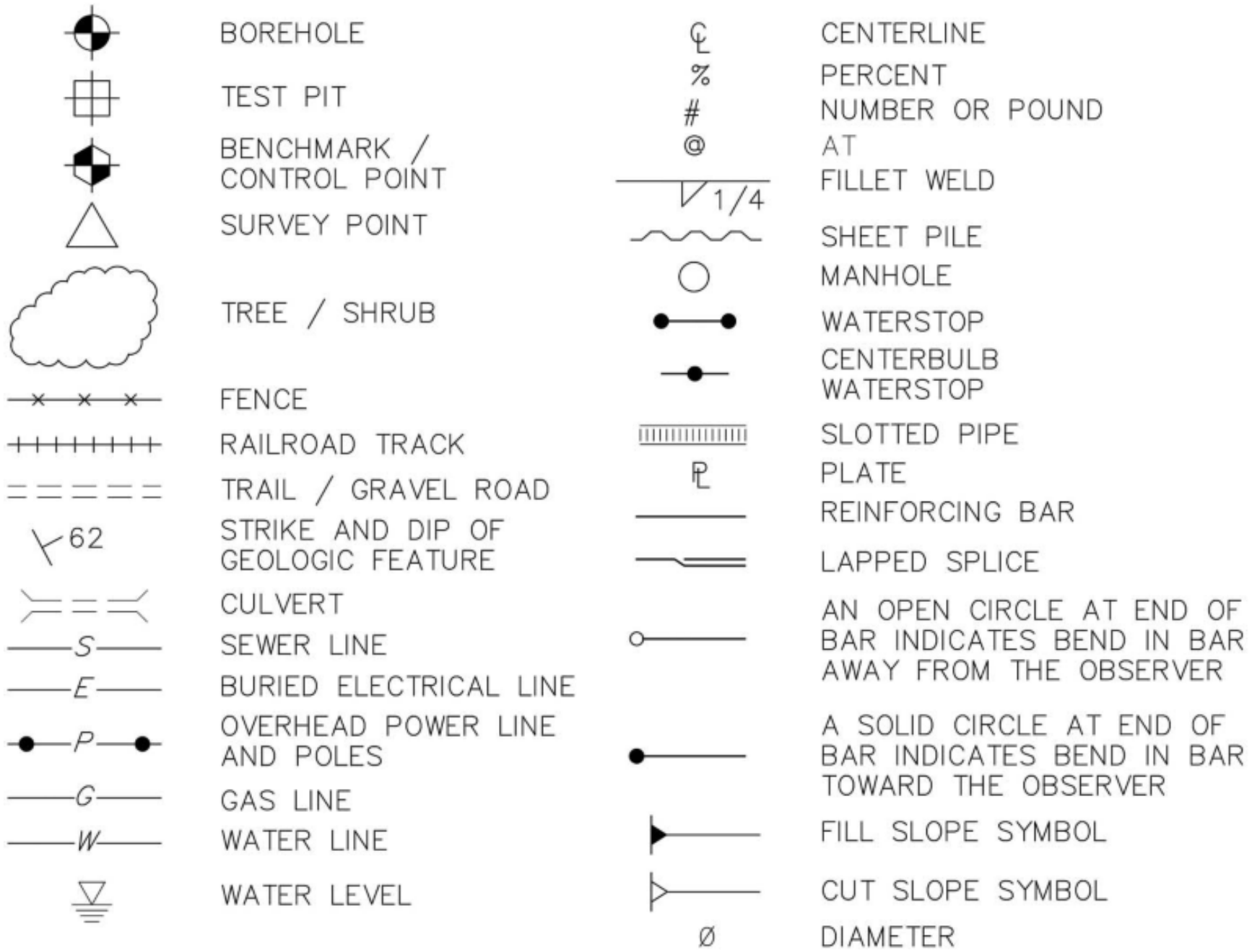
Application	Drawing Sheet Size	Minimum Character Height (mm)
Drawing numbers, etc.	A0, A1, A2 and A3	7
	A4	5
Dimensions and notes	A0	3.5
	A1, A2, A3 and A4	2.5



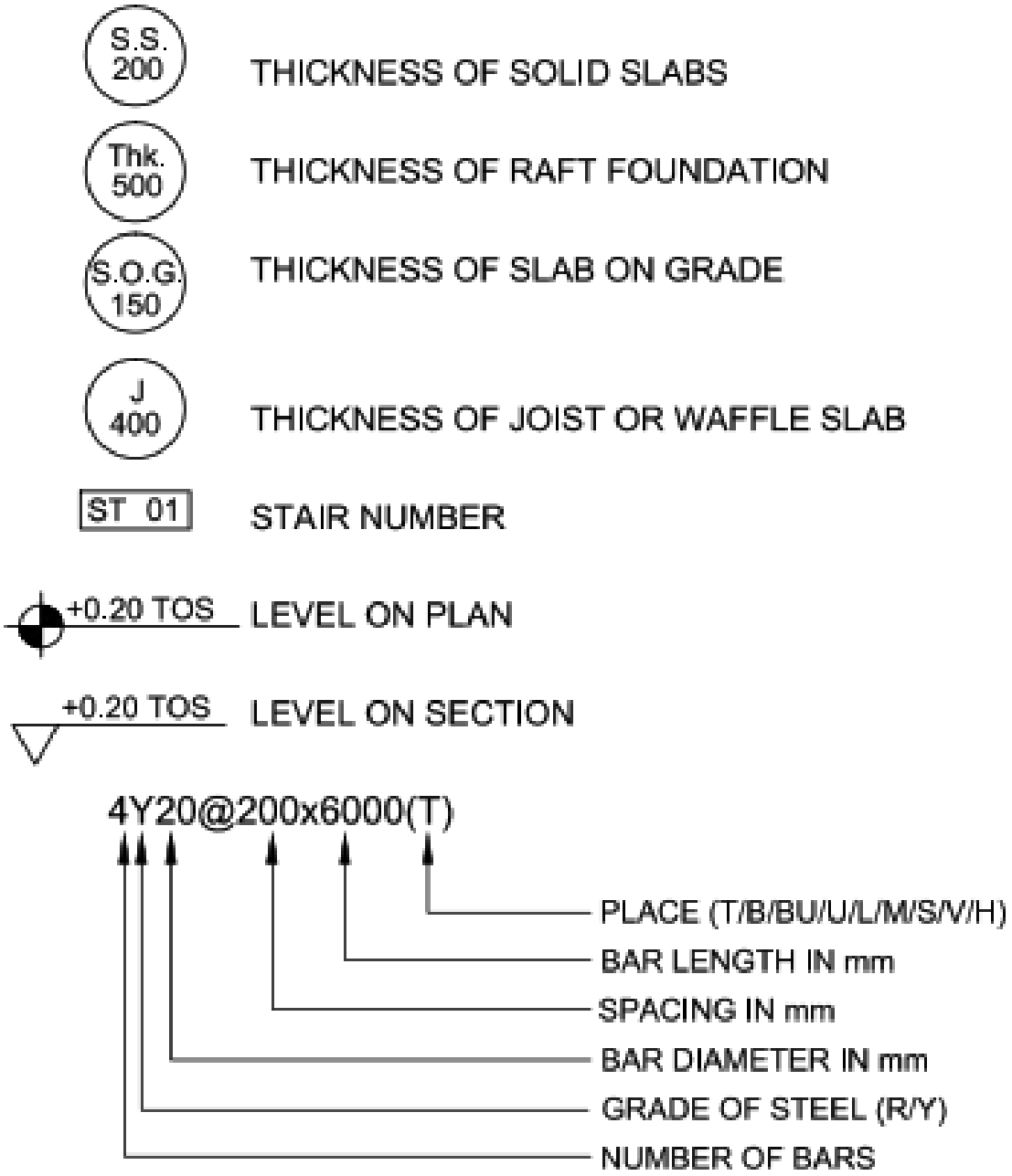
TYPICAL CHANNEL SECTION

Illustration of Proper Use of Lettering Size

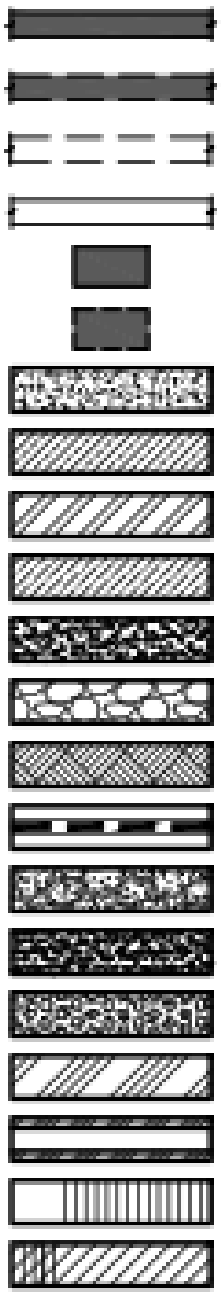
الرموز والاختصارات(Symbols & Abbreviations)



رموز من مخططات إنشائية

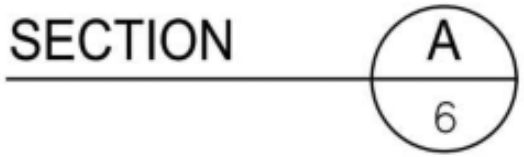


رموز تهشير شائعة في مخططات المباني

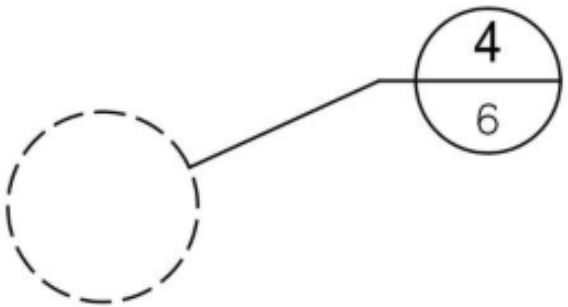


Common Notations Forms

INDICATES LOCATION OF CROSS SECTION "A
THE NUMBER "6" IS THE SHEET NUMBER
WHERE THE SECTION IS SHOWN.



INDICATES LOCATION OF CROSS SECTION "A
THE NUMBER "6" IS THE SHEET NUMBER
WHERE THE SECTION CUT IS SHOWN.



INDICATES LOCATION OF DETAIL "4".
THE NUMBER "6" IS THE SHEET NUMBER
WHERE THE DETAIL IS SHOWN.

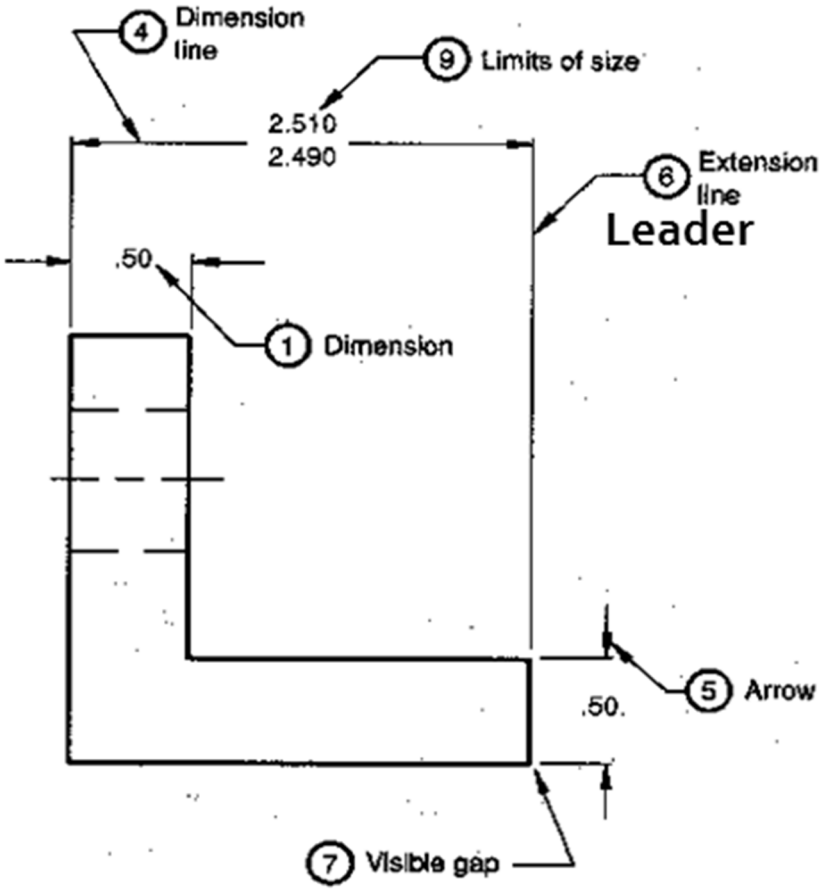
INDICATES DETAIL "4". THE NUMBER "3"
IS THE SHEET NUMBER WHERE THE DETAIL
IS CALLED OUT.

اختصارات شائعة في المخططات الإنشائية

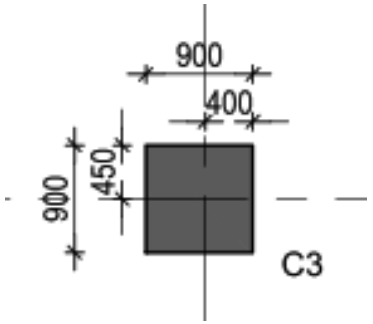
B	BOTTOM BARS
BU	BENT UP BARS
cm	CENTIMETER
C1	COLUMN NUMBER 1
CJ	CONTRACTION JOINT
Dia	DIAMETER
EA	EACH FACE
EJ	EXPANSION JOINT
ES	EACH STEP
EW	EACH WAY
FFL	FINISH FLOOR LEVEL
GB1	GROUND BEAM
H	HORIZONTAL BARS
INV	INVERTED
L	L SHAPED TOP BARS
M	MIDDLE BARS
m	METER
MAX	MAXIMUM
MIN	MINIMUM
No.	NUMBER
NTS	NOT TO SCALE
PLC	PLANTED COLUMN
R	MILD STEEL BARS
RB1	BEAM NUMBER 1
S	STIRRUPS
T	TOP BARS
TOF	TOP LEVEL OF FOUNDATION
TOS	TOP LEVEL OF STRUCTURAL SLAB
TYP	TYPICAL
T&B	TOP AND BOTTOM
U	U SHAPED BARS
V	VERTICAL BARS
VAR	VARIABLE
Y	HIGH YIELD BARS
W1	SHEAR WALL NUMBER 1

الأبعاد (Dimensioning)

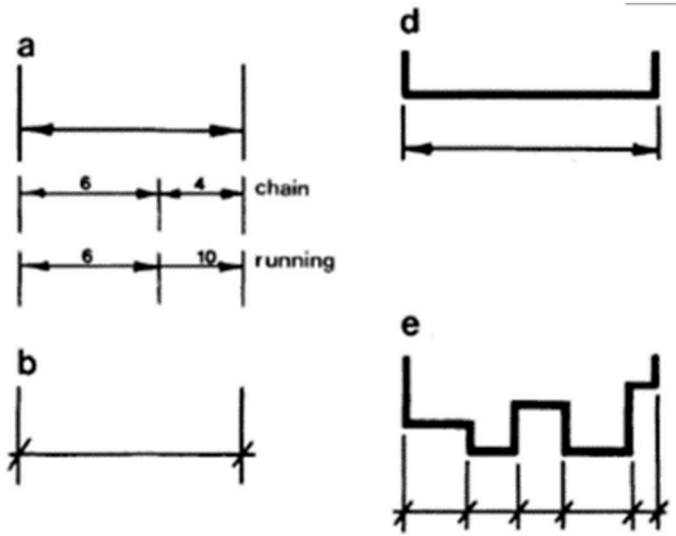
- الأبعاد هي إشارة أو تحديد لطول عنصر معين في المخطط أو المسافة الحقيقية بين نقطتين وتتآلف من خط البعد (Dimension line) والامتداد (Extension line) والكتابة (Dimension).



- بالرغم من أن المخططات الهندسية ترسم بمقياس رسم، تبقى الأبعاد من اهم عناصر المخططات وبالتالي يجب أن تكون واضحة وشامله تفي تماما بحاجة المنفذ دون أن يضطر للقياس من المخططات، وان لا تكون مكررة لنفس العنصر أو المسافة بحث تؤدي الى الإرباك أو تزيد من احتمالات الخطء.



الأبعاد (Dimensioning)

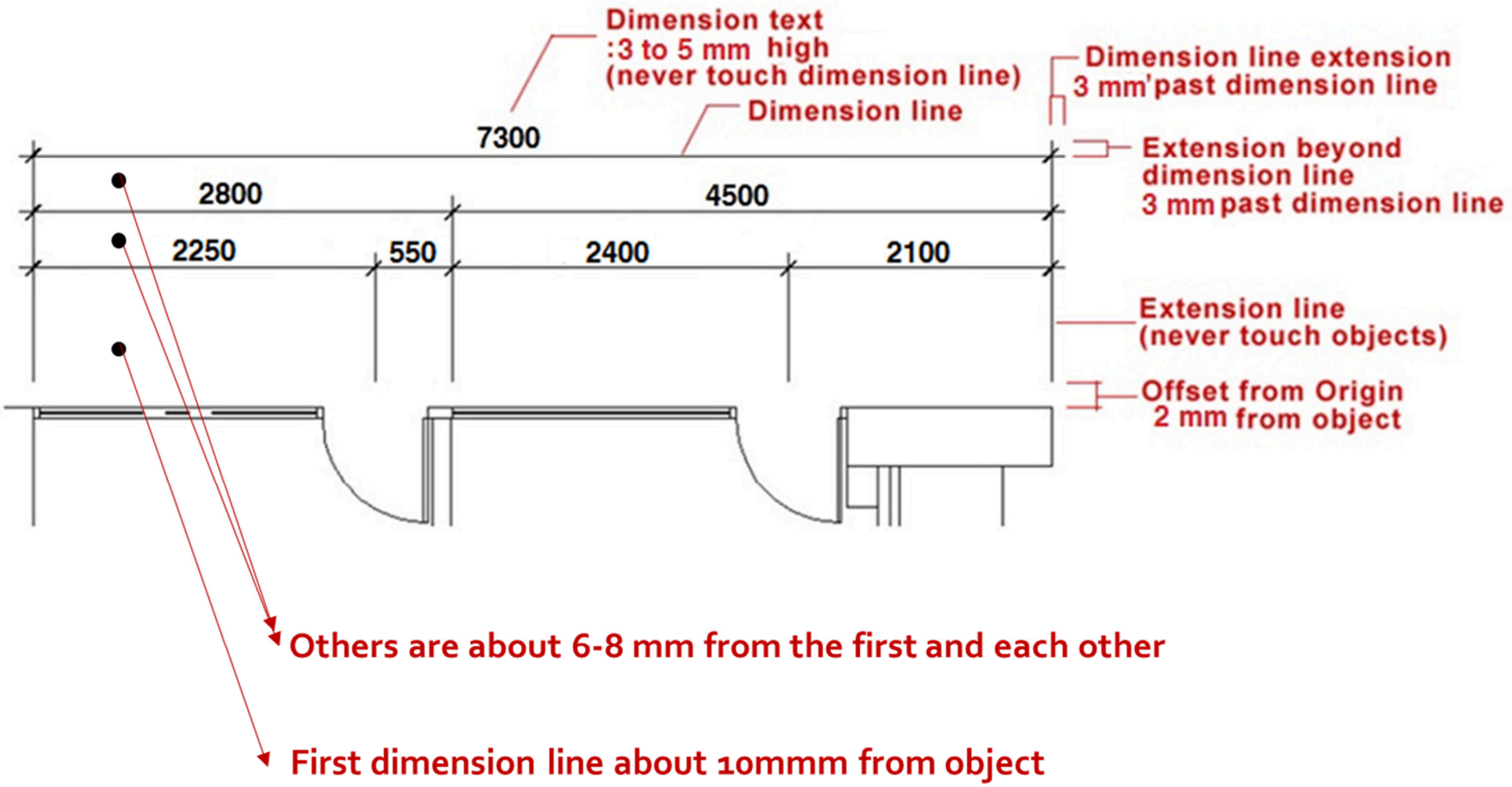


- خط الأبعاد. خط رفيع أفقي أو عمودي أو موازي للعنصر المراد تعينه ينتهي من طرفيه بإشارة قد تكون سهما أو نقطه أو شرطه مائلة وهي الأكثر استخداما في مخططات الأبنية.
- خط الامتداد. هو خط رفيع يمتد من خط الأبعاد الى حافة المسافة المراد قياسها تاركا مسافة صغيرة بينهما (Gap) ويمكن أن يمتد قليلا بعد تقاطعه مع خط الأبعاد كما في الشكل.

- الكتابة. تحديد للمسافة الحقيقية بالأرقام وتكون - في مخططات الأبنية - بوحدة المليمتر. توضع فوق خط الأبعاد بمسافة صغيرة.

الأبعاد (Dimensioning)

- ترتيب نموذجي للأبعاد في مخطط بناية



قراءة وفهم مخططات الأبنية الأساسية

Section

2.2

المخططات المعمارية

Section

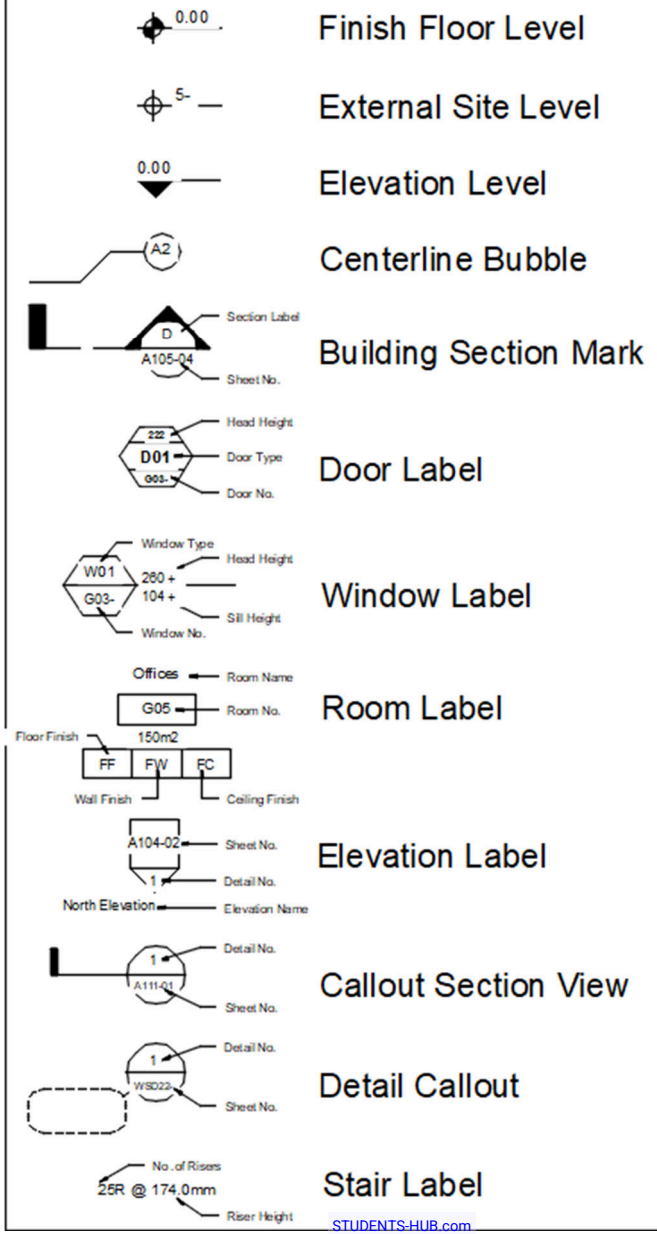
2.2.1

المخططات المعمارية

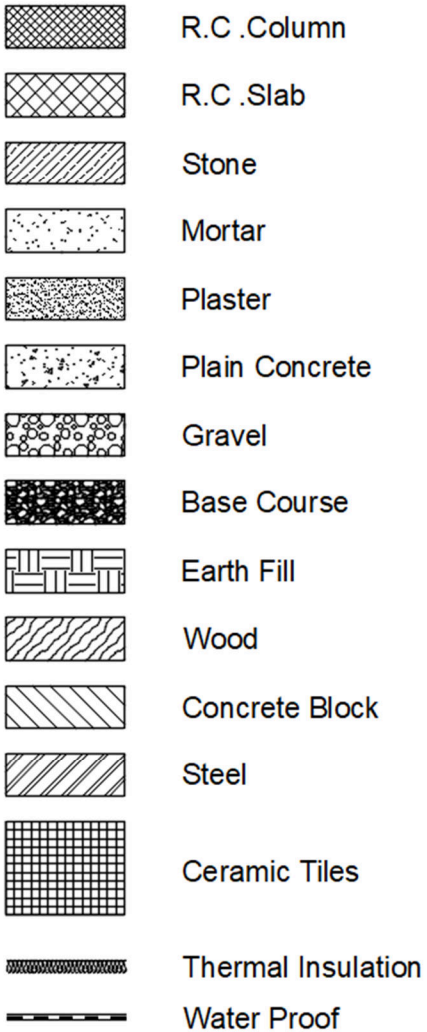
- تعتبر المخططات المعمارية بأنها المخططات الرئيسية للمبنى والتي تحدد شكل وحجم وتقسيم المبنى الى فراغات عملية. ويتم عمل جميع المخططات والتصاميم الهندسية الأخرى بناءً عليها.
- تشمل العناصر الأساسية في هذه المخططات ما يلي:
  - مخطط الموقع – (Site Plan).
  - المساقط الأفقية (Floor plans).
  - الواجهات (Elevations).
  - المقاطع (Sections).
  - التفاصيل المعمارية (Details).
- تبدء قراءة المخططات المعمارية بمعرفة الرموز والاختصارات المستعملة فيها والتي يمكن الاطلاع عليها من خلال لوحة الملاحظات العامة لمخططات العمارة أو ملاحظات اللوحات (لاحظ الشريحة التالية).

الرموز والاختصارات المعمارية

LEGEND



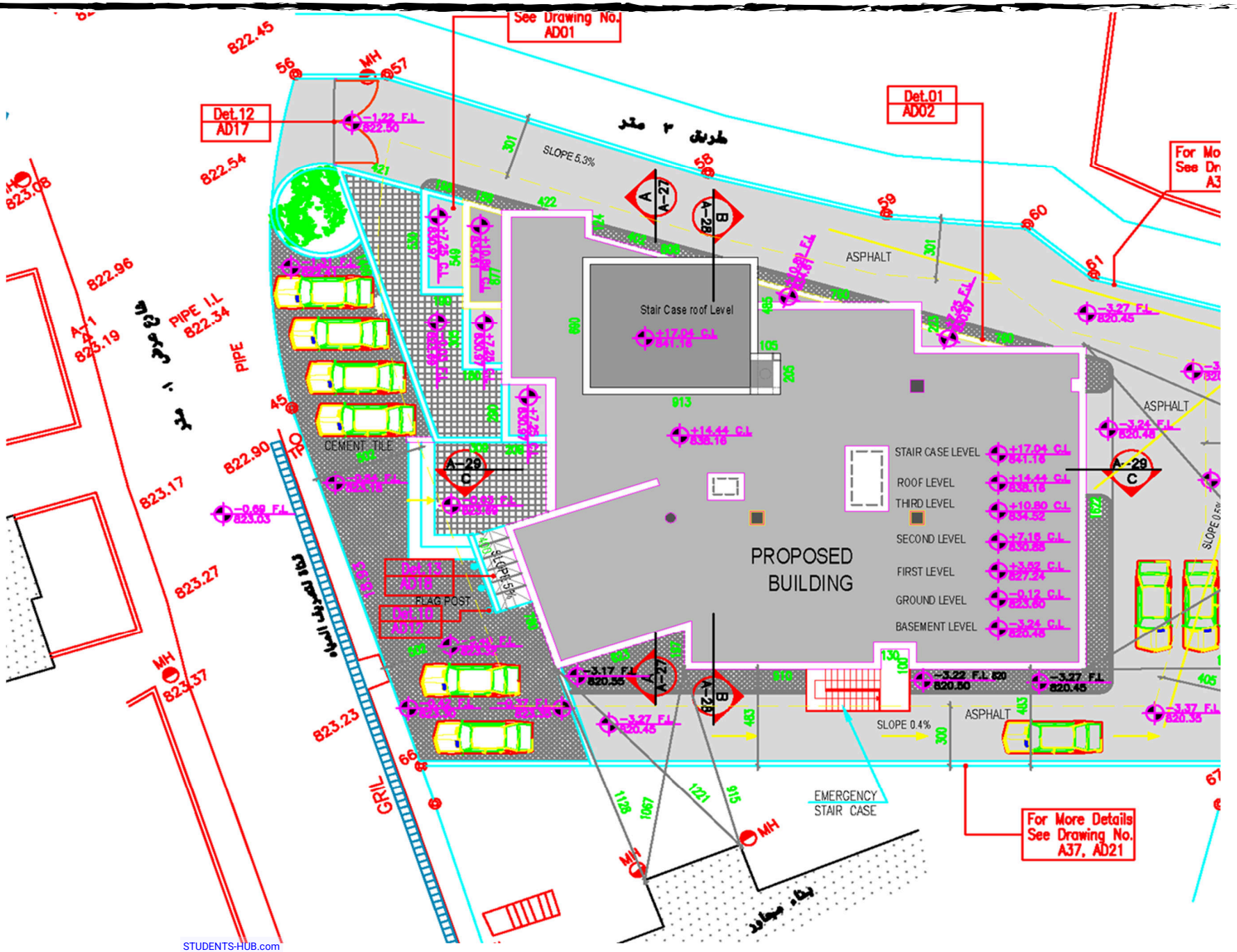
FILL PATTERNS



ABBREVIATIONS

V.O.S.	Verify on Site
A.F.F.	Above Floor Finish Level
C.S.L.	Concrete Slab Level
F.F.L.	Finished Floor Level
N.L.	Natural Level
P.L.	Proposed Level
E.J.	Expansion Joint
CONC.	Concrete
R.C.	Reinforced Concrete
W.P.	Water Proof
G.S.	Galvanized Steel

Site plan - مخطط الموقع العام



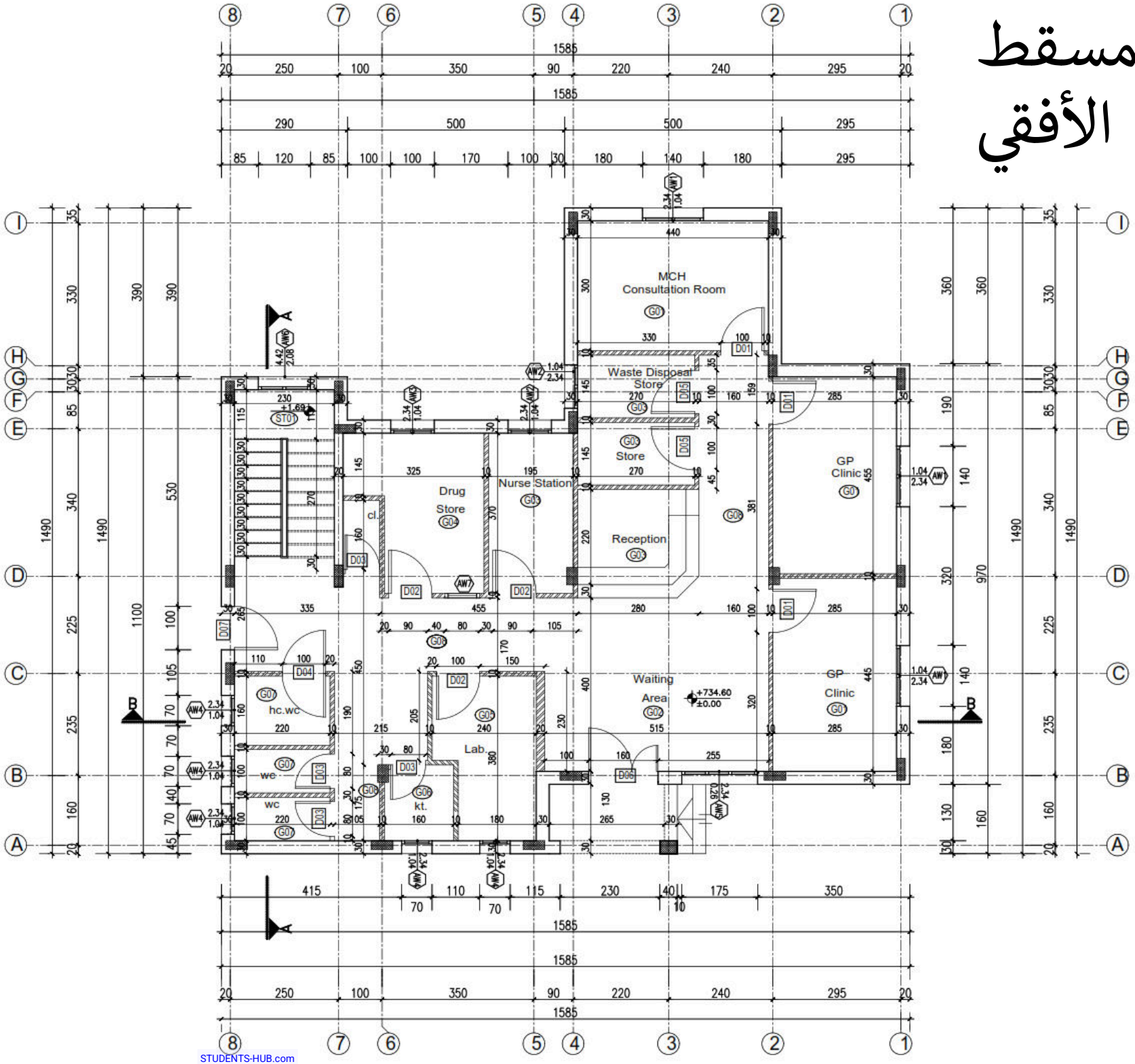
مخطط الموقع العام - Site plan

- لوحة الموقع العام هي أول وأخر اللوحات التنفيذية التي يتم استخدامها عند تنفيذ المبنى وهى عبارة عن إسقاط أفقي للمبنى من الأعلى يظهر المبنى وجميع العناصر المعمارية المحيطة به حتى حدود قطعة الأرض المخصصة للمبنى والشوارع و الطرق المحيطة بالمشروع . وتهدف أساسا الى تحديد موقع المبنى بالنسبة لحدود قطعة الأرض.
- تشمل المعلومات التي يمكن قراءتها والاستفادة منها من اللوحة ما يلي:
- حدود الأرض و علاقة المبنى بها و بالجار والطرق المحيطة .
- المنسوب الرئيسي (Zero level) ومناسيب التصميم المختلفة للموقع .
- كتل أو مباني المشروع وعلاقتهما ببعض.
- منسوب اسطح كتل مكونات المشروع مع ميول المنحدرات و الأسقف.
- مداخل المشروع ووظيفتها.

مخطط الموقع العام - Site plan

- موقع ومصادر الخدمات للمشروع (المياه الكهرباء الصرف الصحي التليفونات خطوط الداتا ... الخ).
- المباني و الأشجار الموجودة بالفعل بالموقع والمطلوب إزالتها أو الحفاظ عليها
- الطرق الداخلية وأماكن انتظار السيارات و الأرصفة والأسوار و الحدائق.
- تفاصيل الموقع (أشجار، أحواض زهور، منحدرات، نافورة، حمام سباحة، مظلة... الخ).
- مواقع المقاطع المعمارية

المسقط الأفقي



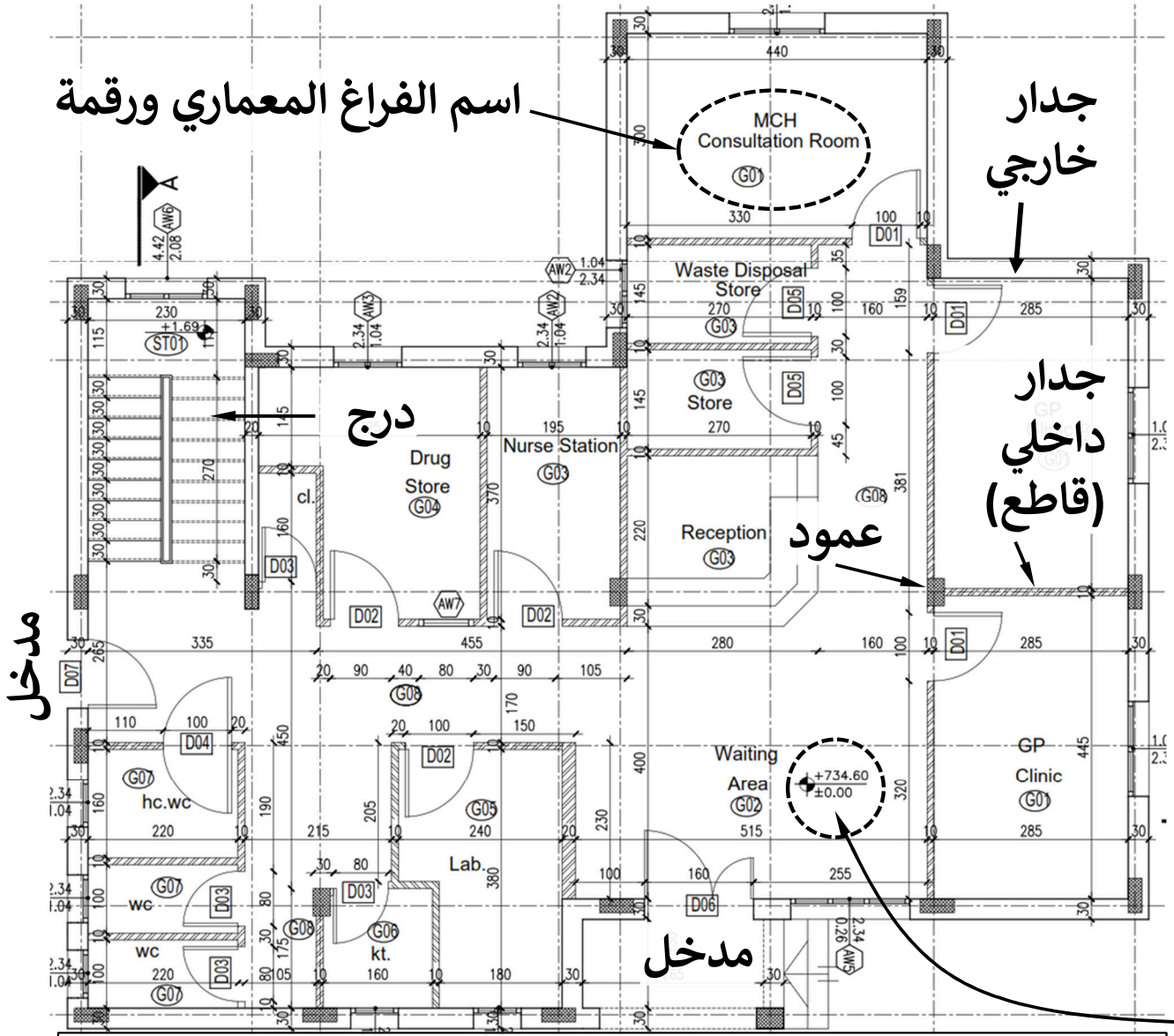
المسقط الأفقي - Floor plan

- **التعريف**. المسقط الأفقي هو قطع أفقي في المبنى يوضح التفاصيل الداخلية للدور ويكون القطع في ثلثي ارتفاع الدور أو على ارتفاع 2 م من منسوب الأرضية .
- يعتبر المخطط الأساسي للمبنى ويستخدم من قبل المهندسين لتحديد وتصميم الأنظمة الإنشائية والميكانيكية والكهربائية للمبنى. كما انه المخطط الأساسي الذي يستند له المعماري في تطوير مخططات الواجهات والمقاطع والتفاصيل المعمارية الأخرى.
- يرتبط هذا المخطط بمخططات أخرى وجداول للأبعاد والمواصفات الخاصة بمكونات المسقط مثل مخطط الفرش وجدول التشطيبات وجداول الأبواب والشبابيك.
- بعد اكتماله وفي مرحلة التصميم النهائية يستعمل المخطط في احتساب كميات الكثير من مواد الأنشاء والتشطيبات وتقدير كلفتها.

المسقط الأفقي - Floor plan

- يوضح المسقط الأفقي ما يلي:

1. الفراغات المعمارية المختلفة والعلاقات بينها والمداخل والحركة الداخلية. حيث يعطى كل فراغ اسما يحدد هدفه ورقما يربطه بجداول لاحقه تحدد أنواع التشطيبات لهذا الفراغ أو الحيز.
2. مستوى الطابق الفعلي والنسبي



يميز بين أنواع الجدران المختلفة (طوب –خرسانه – خرسانه مسلحه بالتهشير

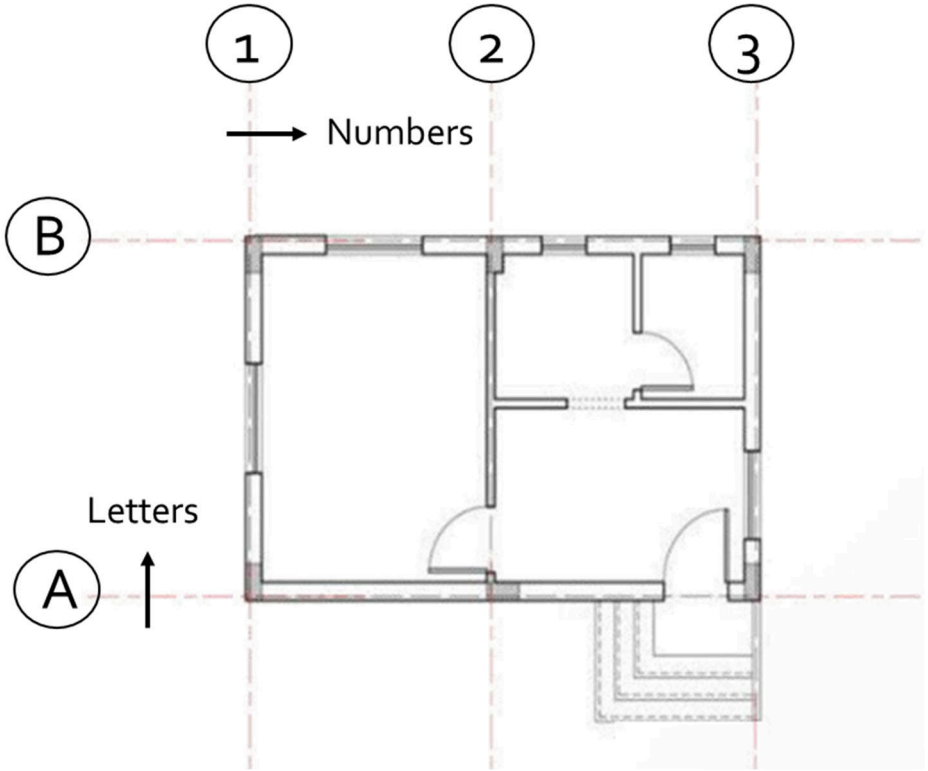
Floor plan - المسقط الأفقي

ROOM #	SPACE NAME	FLOOR	Skirting	WALLS	CEILING	NOTES
G01	MCH .CONSULTATION GP.CLINIC	T.T	T.SK	E.P	P.L And P.P	Oil paint @1.50 m,(0.8x0w x 0.6h) C.T above Sink
G02	WAITING AREA	T.T	T.SK	E.P	P.L And P.P	Oil paint @1.50 m
G03	WASTE DISPOSAL STORE STORE , RECEPTION NURSE STATION	T.T	T.SK	E.P	P.L And P.P	Oil paint @1.50 m
G04	DRUG STORE	T.T	T.SK	E.P And G.C.T	P.L And P.P	C.T 0.6 m above cupbourd, Oil Paint @ 1.5m
G05	LAB.	T.T	T.SK	E.P And G.C.T	P.L And P.P	C.T 0.6 m above cupbourd, Oil Paint @ 1.7m
G06	Kitchenette	C.T	T.SK	E.P And G.C.T	P.L And P.P	1.5 m Height
G07	W.C , HC.WC.	C.T	o	G.C.T	P.L And P.P	2.3 m Height
G08	Lobby	T.T	T.SK	E.P And G.C.T	P.L And P.P	Oil paint @1.50 m
G09	CLOSET	C.T	T.SK	E.P And G.C.T	P.L And P.P	
ST01	STAIR CASE	L.M And T.T	M.SK	E.P And O.P	P.L And P.P	Oil paint @1.50 m

AS	: ASPHALT
	WALL FINISHING
O.P	: OIL PAINT
E.P	: EMULSION PAINT
G.C.T	: GLAZED CERAMIC TILING
G.C.T	: GLAZED CERAMIC TILING
	FLOOR FINISHING
T.T	: TERRAZO TILING (30*30*2.7)cm
C.T	: NON-SLIP CERAMIC TILING(20*20*0.6)cm
L.M	: LOCAL MARBLE(3cm THICK FOR TREADS& 2cm THICK FOR RISERS)
	CEILING FINISHING
P.L	: POLY-CIDE PAINT

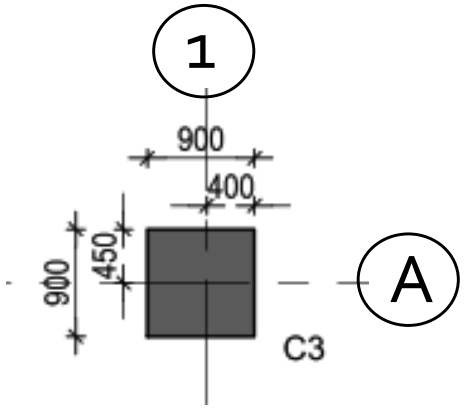
جدول تشطيبات الفراغات التي سميت وعلمت في المسقط الأفقي ويشمل تشطيبات الأرضية والبانيل والجدران والسقف لكل فراغ في المسقط

المسقط الأفقي - Floor plan



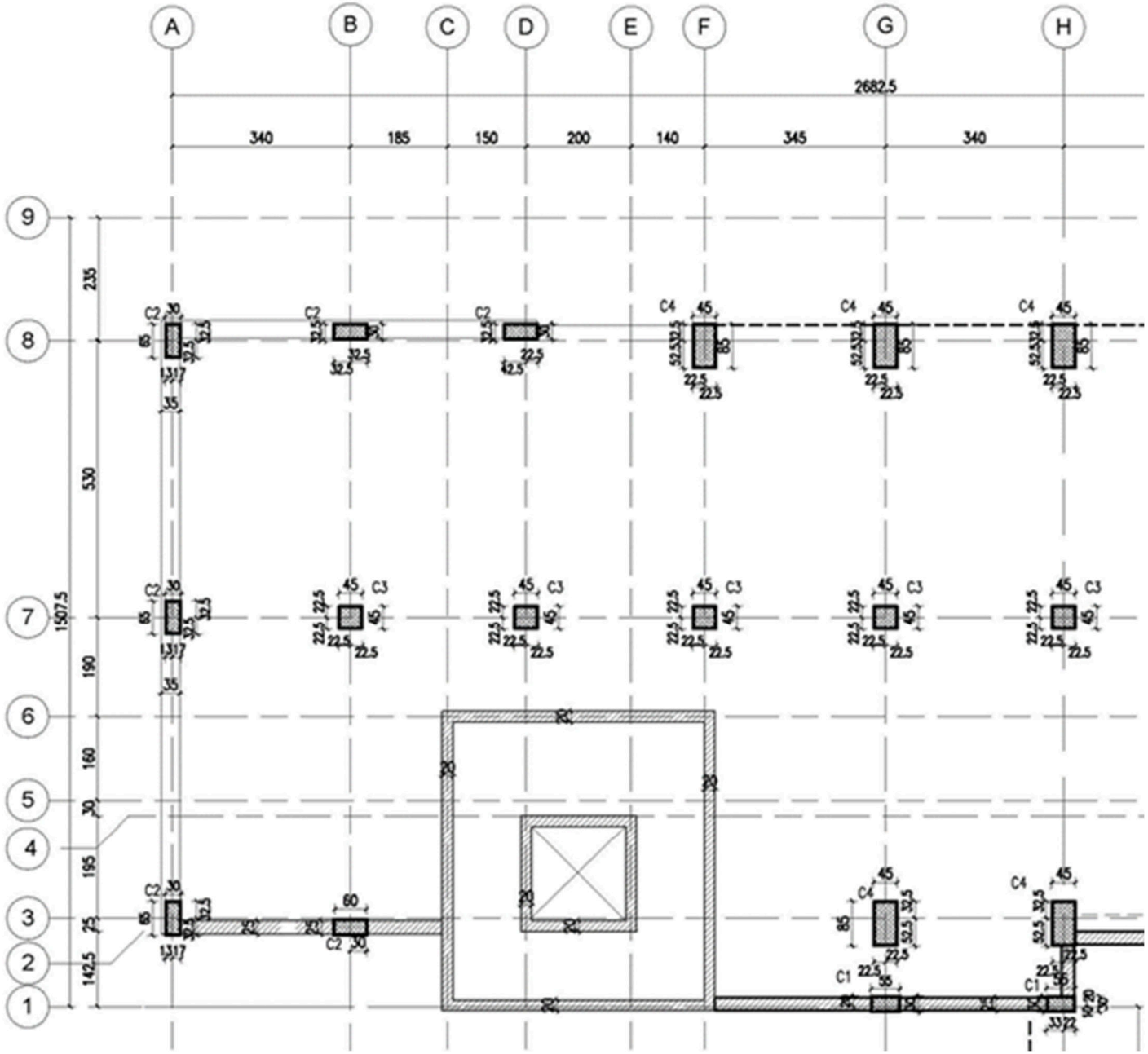
3. المحاور(Axes or grids): ويقصد بها المحاور الإنشائية التي تحدد أماكن العناصر الحاملة للمبنى كالأعمدة والحوائط الحاملة.

- عادة ما يعرف كل عنصر حامل بمحورين أفقي وعمودي يتقاطعان في مركزه واحيانا وتجنبا للازدحام يمكن تعريف مكان العنصر بمحاور غير مركزية كما في الشكل.



- يعد المهندس الإنشائي مخططا خاصا بالمحاور كما في الشريحة التالية وفقا لمحاور المساقط لاستعماله في تحديد أماكن القواعد والأعمدة عند التنفيذ.

Grid/ Center lines plan

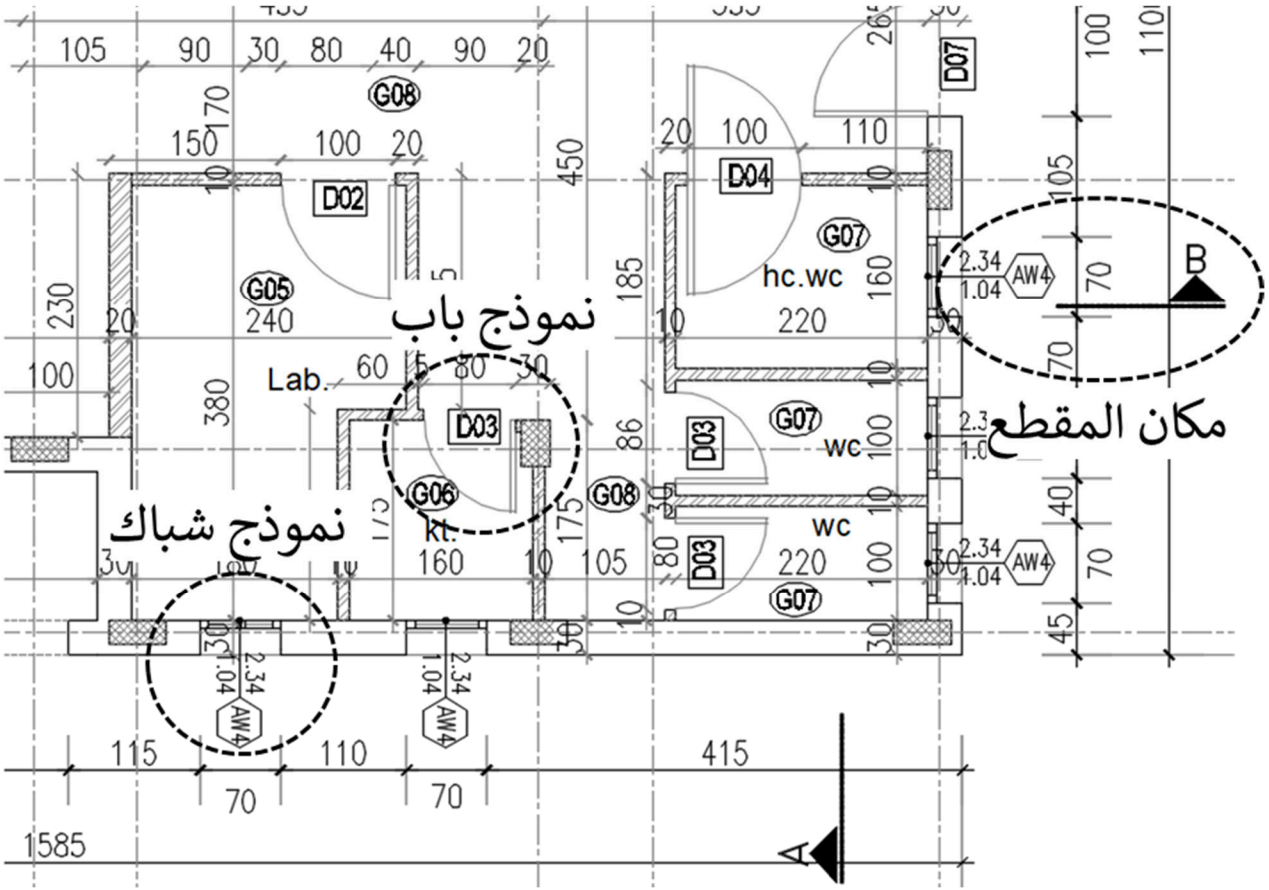


نموذج لمخطط محاور إنشائي – بالإضافة للمحاور المتطابقة مع المحاور المعمارية يوضح المخطط أيضا أبعاد وأرقام العناصر الإنشائية العمودية كلها بالإضافة لحواف المبنى

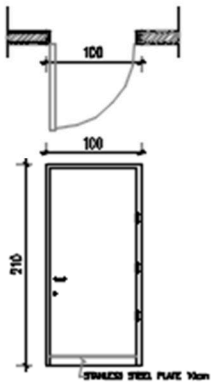
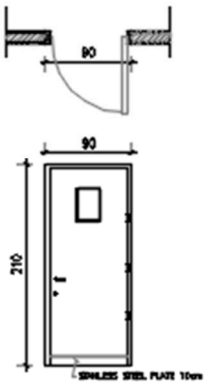
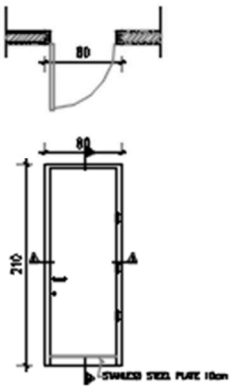
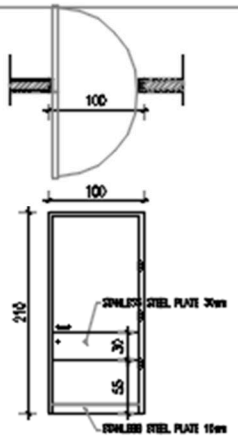
المسقط الأفقي - Floor plan

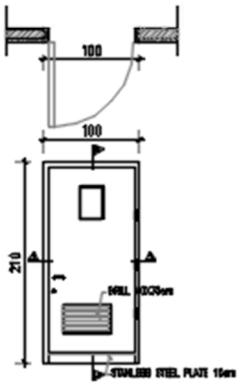
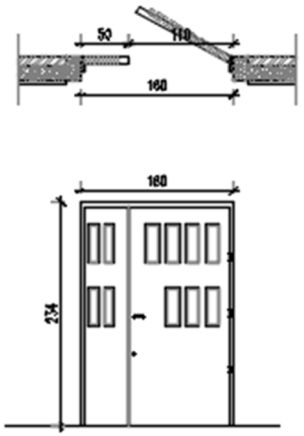
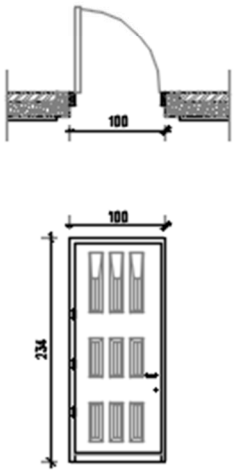
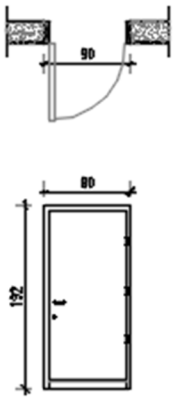
4. موقع المقاطع التي رسمها المعماري للمبنى.

5. رموز تحدد نماذج الأبواب والشبابيك المقترحة في التصميم وهذه ترتبط بجداول أو مخططات لاحقة تبين مواصفاتها وأبعادها بالتفصيل.



نماذج الأبواب المستخدمة

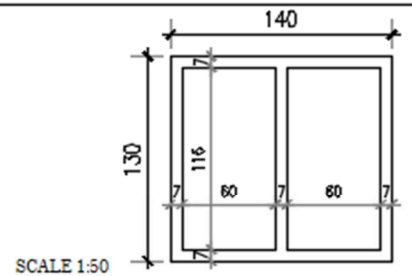
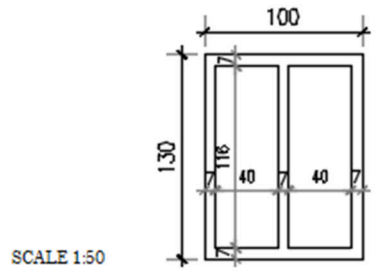
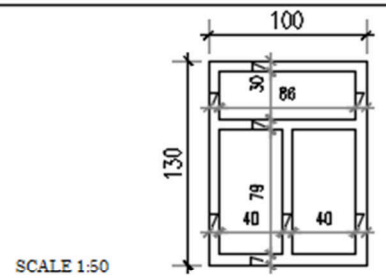
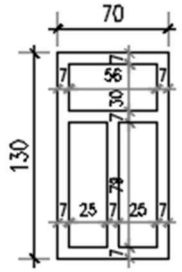
D01	D02	D03	D04
			
MATERIAL : WOODEN NAME : NCH. CONSULTATION No. : 3	MATERIAL : WOODEN NAME : LABORATORY No. : 3	MATERIAL : WOODEN No. : 4	MATERIAL : WOODEN NAME : NC. W/C No. : 1

D05	D06	D07	D08
			
MATERIAL : WOODEN No. : 2	MATERIAL : STEEL NAME : ENTRANCE No. : 1	MATERIAL : STEEL NAME : ENTRANCE No. : 1	MATERIAL : STEEL NAME : STAIR CASE No. : 1

Doors schedule in reference to the door types shown in the floor plan.

نماذج الشبابيك المستخدمة

ALUMINUM WINDOWS SCHEDULE

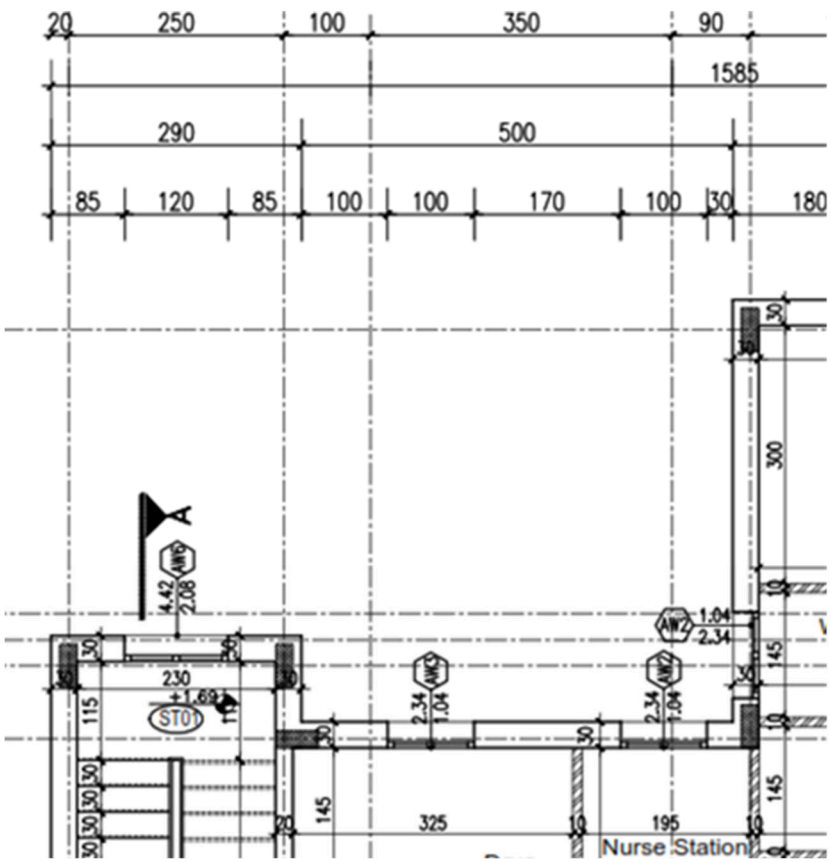
Window No.	Width	Height	Detail
AW1	140	130	
AW2	100	130	
AW3	100	130	
AW4	70	130	

Windows schedule in reference to the window types shown in the floor plan.

Floor plan - المسقط الأفقي

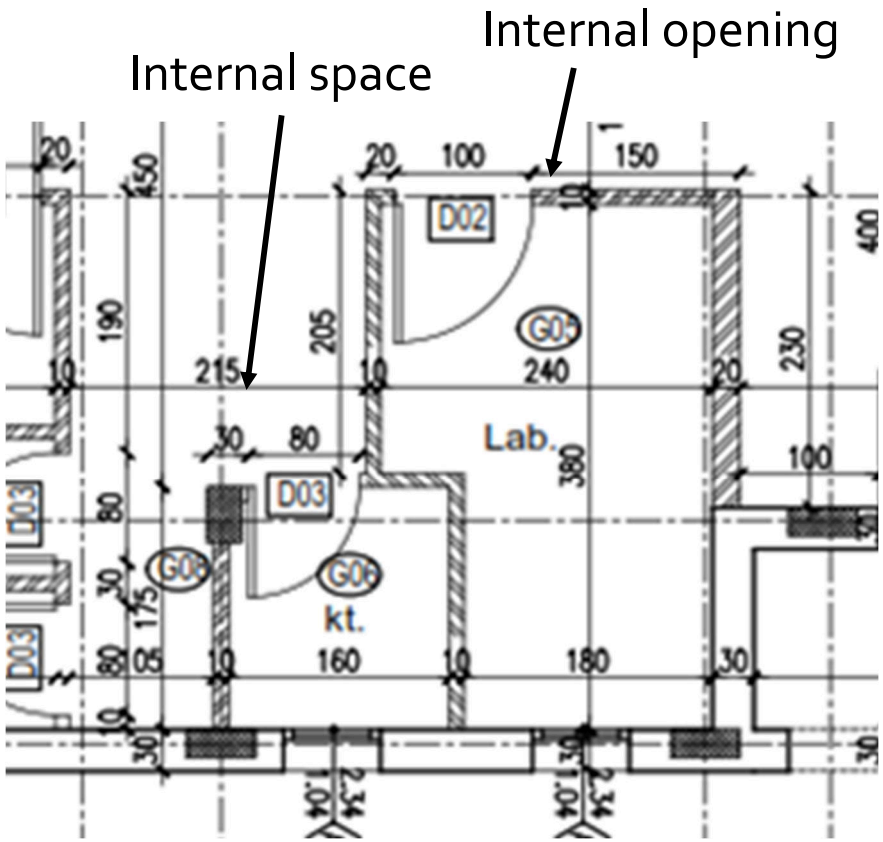
6. الأبعاد

External dimensions



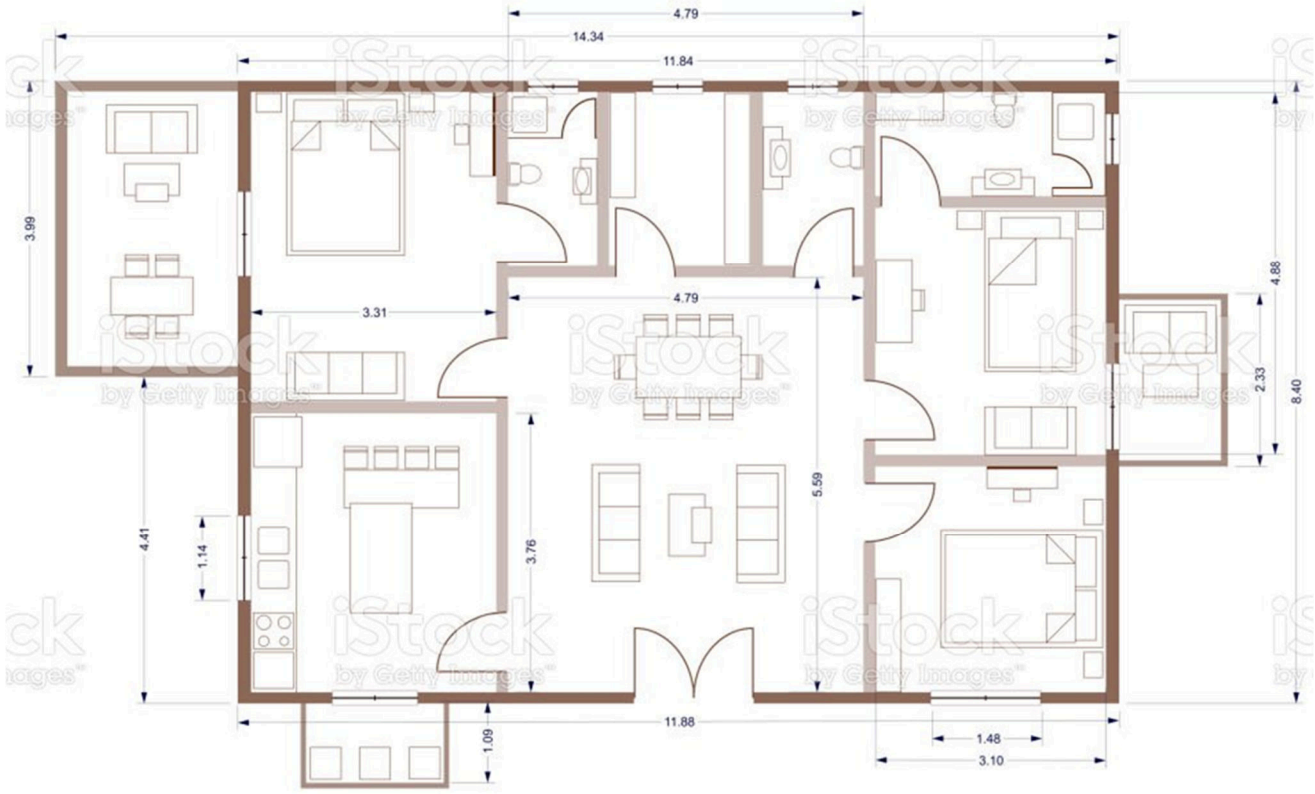
Center lines
Over all
Blocks
Opening

Internal dimensions



المسقط الأفقي - Floor plan

- يبدئ المهندس الإنشائي بالمساقط الأفقية للمبنى ليحدد طبيعة وأماكن عناصر النظام الإنشائي بحيث تتوافق مع الفراغات المقترحة في كل الطوابق وتحقق مستلزمات النظام الإنشائي المنشودة.

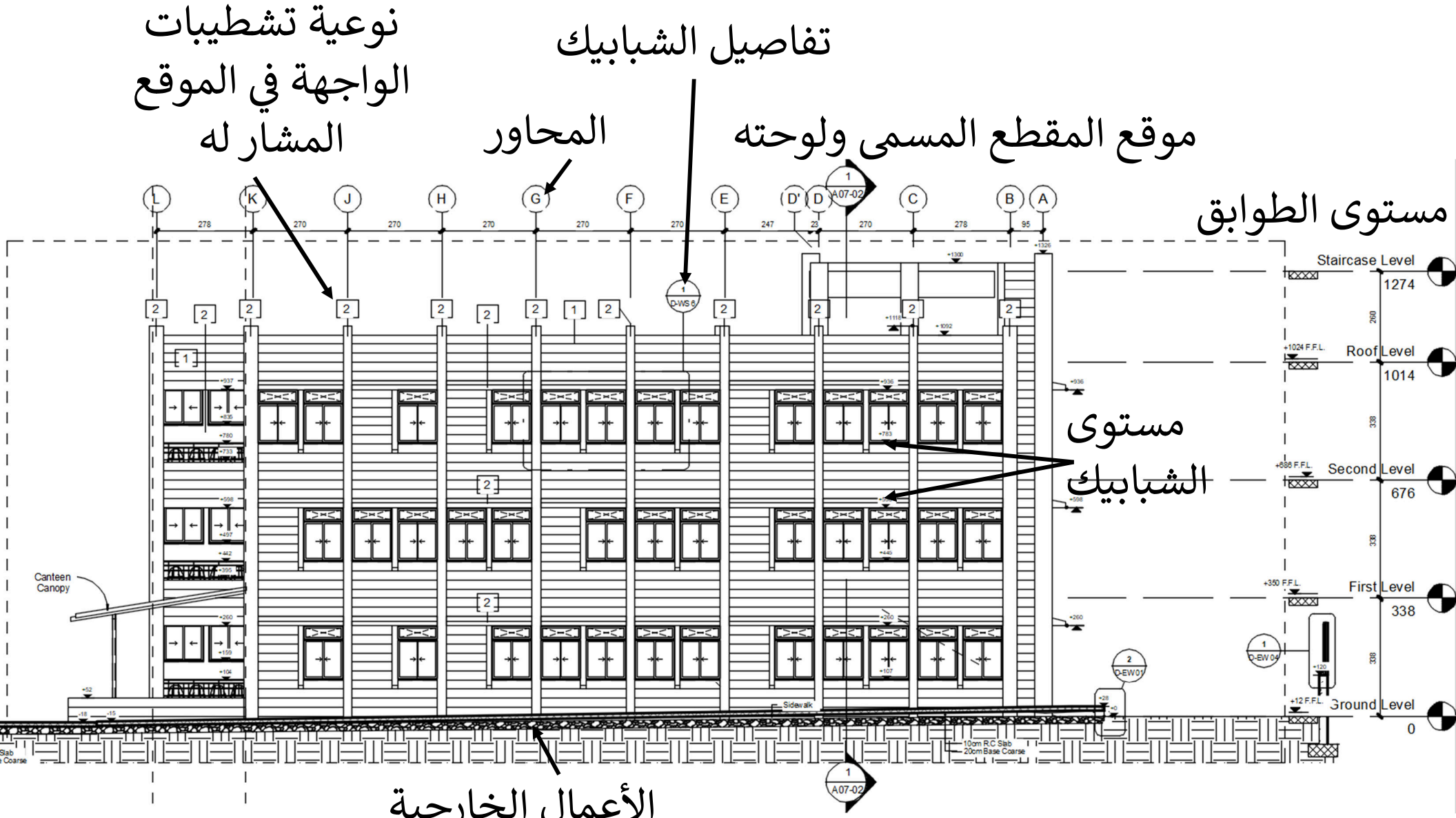


- حاول وضع نظام إنشائي للمسقط الأفقي المعطى – افترض طابق واحد فقط

الواجهات - Elevations

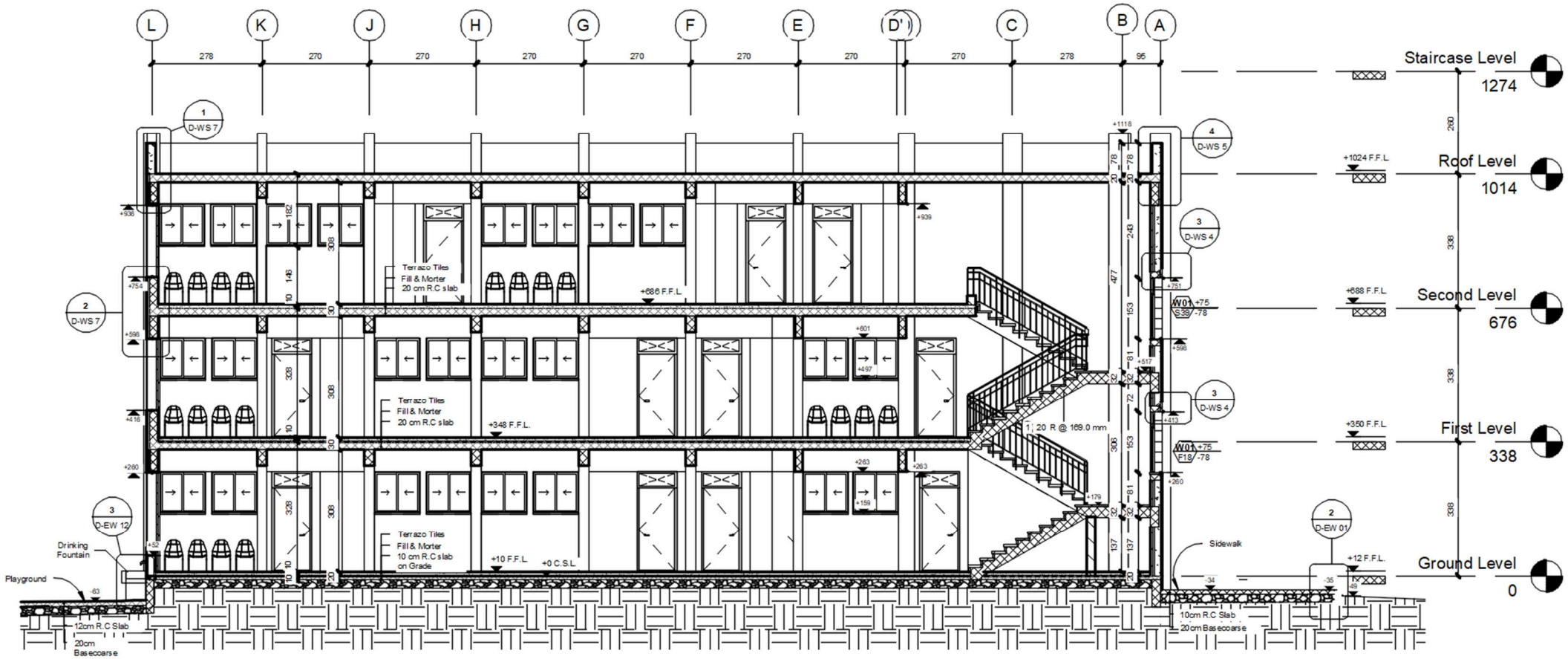
- الواجهة هي عبارة عن قطاع رأسي خارج المبنى يتم فيه قطع خط الأرض بمستوى رأسي افتراضي وترسم الواجهات كإسقاط هندسي للمبنى وتوضح لوحة الواجهات التنفيذية كافة العناصر المعمارية بواجهة المبنى وتكون الإسقاطات متطابقة مع خطوط المساقط الأفقية والقطاعات واللوح المعمارية الأخرى.
- يستفاد من لوحات الواجهات معرفة:
- أنواع جميع التشطيبات الخارجية وألوانها .
- أشكال وأماكن جميع الفتحات الخارجية (شبابيك أبواب ....ألخ) .
- نمط الواجهات الخارجية .
- نمط وشكل المدخل الرئيسي والمداخل الثانوية أن وجدت .
- أماكن وأنماط وأشكال جميع العناصر البارزة و الغاطسة والتشكيلات المختلفة بواجهة المبنى .
- الارتفاع الكلى للمبنى .
- يمكن من خلالها حساب الكميات وتقدير التكلفة لبنود الأعمال المختلفة المتصلة بالواجهات الخارجية للمبنى .

الواجهات - Elevations



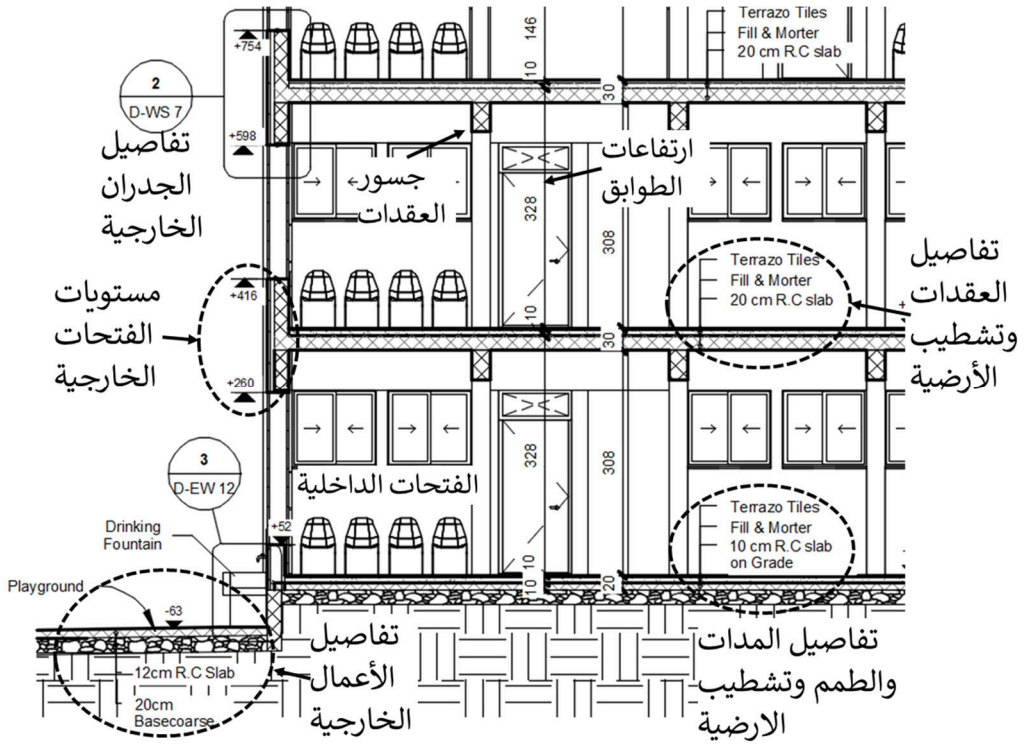
المقاطع - Sections

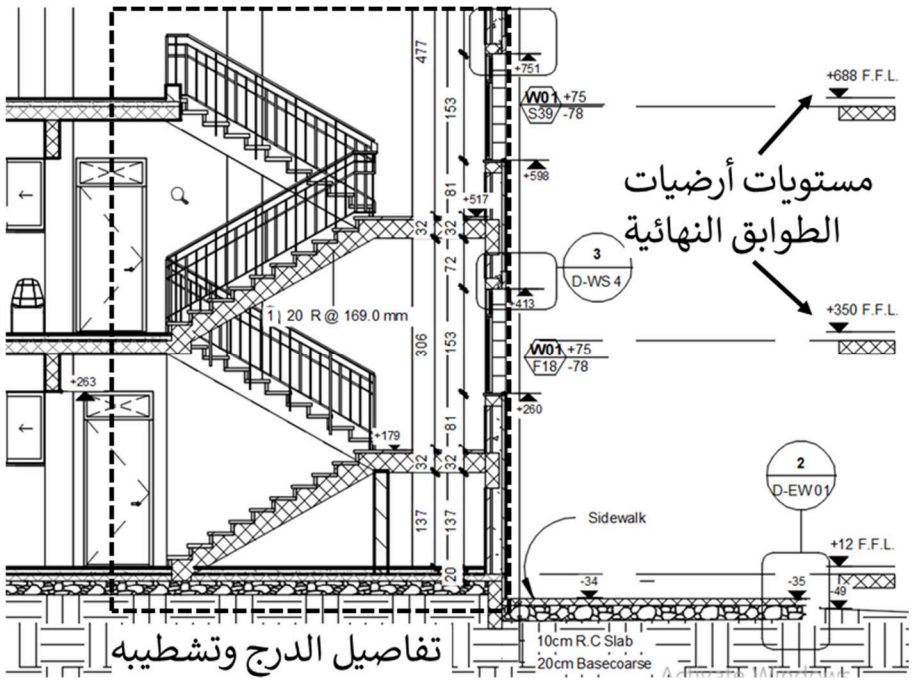
المقطع عبارة عن قطاع راسي يتم فيه قطع المبنى (طوليا أو عرضيا) بمستوى افتراضي لتوضيح التفاصيل الداخلية. ويمكن في بعض الأحيان أن يكون خط القطع منكسر بالمسقط الأفقي ليمر بأكبر قدر من تفاصيل المبنى .



المقاطع - Sections

- وتوضح لوحات المقاطع كافة عناصر المبنى المعمارية (حوائط بلاطات خرسانة مسلحة للأسقف ، مدات خرسانية للأرضيات فوق الردم ، طبقات التشطيبات ، فتاحات الأبواب والشبابيك ، الأدراج ، واي تشكيلات أخرى). وتتطابق إسقاطات خطوط لوحة المقاطع مع خطوط المساقط الأفقية وخطوط الواجهات وأي لوحات معمارية أخرى .





المقاطع - Sections

يحتاج المهندسين لوحات المقاطع أثناء التصميم والإنشاء بالأساس ل

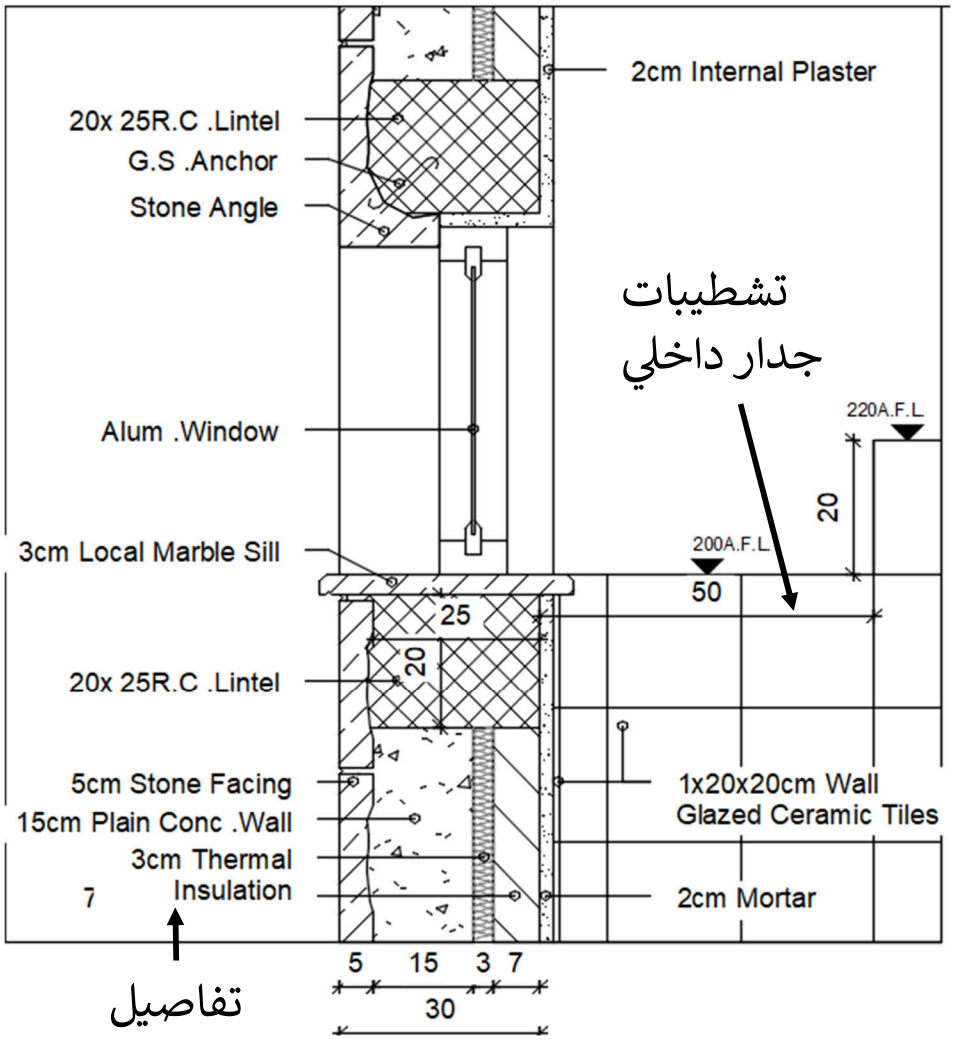
1. تحديد الارتفاعات المختلفة بين الأدوار وكذلك المناسيب وعلاقتها بالأرض الطبيعية .
2. تحديد ارتفاعات الفتحات (أبواب شبابيك عقود ...الخ) سواء بالجدران الداخلية أو الخارجية للمبنى .
3. فهم التفاصيل المعمارية المختلفة (الشرفات، الدرابزين، الدرج، العزل، أحواض الزرع ... الخ).
4. حساب الأوزان الميته المنقولة للعناصر الإنشائية والمتأتية من التشطيبات والجدران.

التفاصيل المعمارية – Architectural Details

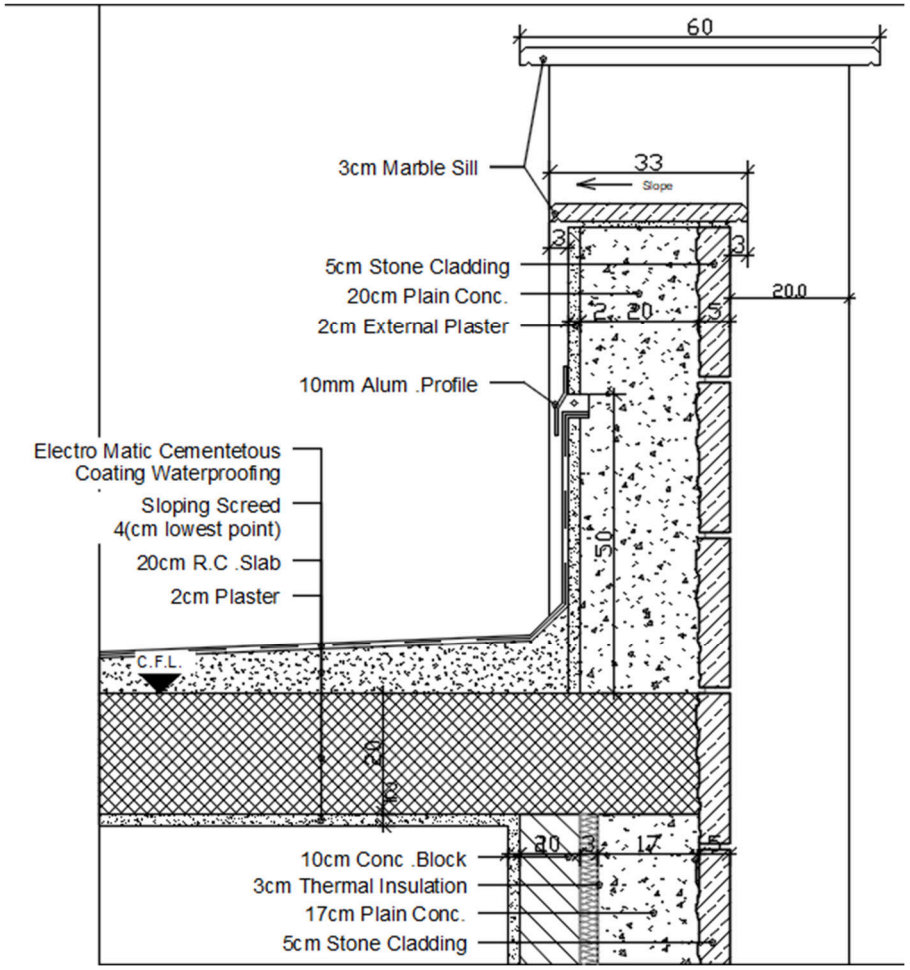
يعد المعماريون الكثير من التفاصيل النموذجية للأعمال اللازمة لإنشاء المبنى ويصدروها – بالعادة – في مجموعة خاصة يسمونها كتيب التفاصيل المعمارية.
ترسم هذه التفاصيل عادة بمقياس رسم 1:20 – 1:10 وتشمل:

- تفاصيل الفواصل (إنشائية – حرارية – زلزاليه).
- تفاصيل جدران البناية الداخلية والخارجية
- تفاصيل الأدراج.
- تفاصيل الأعمال الخارجية وأعمال التنسيق.
- تفاصيل التشطيبات (قصاره – بلاط – حجر – دهان ...).
- تفاصيل الأبواب والشبابيك بأنواعها (خشب، حديد، المنيوم).
- تفاصيل العزل (مائي – حراري – رطوبة)
- تفاصيل صرف مياه الأمطار.
- تفاصيل خاصة باستعمالات الفراغات مثل تفاصيل غرف الصف في المدارس أو غرف العمليات في المستشفيات ... الخ)

امثله على التفاصيل المعمارية

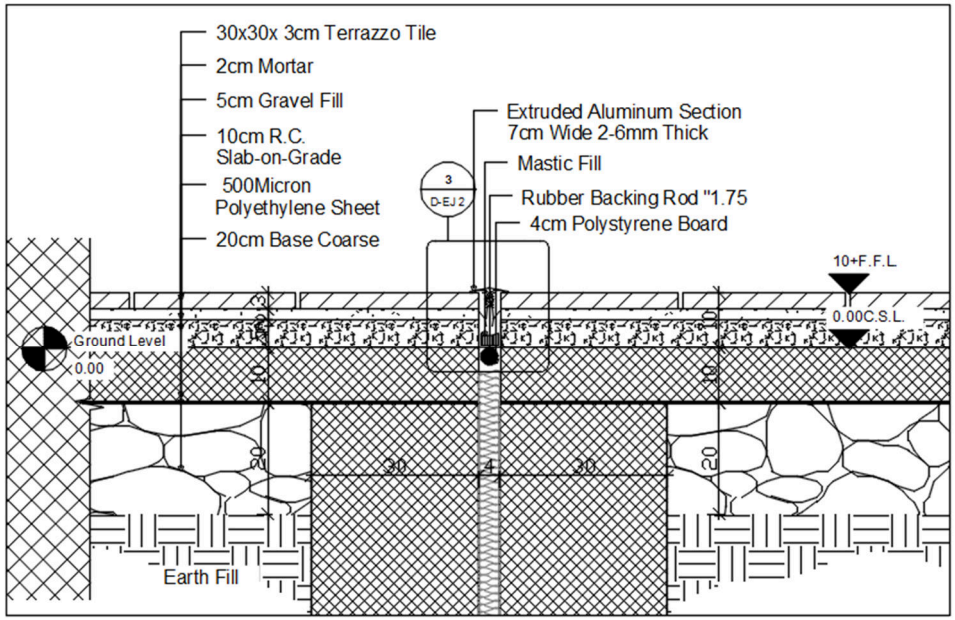


تفاصيل
الجدار الداخلي



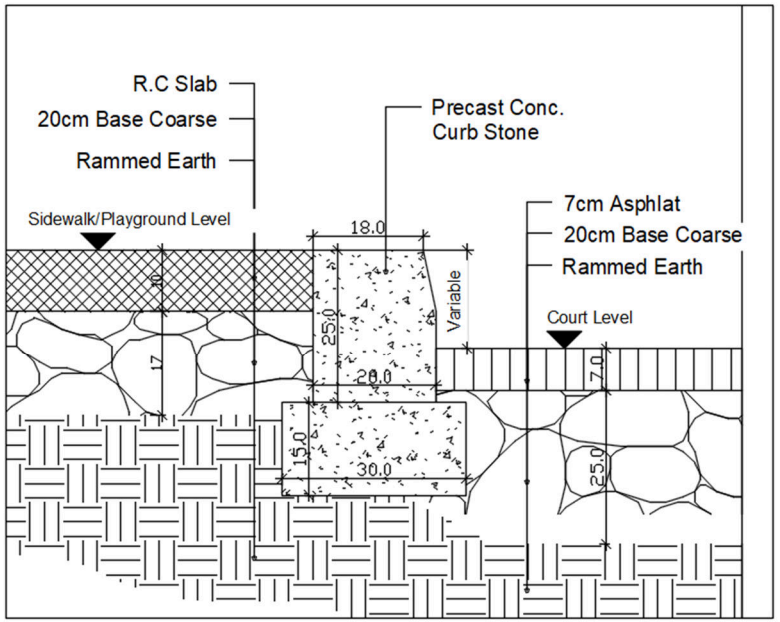
تفاصيل التصوينة ومدة ميلان المطر وعزل
السطح

امثله على التفاصيل المعمارية



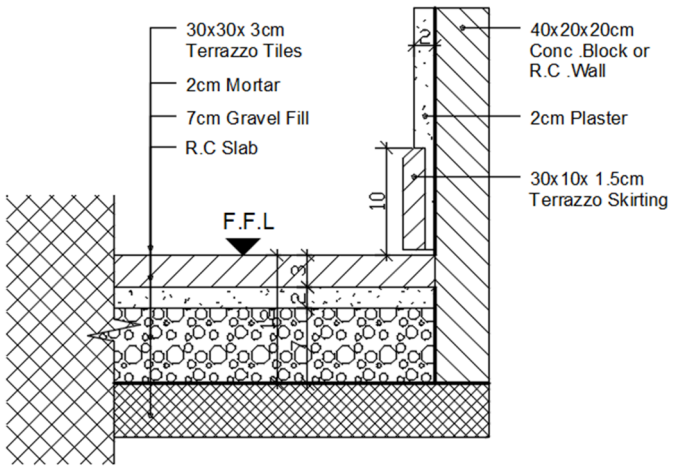
3 D-EJ 1 Expansion Joint @ Ground Level Corridor

10 : 1



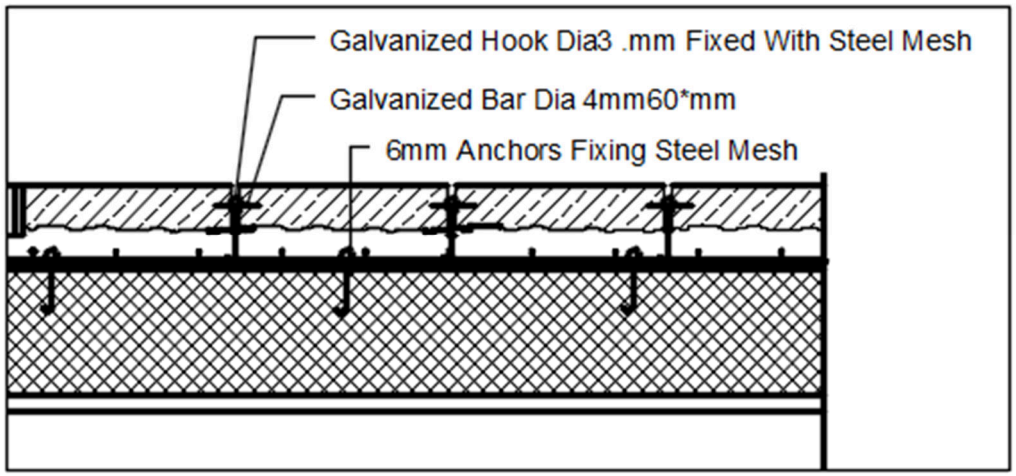
1 D-EW 12 Sidewalk &Playground Slab Detail

10 : 1



1 D-GD 1 Terrazzo Tile Detail

1:5



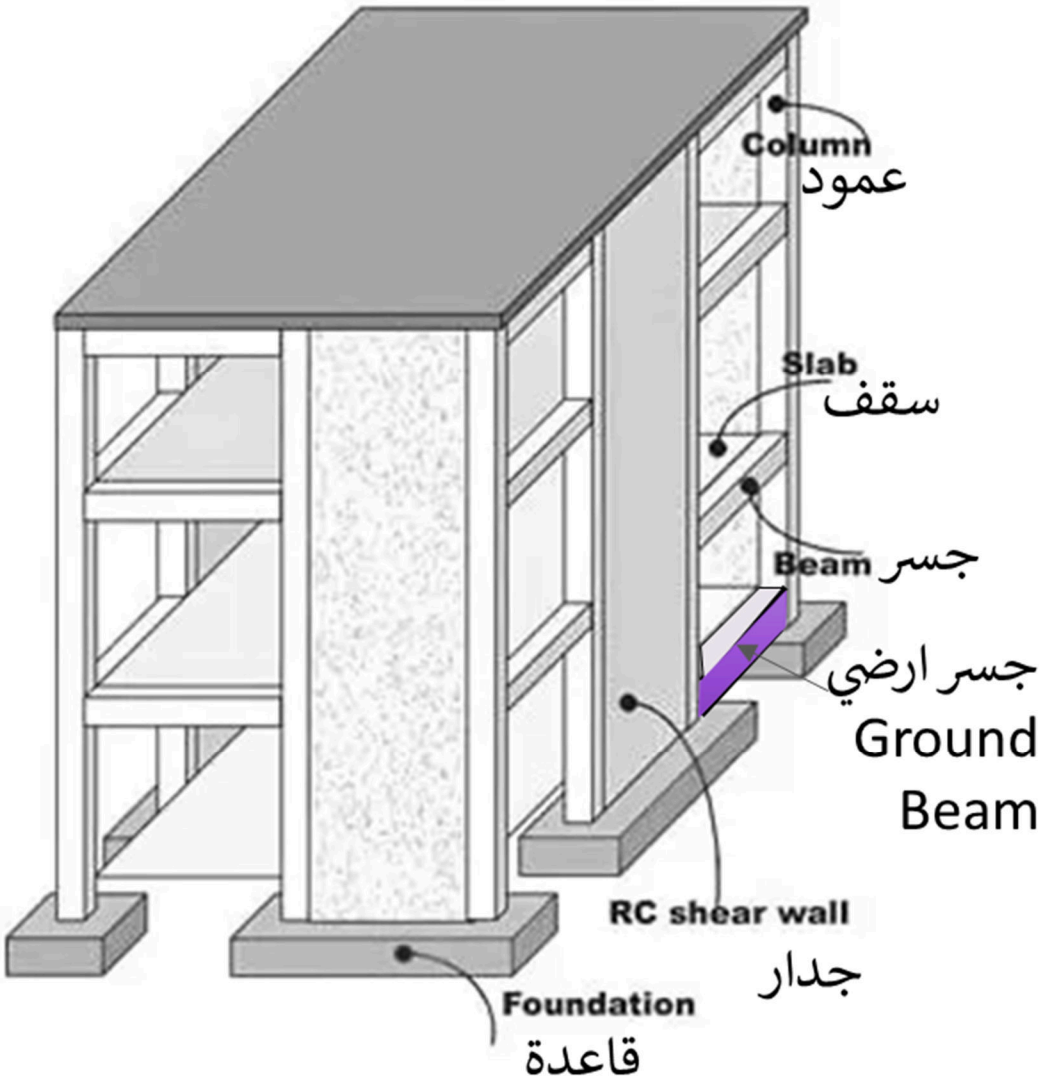
Stone Cladding Details

المخططات الإنشائية

Section

2.2.2

المخططات الإنشائية – Structural Drawings



- **المخططات الإنشائية هي المخططات التي تصف وتحدد شكل وأبعاد وموقع كل عنصر إنشائي (Structural elements) حامل في المبنى بالإضافة الى طريقة وصل هذه العناصر معاً وتفاصيل تسليحها ومواصفات المواد المستعملة فيها.**
- يوضح الشكل العناصر الإنشائية الرئيسية في مبنى نموذجي ويضاف لها عناصر أخرى مثل الأدراج وجدران التسويات.

Structural Drawings – المخططات الإنشائية

- بصفة عامة، تتألف المخططات الإنشائية من مجموعة من اللوحات على شكل مساقط أفقية للعناصر الإنشائية يليها مقاطع هذه العناصر وأخيرا مجموعة من التفاصيل العامة والخاصة الموضحة لكل الجوانب اللازمة لتنفيذ النظام الإنشائي.

For a typical building the structural drawings usually include:

- General notes
- Center lines of the structural elements.
- Foundations plan and details
- Ground beams and slap on grade
- Columns and walls details
- Floors plans
- Framing details (beams and joints)
- Stair case details
- External works details

General notes sheet (لوحة معطيات التصميم)

1. GENERAL

1.1 ALL STRUCTURAL DRAWINGS SHALL BE READ IN CONJUNCTION WITH PERTINENT INFRA STRUCTURE, ARCHITECTURAL, MECHANICAL AND ELECTRICAL DRAWINGS, B.O.Q AND SPECIFICATIONS. IN CASE OF ANY DISCREPANCY, THE CONTRACTOR MUST CONTACT THE ENGINEER FOR CLARIFICATION.

1.2 ALL DIMENSIONS ARE IN MILLIMETERS, AND ALL LEVELS ARE IN METERS UNLESS OTHERWISE NOTED.

1.3 DO NOT SCALE DRAWINGS, USE ONLY WRITTEN DIMENSIONS.

1.4 ALL SECTIONS SHALL BE COORDINATED WITH ARCHITECTURAL DRAWINGS BEFORE ERECTION OF FORMWORK. ANY DISCREPANCY SHALL BE BROUGHT TO THE NOTICE OF THE ENGINEER FOR CLARIFICATION.

1.5 ALL OPENINGS SHALL BE FORMED OR SLEEVED BEFORE PLACING CONCRETE. REFER TO ARCHITECTURAL, LANDSCAPE, CIVIL, MECHANICAL AND ELECTRICAL DRAWINGS FOR OPENINGS AND SLEEVES IN CONCRETE SLABS AND WALLS NOT SHOWN ON STRUCTURAL DRAWINGS, AND FOR SIZE AND LOCATION OF OPENINGS NOT DIMENSIONED. NO BREAKAGE IS ALLOWED IN CONCRETE AFTER CASTING.

1.6 UNLESS OTHERWISE NOTED, DETAILS SHOWN ON ANY DRAWING ARE TO BE CONSIDERED TYPICAL FOR ALL SIMILAR CONDITIONS.

1.7 FOR OPENINGS IN STRUCTURAL SLABS, ADDITIONAL 2Y18 BARS AT ALL SIDES, TOP AND BOTTOM SHALL BE PROVIDED, UNLESS OTHERWISE NOTED.

1.8 FOR OPENINGS IN REINFORCED CONCRETE WALLS ADDITIONAL REINFORCEMENT IN ACCORDANCE WITH TYPICAL DETAILS SHALL BE PROVIDED, UNLESS OTHERWISE SHOWN ON DRAWINGS.

1.9 NO OPENINGS OR SLEEVES SHALL BE PLACED IN BEAMS OR COLUMNS EXCEPT AS INDICATED ON STRUCTURAL DRAWINGS AND AS APPROVED.

1.10 ALL CORNERS OF FAIR FACE CONCRETE SHALL BE CHAMFERED 25x25 mm. CHAMFERS ARE NOT SHOWN FOR CLARITY.

1.11 IT IS NOT ALLOWED TO PLACE MECHANICAL EQUIPMENT SUCH AS AIR HANDLING UNITS, CHILLERS, WATER TANKS, EXPANSION TANKS, ETC. DIRECTLY ON THE CONCRETE SCREED OR THE REINFORCED CONCRETE ROOF SLAB. THEY SHALL BE RAISED BY MEANS OF CONCRETE CHAIRS, PLINTHS OR STEEL BEAMS. SHOP DRAWINGS SHOWING THE EXACT DIMENSIONS, LOCATION AND ALL NECESSARY DETAILS OF THE REQUIRED CHAIRS, PLINTHS OR STEEL BEAMS ARRANGEMENT SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL.

1.12 THE CONTRACTOR SHALL PREPARE COMPLETE SHOP DRAWINGS AND DESIGN CALCULATIONS REQUIRED BY THE ENGINEER BASED ON STRUCTURAL SYSTEMS AND DETAILS SHOWN ON DRAWINGS. THE CONTRACTOR SHALL SUBMIT THE SHOP DRAWINGS INCLUDING BAR BENDING SCHEDULES OF REINFORCING BARS AND ADDITIONAL DESIGN CALCULATIONS FOR APPROVAL BY THE ENGINEER BEFORE CONSTRUCTION AND WITHOUT ANY EXTRA COST TO THE OWNER.

1.13 RESHORING AND SEQUENCE OF CONSTRUCTION SHALL BE CAREFULLY STUDIED AND CONSIDERED BY THE CONTRACTOR BEFORE CONSTRUCTION. THE CONTRACTOR MUST TAKE INTO ACCOUNT ANY CONSTRUCTION LOADS EXCEEDING THE DESIGN LOADS GIVEN IN DESIGN CRITERIA AND IS RESPONSIBLE FOR THE ADEQUACY OF ALL SUPPORTING ELEMENTS DURING CONSTRUCTION. SHORING SHALL NOT BE REMOVED UNTIL SUPPORTED ELEMENTS HAVE DEVELOPED DESIGN PROPERTIES REQUIRED TO SUPPORT ALL LOADS AND LIMIT DEFLECTIONS AND CRACKING AT TIME OF SHORING REMOVAL.

1.14 THE CONTRACTOR SHALL BE DEEMED TO HAVE VISITED THE SITE OF WORKS AND SATISFIED HIMSELF AS TO THE NATURE OF THE GROUND AND MADE HIMSELF CONVERSANT WITH LOCAL CONDITIONS TO BE ENCOUNTERED DURING THE EXECUTION OF WORK.

1.15 UNLESS OTHERWISE SHOWN, BAR BENDS, LAP SPLICES AND REINFORCEMENT DETAILS SHALL CONFORM TO ACI DETAILING MANUAL.

1.16 ALL MATERIALS, WORKMANSHIP, WELDING AND TESTS SHALL CONFORM TO ASTM AND AWS STANDARDS.

1.17 LIGHT WEIGHT FILL DENSITY WHERE USED SHALL NOT EXCEED 400 kg/m³ AND SHALL BE CAST TO THE LEVELS INDICATED ON STRUCTURAL DRAWINGS.

1.18 IN CASE OF FUTURE EXTENSION, DOWELS SHALL BE WRAPPED WITH POLYETHYLENE SHEET AND PROTECTED WITH CONCRETE GRADE 21 MPa. POLYSTYRENE 50 mm THICK SHALL SEPARATE STRUCTURAL CONCRETE FROM PROTECTION CONCRETE.

2. DESIGN CRITERIA

DESIGN OF ALL CONCRETE STRUCTURAL ELEMENTS SHALL BE BASED ON ULTIMATE STRENGTH.

2.1 DESIGN CODES AND SPECIFICATIONS

DESIGN AND DETAILING SHALL BE ACCORDING TO:

- ACI 318 - 02 : BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE AND COMMENTARY.
- UBC - 97 : UNIFORM BUILDING CODE, STRUCTURAL REQUIREMENTS FOR EARTHQUAKE AND WIND FORCES.
- JCLF - 06 : JORDAN CODE FOR LOADS AND FORCES.
- BS 6399 : LOADING FOR BUILDINGS.
- BS - 8007 : BRITISH STANDARDS FOR THE DESIGN OF CONCRETE STRUCTURES RETAINING AQUEOUS LIQUIDS.
- ASCE7 - 05 : AMERICAN SOCIETY OF CIVIL ENGINEERING, FOR WIND LOADS.

2.2 DESIGN LOADS

2.2.1 DEAD LOADS

AS PER JCLF - 06

(a) MATERIALS

- REINFORCED CONCRETE ..... 24.5 kN/m³
- FLOOR FINISHES :
  - TILES ..... 24.0 kN/m³
  - MORTER ..... 22.0 kN/m³
- LIGHT WEIGHT PARTITIONS ..... 10.0 kN/m³
- SAND FILL ..... 16.0 kN/m³
- FALSE CEILING AND DUCTING ..... 0.5 kN/m³
- WATER ..... 10.0 kN/m³
- ELEVATIONS :
  - GLASS ..... 26.0 kN/m³

2.2.2 LIVE LOADS

AS PER JCLF - 06

(a) FLOORS

- OFFICES ..... kN/m²
- STORES ..... kN/m²
- MAIN LOBBY (OPEN AREA) ..... 4.0 kN/m²
- MECHANICAL ROOMS ..... 7.5 kN/m²
- TRANSFORMER ROOM ..... 10.0 kN/m²
- GENERATOR ROOM ..... 10.0 kN/m²
- PARKING AREAS ..... 3.0 kN/m²
- RAMPS & CAR TRACK ..... 5.0 kN/m²
- STORES ..... 5.0 kN/m²
- ELECTRICAL ROOMS ..... 3.0 kN/m²
- LOAD/IND/UNLOADING AREAS ..... 10.0 kN/m²
- VAULT ..... 10.0 kN/m²
- PUBLIC SPACES ..... 5.0 kN/m²
- HALLS ..... 5.0 kN/m²
- SITE ..... 5.0 kN/m²
- RESTROOMS ..... 2.0 kN/m²
- IT ROOMS ..... 5.0 kN/m²
- PRAYER ROOMS ..... 5.0 kN/m²
- ARCHIVE ..... 4.0 kN/m²
- MEETING ROOMS ..... 3.0 kN/m²
- TRAINING CENTERS ..... 5.0 kN/m²
- CAFETERIA ..... 4.0 kN/m²
- LOBBIES & MAIN CORRIDORS ..... 5.0 kN/m²

(b) ROOFS

- WITH ACCESS ..... 1.5 kN/m²
- MECHANICAL EQUIPMENT ..... 3.0 kN/m²
- SNOW LOAD ..... 1.5 kN/m²

2.2.3 WIND LOADS

- BASIC WIND SPEED ..... 40 m/sec
- EXPOSURE C

2.2.4 SEISMIC LOADS

- SEISMIC ZONE 2A
- IMPORTANCE FACTOR 1.0
- SOIL PROFILE ..... Sb
- R (SHEAR WALL BUILDING) 5.5

3. MATERIALS

3.1 CONCRETE

3.1.1 COMPRESSIVE STRENGTH OF CONCRETE, f_c', AS DEFINED BY A STANDARD 150mm X 300mm CYLINDER AT 28 DAYS SHALL BE

- 40 MPa : FOR REINFORCED CONCRETE.
- 15 MPa : FOR PLAIN CONCRETE.

3.1.2 TRIAL MIXES SHALL BE PERFORMED AND 28 DAY STRENGTH AND DURABILITY TEST (AS PER DESIGN CODES AND SPECIFICATIONS) RESULTS MUST BE SUBMITTED TO THE ENGINEER FOR HIS APPROVAL PRIOR TO ANY CONCRETE WORK.

3.1.3 ALL REINFORCED CONCRETE SHALL BE VIBRATED PROPERLY.

3.2 CEMENT

3.2.1 ORDINARY PORTLAND CEMENT SHALL BE USED FOR ALL REINFORCED AND UNREINFORCED CONCRETE ELEMENTS.

3.2.2 WATER-CEMENT RATIO SHALL NOT BE MORE THAN:

- 0.5 : FOR REINFORCED CONCRETE
- 0.6 : FOR PLAIN CONCRETE

3.2.3 CEMENT CONTENT SHALL BE DETERMINED BY DESIGN MIX TO BE APPROVED BY THE CONSULTANT AND SHALL NOT BE LESS THAN:

- 350 kg/m³ : FOR REINFORCED CONCRETE
- 250 kg/m³ : FOR PLAIN CONCRETE

3.3 AGGREGATES

MAXIMUM AGGREGATE SIZE SHALL BE 20 mm.

3.4 REINFORCING STEEL

3.4.1 ALL REINFORCING STEEL BARS DENOTED BY "Y" BARS SHALL BE DEFORMED, HIGH YIELD STRENGTH BARS WITH A MINIMUM YIELD STRENGTH OF Fy = 420 MPa.

3.4.2 BARS AND STIRRUPS OF 8 mm DIAMETER DENOTED BY "R" BARS SHALL BE SMOOTH, MILD STEEL OF YIELD STRENGTH, Fy = 280 MPa.

3.4.3 REINFORCEMENT SHALL CONFORM TO ASTM A615 STANDARDS.

3.4.4 REINFORCEMENT SHALL BE PLACED AS SHOWN ON THE DRAWINGS AND IN THE LENGTHS SPECIFIED.

3.4.5 BAR CRANK SHALL NOT EXCEED 1:12.

3.4.6 BEAM REINFORCEMENT IN MULTIPLE LAYERS SHALL HAVE Y25 mm SPACER BARS.

3.4.7 DETAILS OF REINFORCEMENT

3.4.7.1 SPLICES OF REINFORCEMENT

(a) WHERE BAR LENGTH IS NOT SPECIFIED, LONGEST PRACTICABLE BAR LENGTH SHALL BE EMPLOYED WITH STAGGERED LAP SPLICES. LAP LENGTH SHALL BE A MINIMUM OF 60 TIMES THE BAR DIAMETER, UNLESS OTHERWISE NOTED.

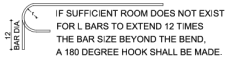
BAR DIAMETER (mm)	BARS IN TENSION	BARS IN COMPRESSION
10	600	600
12	750	600
14	850	850
16	1000	1000
18	1100	1100
20	1200	1200
25	1500	1500
32	2000	2000

AT ANY SECTION, NOT MORE THAN 50% OF THE REINFORCEMENT SHALL BE SPLICED.

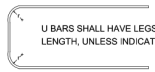
(b) REINFORCEMENT BARS MAY BE MECHANICALLY SPLICED, COUPLERS SHALL BE TENSION- COMPRESSION TYPE. MECHANICAL SPLICE SHALL DEVELOP IN TENSION OR COMPRESSION AT LEAST 125% OF THE SPECIFIED YIELD STRENGTH OF THE BAR.

3.4.7.2 RADIUS OF BENDS

MINIMUM RADIUS OF BEND FOR L BARS AND U BARS SHALL BE AS DETAILED BELOW. FOR OTHER BARS, MINIMUM RADIUS OF BEND SHALL BE EQUAL TO 2 TIMES BAR SIZE FOR MILD STEEL AND 3 TIMES BAR SIZE FOR HIGH YIELD STEEL.



IF SUFFICIENT ROOM DOES NOT EXIST FOR L BARS TO EXTEND 12 TIMES THE BAR SIZE BEYOND THE BEND, A 180 DEGREE HOOK SHALL BE MADE.



U BARS SHALL HAVE LEGS OF EQUAL LENGTH, UNLESS INDICATED OTHERWISE.

BAR DIAMETER (mm)	MINIMUM r (mm)
8	25
10	30
12	35
14	40
16	50
18	55
20	60
22	65
25	100
32	125

4. BLOCKWORK

4.1 MINIMUM COMPRESSIVE STRENGTH FOR NON-LOAD BEARING HOLLOW BLOCKS SHALL BE 3.5 MPa.

4.2 MINIMUM COMPRESSIVE STRENGTH FOR NON-LOAD BEARING SOLID BLOCKS SHALL BE 7.0 MPa.

4.3 BLOCK WALLS 10 cm THICKNESS, NOT LOCATED DIRECTLY ON GROUND BEAMS, MAY BE BUILT DIRECTLY ON THE GROUND SLAB.

4.4 BLOCK WALLS 15 cm THICKNESS OR MORE, NOT LOCATED DIRECTLY ON GROUND BEAMS, SHALL BE PLACED ON THE DROPPED GROUND SLAB AS SHOWN IN THE TYPICAL DETAILS.

4.5 CONCRETE HOLLOW BLOCKS AT ENDS OF ROWS SHALL HAVE CLOSED SIDES TO PREVENT INGRESS OF CONCRETE.

4.6 THE CONCRETE BLOCKS SHALL BE FROM AN APPROVED MANUFACTURER WITH APPROPRIATE STRENGTH AND ADEQUATELY CURED AS PER STANDARD SPECIFICATIONS.

4.7 ALL BLOCK WALLS EXCEEDING 3.0 m IN CLEAR HEIGHT SHALL BE PROVIDED WITH A STIFFENER BEAM AS SHOWN IN THE TYPICAL DETAILS.

4.8 ALL BLOCK WALLS WITH UNBRACED LENGTH EXCEEDING 5.0 m SHALL BE PROVIDED WITH A STIFFENER COLUMN AS SHOWN IN THE TYPICAL DETAILS.

5. FOUNDATIONS AND BACKFILLING

5.1 THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE STABILITY OF ALL EXCAVATIONS AND EMBANKMENTS AND SHALL PROVIDE ALL NECESSARY PLANKING, STRUTTING OR OTHER TEMPORARY WORKS REQUIRED TO MAINTAIN THE STABILITY OF EARTHWORKS. THE CONTRACTOR SHALL PROVIDE ALL MEASURES AND PRECAUTIONS NECESSARY TO PREVENT SETTLEMENT OR DAMAGE OF ADJACENT EXISTING OR NEW CONSTRUCTION.

5.2 IT IS NOT WARRANTED THAT THE SUBSURFACE CONDITIONS DESCRIBED IN THE DRAWINGS, SPECIFICATIONS OR OTHER DOCUMENTS ARE REPRESENTATIVE OF THE MATERIALS AND CONDITIONS AT OTHER LOCATIONS, TIMES AND GREATER DEPTHS THAN INDICATED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO THOROUGHLY INVESTIGATE THE SUBSOIL CONDITIONS AND TO ENSURE THAT BEARING CAPACITY IS ACHIEVED AT SITE WITH RESPECT TO THE PROPOSED FOUNDATION LEVEL.

5.3 BASED ON SOIL INVESTIGATION REPORT REF (SI 17/935-MODIFIED) DATED (OCTOBER, 2017) PREPARED BY THE GEOTECHNICAL & MATERIAL TESTING CENTER (GMT). THE FOLLOWING POINTS SHALL BE CONSIDERED:

5.3.1 FOOTINGS ARE DESIGNED FOR A NET ALLOWABLE BEARING CAPACITY OF 400 kPa AND A GROSS ALLOWABLE BEARING CAPACITY OF 550 kPa ON VERY WEAK TO MODERATELY WEAK LIMESTONE WITH MARL FILLING THE FRACTURES FOR AREAS OUTSIDE BUILDING CORE AREA AND BUILDING BASEMENT WALLS AND A GROSS ALLOWABLE BEARING CAPACITY OF 650 kPa BELOW BUILDING CORE AREA AND BUILDING BASEMENT WALLS. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO ENSURE THAT THIS BEARING CAPACITY IS ACHIEVED AT SITE WITH RESPECT TO THE LOCATION OF FOUNDATION.

5.4 THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY AFTER FOUNDATION EXCAVATION AND BEFORE FOUNDATION CONSTRUCTION TO INSPECT THE EXCAVATION AND CONFIRM THAT THE REQUIRED FOUNDING STRATA

5.5 NO FOUNDATION WORK SHALL BE PERFORMED UNTIL ALL FOUNDATION WORK IS COORDINATED WITH ALL UNDERGROUND UTILITIES.

5.6 FOUNDATION ON BACKFILL IS NOT ALLOWED. BACKFILL AND FILL NEXT TO FOOTINGS, UNDER SUBFLOORS SHALL BE COMPACTED BY MECHANICAL TAMPERS OR AS APPROVED BY THE ENGINEER.

5.7 FOOTINGS THAT ARE VERY CLOSE TO EACH OTHER, SHALL NOT IN ANY CASE, BE CAST AS ONE FOOTING, THE REINFORCED CONCRETE SHALL BE SEPARATED USING SOLID CEMENT BLOCKS OR POLYSTYRENE IF THE DISTANCE BETWEEN FOOTINGS DOES NOT ALLOW FOR SHUTTERING.

5.8 UNLESS OTHERWISE NOTED, FOUNDATIONS ARE TO BE CENTERED BELOW COLUMNS AND WALLS.

5.9 BACKFILL BEHIND WALLS SHALL MEET THE SOIL REPORT RECOMMENDATIONS.

5.9.1 SOIL OR SOIL-ROCK MIXTURE FREE FROM ORGANIC MATTER AND DELETERIOUS SUBSTANCES.

5.9.2 SHALL NOT CONTAIN ROCKS OR LUMPS OVER 15 cm IN GREATEST DIMENSION.

5.9.3 THE PLASTICITY INDEX FOR THE BACKFILL MATERIAL SHALL NOT BE MORE THAN 10%.

5.9.4 IT SHALL BE PLACED IN LIFTS NOT EXCEEDING 250 mm IN UNCOMPACTED THICKNESS AND COMPACTED TO DENSITY NOT LESS THAN 95% OF THE MAXIMUM DRY DENSITY AS OBTAINED BY MODIFIED PROCTOR COMPACTION TEST (ASTM D 1557).

5.10 BACKFILLING INFRONT AND BEHIND RETAINING WALLS SHALL BE DONE SIMULTANEOUSLY, IF APPLICABLE.

5.11 BACKFILLING AGAINST CONCRETE WALLS IS NOT ALLOWED UNTIL SUPPORTING SLABS AND OTHER SUPPORTING ELEMENTS, INCLUDING SLAB ON GRADE, ARE IN PLACE, FULLY ANCHORED AND HAVE REACHED FULL DESIGN STRENGTH.

5.12 NO FILLING SHALL TAKE PLACE AROUND ANY STRUCTURE UNTIL THE ENGINEER'S APPROVAL TO BACKFILL HAS BEEN OBTAINED.

5.13 COLUMNS, WALLS AND FOOTINGS ARE DESIGNED TO CARRY THE LOADS OF MAXIMUM EIGHTEEN FLOORS INCLUDING FIVE CELLARS, ONE BASEMENT, GROUND FLOOR, TEN TYPICAL FLOORS AND ROOF.

6. JOINTS

6.1 CONSTRUCTION JOINTS IN FLOORS SHALL BE LOCATED WITHIN THE MIDDLE THIRD OF SPANS OF SLABS, BEAMS AND GIRDERS. CONSTRUCTION JOINTS IN GIRDERS SHALL BE OFFSET A MINIMUM DISTANCE OF TWO TIMES THE WIDTH OF THE INTERSECTING BEAMS. VERTICAL CONSTRUCTION JOINTS IN SHEAR WALLS ARE NOT ALLOWED. HORIZONTAL CONSTRUCTION JOINTS IN WALLS SHALL BE LOCATED ONLY AS INDICATED. HORIZONTAL CONSTRUCTION JOINTS IN FOOTINGS, SLABS, BEAMS AND GIRDERS ARE NOT PERMITTED EXCEPT AS SPECIFICALLY INDICATED ON STRUCTURAL DRAWINGS OR APPROVED BY THE ENGINEER.

6.2 SURFACE OF CONCRETE CONSTRUCTION JOINTS SHALL BE ROUGHENED AND CLEANED.

6.3 THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS SHOWING PROPOSED CONSTRUCTION / CONTRACTION JOINTS LAYOUT FOR APPROVAL BY THE ENGINEER BEFORE CONSTRUCTION.

7. CONCRETE PROTECTION

7.1 ALL UNDERGROUND CONCRETE INCLUDING BOTTOM OF FOUNDATIONS AND BASEMENT WALLS SHALL BE PROTECTED BY AN APPROVED WATER PROOFING MEMBRANE SYSTEM.

7.2 ALL INTERNAL SURFACES OF REINFORCED CONCRETE WATER TANKS SHALL BE WATERPROOFED AS PER SPECIFICATIONS.

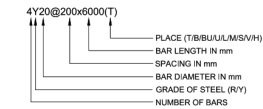
7.3 THE CONTRACTOR SHALL SUBMIT WATER PROOFING SHOP DRAWINGS FOR ENGINEER'S APPROVAL.

7.4 UNLESS OTHERWISE NOTED, CLEAR CONCRETE COVER TO REINFORCEMENT SHALL BE:

- 75 mm :FOR FOUNDATIONS IN CONTACT WITH SOIL, BLINDING OR WATER PROOFING.
- 50 mm :FOR CONCRETE SURFACE IN CONTACT WITH WATER.
- 50 mm :FOR BASEMENT WALLS.
- 40 mm :FOR COLUMNS AND BEAMS.
- 25 mm :FOR SLABS, STAIRS AND WALLS.

8. SYMBOLS

- STRUCTURAL WALL BELOW SLAB LEVEL
- STRUCTURAL WALL PLANTED ABOVE SLAB LEVEL
- DROP BEAM
- INVERTED BEAM OR PARAPET ABOVE SLAB LEVEL
- COLUMN BELOW SLAB LEVEL
- COLUMN PLANTED ABOVE SLAB LEVEL
- PLAIN CONCRETE
- SOLID BLOCK WALL
- HOLLOW BLOCK WALL
- STONE
- SAND FILL
- HARDCORE LAYER
- COMPACTED FILL
- WATER PROOFING
- BASECOURSE
- LIGHT WEIGHT FILL
- LIGHT WEIGHT CONCRETE
- PRECAST CONCRETE
- HOLLOW CORE SLAB
- PROTECTION BOARD
- SUNKEN SLAB
- S.S 200 — THICKNESS OF SOLID SLABS
- Thk. 500 — THICKNESS OF RAFT FOUNDATION
- S.O.G 150 — THICKNESS OF SLAB ON GRADE
- J 400 — THICKNESS OF JOIST OR WAFFLE SLAB
- ST 01 — STAIR NUMBER
- +0.20 TOS — LEVEL ON PLAN
- +0.20 TOS — LEVEL ON SECTION



9. ABBREVIATIONS AND MARKS

1cB1	BEAM NUMBER 1 AT FIRST CELLAR FLOOR FRAMING LEVEL
2cB1	BEAM NUMBER 1 AT SECOND CELLAR FLOOR FRAMING LEVEL
3cB1	BEAM NUMBER 1 AT THIRD CELLAR FLOOR FRAMING LEVEL
4cB1	BEAM NUMBER 1 AT FOURTH CELLAR FLOOR FRAMING LEVEL
1bB1	BEAM NUMBER 1 AT FIRST BASEMENT FLOOR FRAMING LEVEL
1B1	BEAM NUMBER 1 AT FIRST FLOOR FRAMING LEVEL
2B1	BEAM NUMBER 1 AT SECOND FLOOR FRAMING LEVEL
B	BOTTOM BARS
BU	BENT UP BARS
cm	CENTIMETER
C1	COLUMN NUMBER 1
CJ	CONTRACTION JOINT
Dia	DIAMETER
EA	EACH FACE
EJ	EXPANSION JOINT
ES	EACH STEP
EW	EACH WAY
FFL	FINISH FLOOR LEVEL
GB1	BEAM NUMBER 1 AT GROUND FLOOR FRAMING LEVEL
H	HORIZONTAL BARS
INV	INVERTED
L	L SHAPED TOP BARS
M	MIDDLE BARS
m	METER
MAX	MAXIMUM
MIN	MINIMUM
mm	MILLIMETER
No.	NUMBER
NTS	NOT TO SCALE
PLC	PLANTED COLUMN
R	MILD STEEL BARS
RB1	BEAM NUMBER 1 AT ROOF FRAMING LEVEL
S	STIRRUPS
T	TOP BARS
TOF	TOP LEVEL OF FOUNDATION
TOS	TOP LEVEL OF STRUCTURAL SLAB
TYP	TYPICAL
T&B	TOP AND BOTTOM
U	U SHAPED BARS
V	VERTICAL BARS
VAR	VARIABLE
Y	HIGH YIELD BARS
W1	SHEAR WALL NUMBER 1

General notes sheet (لوحة معطيات التصميم)

- لوحة المعطيات واحدة من اهم لوحات المشروع. تلخص اللوحة الأسس الفنية للمشروع، مواد المشروع ومتطلباتها، مفتاح اللوحات ورموزها، التعليمات العامة للمقاول المتعلقة بكيفية قراءة اللوحات وتنفيذها بالإضافة الى مجموعة من التفاصيل الإنشائية العامة والمتكررة.
- ينصح المهندس بمراجعة اللوحة وفهمها عبر الإحاطة بالأسس والخلفيات النظرية لما ورد فيها حيث يتيح له ذلك قوة معرفيه تمكنه من إدارة المشروع جيدا في إطارة الفني وقدرة على تخيل المشروع وتفسيره كما أراد المصمم.
- نموذجيا، تحتوي اللوحة على ما يلي:

1. **A list of general notes** or instructions to the contractor about the drawings and how they should be read, in addition to obligations that he should fulfill. Examples of these instructions are shown in the next slide.

General notes sheet (لوحة معطيات التصميم)

1. GENERAL

1.1 ALL STRUCTURAL DRAWINGS SHALL BE READ IN CONJUNCTION WITH PERTINENT INFRA STRUCTURE, ARCHITECTURAL, MECHANICAL AND ELECTRICAL DRAWINGS, B.O.Q AND SPECIFICATIONS. IN CASE OF ANY DISCREPANCY, THE CONTRACTOR MUST CONTACT THE ENGINEER FOR CLARIFICATION.

1.2 ALL DIMENSIONS ARE IN MILLIMETERS, AND ALL LEVELS ARE IN METERS UNLESS OTHERWISE NOTED.

1.3 DO NOT SCALE DRAWINGS, USE ONLY WRITTEN DIMENSIONS.

1.4 ALL SECTIONS SHALL BE COORDINATED WITH ARCHITECTURAL DRAWINGS BEFORE ERECTION OF FORMWORK. ANY DISCREPANCY SHALL BE BROUGHT TO THE NOTICE OF THE ENGINEER FOR CLARIFICATION.

1.5 ALL OPENINGS SHALL BE FORMED OR SLEEVED BEFORE PLACING CONCRETE. REFER TO ARCHITECTURAL, LANDSCAPE, CIVIL, MECHANICAL AND ELECTRICAL DRAWINGS FOR OPENINGS AND SLEEVES IN CONCRETE SLABS AND WALLS NOT SHOWN ON STRUCTURAL DRAWINGS, AND FOR SIZE AND LOCATION OF OPENINGS NOT DIMENSIONED. NO BREAKAGE IS ALLOWED IN CONCRETE AFTER CASTING.

1.6 UNLESS OTHERWISE NOTED, DETAILS SHOWN ON ANY DRAWING ARE TO BE CONSIDERED TYPICAL FOR ALL SIMILAR CONDITIONS.

1.7 FOR OPENINGS IN STRUCTURAL SLABS, ADDITIONAL 2Y18 BARS AT ALL SIDES, TOP AND BOTTOM SHALL BE PROVIDED, UNLESS OTHERWISE NOTED.

1.8 FOR OPENINGS IN REINFORCED CONCRETE WALLS ADDITIONAL REINFORCEMENT IN ACCORDANCE WITH TYPICAL DETAILS SHALL BE PROVIDED, UNLESS OTHERWISE SHOWN ON DRAWINGS.

1.9 NO OPENINGS OR SLEEVES SHALL BE PLACED IN BEAMS OR COLUMNS EXCEPT AS INDICATED ON STRUCTURAL DRAWINGS AND AS APPROVED.

1.10 ALL CORNERS OF FAIR FACE CONCRETE SHALL BE CHAMFERED 25x25 mm. CHAMFERS ARE NOT SHOWN FOR CLARITY.

1.11 IT IS NOT ALLOWED TO PLACE MECHANICAL EQUIPMENT SUCH AS AIR HANDLING UNITS, CHILLERS, WATER TANKS, EXPANSION TANKS, ETC. DIRECTLY ON THE CONCRETE SCREED OR THE REINFORCED CONCRETE ROOF SLAB. THEY SHALL BE RAISED BY MEANS OF CONCRETE CHAIRS, PLINTHS OR STEEL BEAMS. SHOP DRAWINGS SHOWING THE EXACT DIMENSIONS, LOCATION AND ALL NECESSARY DETAILS OF THE REQUIRED CHAIRS, PLINTHS OR STEEL BEAMS ARRANGEMENT SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL.

1.12 THE CONTRACTOR SHALL PREPARE COMPLETE SHOP DRAWINGS AND DESIGN CALCULATIONS REQUIRED BY THE ENGINEER BASED ON STRUCTURAL SYSTEMS AND DETAILS SHOWN ON DRAWINGS. THE CONTRACTOR SHALL SUBMIT THE SHOP DRAWINGS INCLUDING BAR BENDING SCHEDULES OF REINFORCING BARS AND ADDITIONAL DESIGN CALCULATIONS FOR APPROVAL BY THE ENGINEER BEFORE CONSTRUCTION AND WITHOUT ANY EXTRA COST TO THE OWNER.

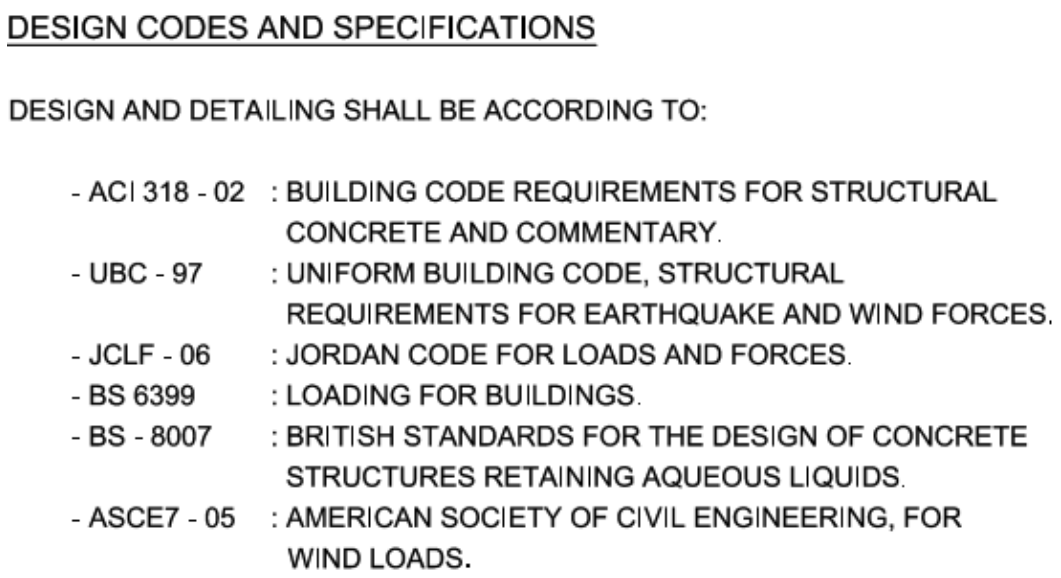
1.13 RESHORING AND SEQUENCE OF CONSTRUCTION SHALL BE CAREFULLY STUDIED AND CONSIDERED BY THE CONTRACTOR BEFORE CONSTRUCTION. THE CONTRACTOR MUST TAKE INTO ACCOUNT ANY CONSTRUCTION LOADS EXCEEDING THE DESIGN LOADS GIVEN IN DESIGN CRITERIA AND IS RESPONSIBLE FOR THE ADEQUACY OF ALL SUPPORTING ELEMENTS DURING CONSTRUCTION. SHORING SHALL NOT BE REMOVED UNTIL SUPPORTED ELEMENTS HAVE DEVELOPED DESIGN PROPERTIES REQUIRED TO SUPPORT ALL LOADS AND LIMIT DEFLECTIONS AND CRACKING AT TIME OF SHORING REMOVAL.

1.14 THE CONTRACTOR SHALL BE DEEMED TO HAVE VISITED THE SITE OF WORKS AND SATISFIED HIMSELF AS TO THE NATURE OF THE GROUND AND MADE HIMSELF CONVERSANT WITH LOCAL CONDITIONS TO BE ENCOUNTERED DURING THE EXECUTION OF WORK.

1.15 UNLESS OTHERWISE SHOWN, BAR BENDS, LAP SPLICES AND REINFORCEMENT DETAILS SHALL CONFORM TO ACI DETAILING MANUAL.

General notes sheet (لوحة معطيات التصميم)

2. **Building Codes**. These are the official codes implemented during the design and preparation of the project documents. The codes include:



DESIGN CODES AND SPECIFICATIONS

DESIGN AND DETAILING SHALL BE ACCORDING TO:

- ACI 318 - 02 : BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE AND COMMENTARY.
- UBC - 97 : UNIFORM BUILDING CODE, STRUCTURAL REQUIREMENTS FOR EARTHQUAKE AND WIND FORCES.
- JCLF - 06 : JORDAN CODE FOR LOADS AND FORCES.
- BS 6399 : LOADING FOR BUILDINGS.
- BS - 8007 : BRITISH STANDARDS FOR THE DESIGN OF CONCRETE STRUCTURES RETAINING AQUEOUS LIQUIDS.
- ASCE7 - 05 : AMERICAN SOCIETY OF CIVIL ENGINEERING, FOR WIND LOADS.

- **Loads codes** that identify the load calculation process, such as the Jordanian load code and ASCE-7.
- **Design codes**. These identify the permitted structural analysis methods, the structural design criteria, set the materials' allowable stress, and the detailing requirements. Examples of design codes are the ACI 318 reinforced concrete design code and AISC structural steel design code.

General notes sheet (لوحة معطيات التصميم)

3. **Design Loads**. A simplified description of the loads (dead, live, wind, snow, earthquake …) that had been used in the structural analysis and design.

2.2.1 DEAD LOADS
AS PER JCLF - 06

(a) MATERIALS

- REINFORCED CONCRETE	24.5 kN/m³
- FLOOR FINISHES :	
- TILES	24.0 kN/m³
- MORTER	22.0 kN/m³
- LIGHT WEIGHT PARTITIONS	10.0 kN/m³
- SAND FILL	16.0 kN/m³
- FALSE CEILING AND DUCTING	0.5 kN/m³
- WATER	10.0 kN/m³
- ELEVATIONS :	
- GLASS	26.0 kN/m³

2.2.3 WIND LOADS

- BASIC WIND SPEED	40	m/sec
- EXPOSURE	C	

2.2.4 SEISMIC LOADS

- SEISMIC ZONE	2A
- IMPORTANCE FACTOR	1.0
- SOIL PROFILE	SB
- R (SHEAR WALL BUILDING)	5.5

2.2.2 LIVE LOADS
AS PER JCLF - 06

(a) FLOORS

- OFFICES	2.5	kN/m²
- STAIRCASES	4.0	kN/m²
- MAIN LOBBY (OPEN AREA)	4.0	kN/m²
- MECHANICAL ROOMS	7.5	kN/m²
- TRANSFORMER ROOM	10.0	kN/m²
- GENERATOR ROOM	10.0	kN/m²
- PARKING AREAS	3.0	kN/m²
- RAMPS & CAR TRACK	5.0	kN/m²
- STORES	5.0	kN/m²
- ELECTRICAL ROOMS	3.0	kN/m²
- LOADIND/UNLOADING AREAS	10.0	kN/m²
- VAULT	10.0	kN/m²
- PUBLIC SPACES	5.0	kN/m²
- HALLS	5.0	kN/m²
- SITE	5.0	kN/m²
- RESTROOMS	2.0	kN/m²
- IT ROOMS	5.0	kN/m²
- PRAYER ROOMS	5.0	kN/m²
- ARCHIVE	4.0	kN/m²
- MEETING ROOMS	3.0	kN/m²
- TRAINING CENTERS	5.0	kN/m²
- CAFETERIA	4.0	kN/m²
- LOBBIES & MAIN CORRIDORS	5.0	kN/m²

General notes sheet (لوحة معطيات التصميم)

4. **Materials.** A brief description of the primary construction material and their mechanical properties.

   - A detailed description of the materials, including preparation, physical and mechanical properties, testing procedures, and construction methods, can be found in the project's specifications.

3.1 CONCRETE

3.1.1 COMPRESSIVE STRENGTH OF CONCRETE, f_c', AS DEFINED BY A STANDARD 150mm X 300mm CYLINDER AT 28 DAYS SHALL BE

- 40 MPa : FOR REINFORCED CONCRETE.
- 15 MPa : FOR PLAIN CONCRETE.

3.1.2 TRIAL MIXES SHALL BE PERFORMED AND 28 DAY STRENGTH AND DURABILITY TEST (AS PER DESIGN CODES AND SPECIFICATIONS) RESULTS MUST BE SUBMITTED TO THE ENGINEER FOR HIS APPROVAL PRIOR TO ANY CONCRETE WORK.

3.1.3 ALL REINFORCED CONCRETE SHALL BE VIBRATED PROPERLY.

3.2 CEMENT

3.2.1 ORDINARY PORTLAND CEMENT SHALL BE USED FOR ALL REINFORCED AND UNREINFORCED CONCRETE ELEMENTS.

3.2.2 WATER-CEMENT RATIO SHALL NOT BE MORE THAN:

- 0.5 : FOR REINFORCED CONCRETE
- 0.6 : FOR PLAIN CONCRETE

3.2.3 CEMENT CONTENT SHALL BE DETERMINED BY DESIGN MIX TO BE APPROVED BY THE CONSULTANT AND SHALL NOT BE LESS THAN:

- 350 kg/m³ : FOR REINFORCED CONCRETE
- 250 kg/m³ : FOR PLAIN CONCRETE

3.3 AGGREGATES

MAXIMUM AGGREGATE SIZE SHALL BE 20 mm.

3.4 REINFORCING STEEL

3.4.1 ALL REINFORCING STEEL BARS DENOTED BY "Y" BARS SHALL BE DEFORMED, HIGH YIELD STRENGTH BARS WITH A MINIMUM YIELD STRENGTH OF Fy = 420 MPa.

3.4.2 BARS AND STIRRUPS OF 8 mm DIAMETER DENOTED BY "R" BARS SHALL BE SMOOTH, MILD STEEL OF YIELD STRENGTH, Fy = 280 MPa.

3.4.3 REINFORCEMENT SHALL CONFORM TO ASTM A615 STANDARDS.

3.4.4 REINFORCEMENT SHALL BE PLACED AS SHOWN ON THE DRAWINGS AND IN THE LENGTHS SPECIFIED.

3.4.5 BAR CRANK SHALL NOT EXCEED 1:12.

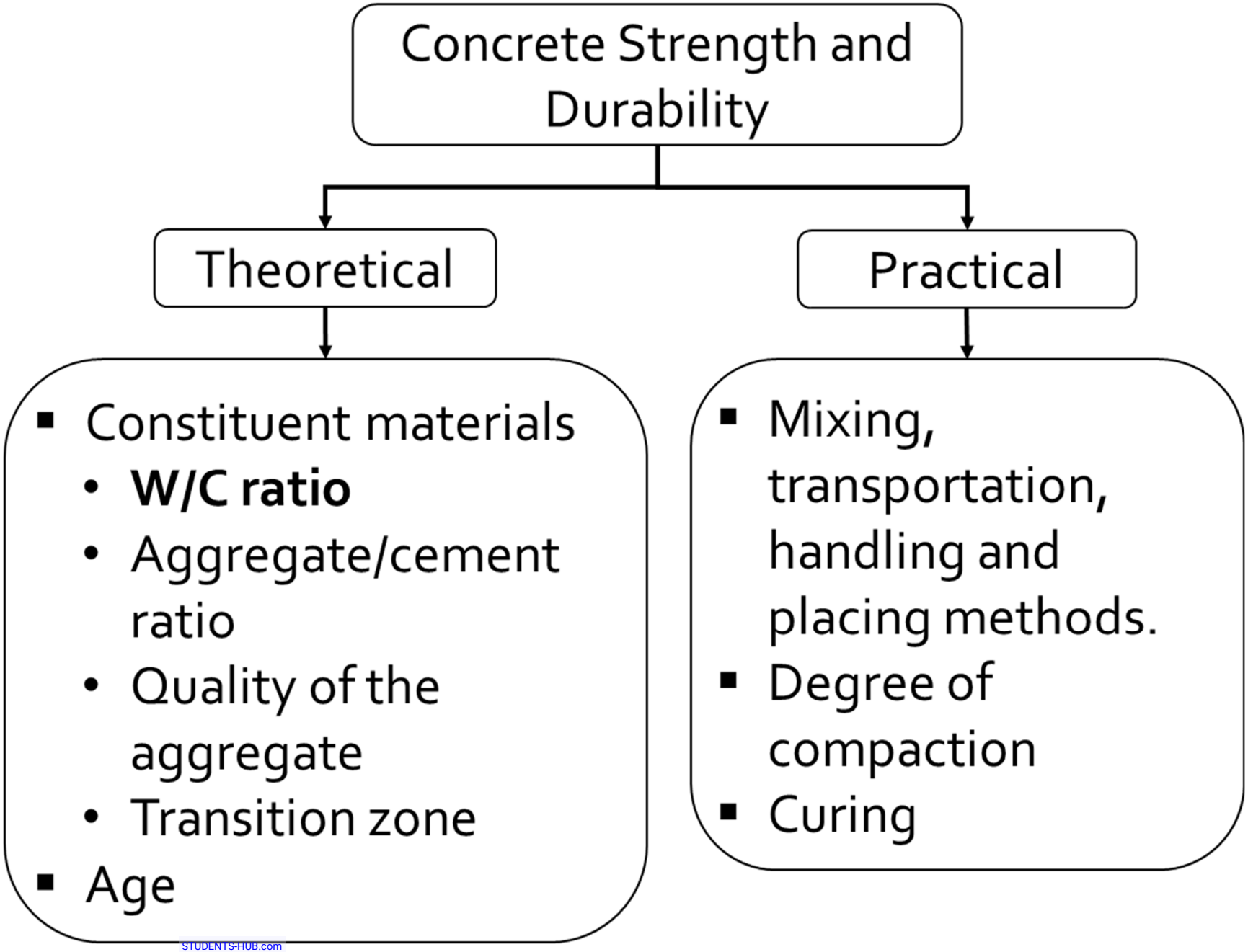
3.4.6 BEAM REINFORCEMENT IN MULTIPLE LAYERS SHALL HAVE Y25 mm SPACER BARS.

Review – Concrete

Essential knowledge of Concrete as a construction material

- What is concrete?
- What are the limitations of concrete?
- What are the desirable properties of concrete, and how can they be achieved?
- How should concrete be prepared, handled, placed, and cured after casting?
- How can weather conditions impact the concreting process?
- What are the potential defects in concrete, and how can they be addressed?

Review – Concrete

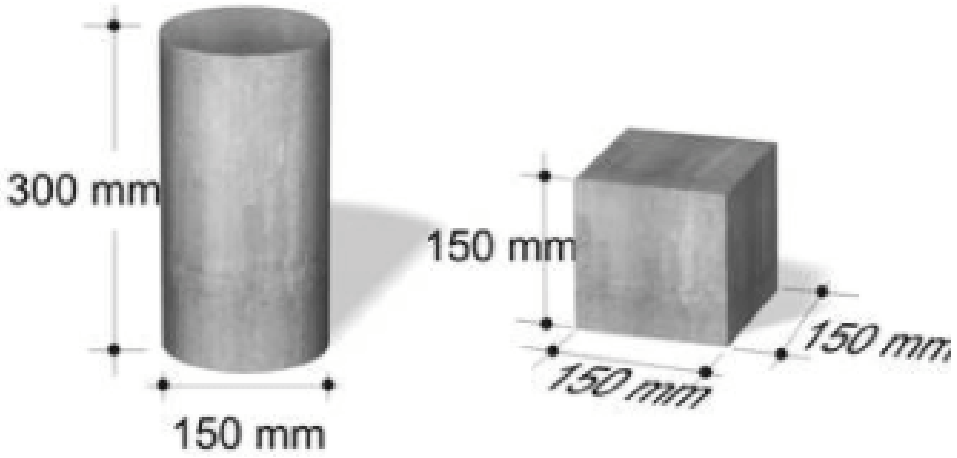


Review - Concrete Grades

- Concrete grade refers to the compressive strength of concrete measured using a standard specimen 28 days after casting. The specimen could be a cylinder 15X30 cm or a cube 15X15 or 10X10 cm.
- In the local practice, the concrete grade is defined as B300, B350, … where B300 means a cube compressive strength of 300 Kg/ cm² – equivalent to 30 Mpa.

Standard Concrete Grades (European standards)

		Concrete class					
		C12/15	C16/20	C20/25	C25/30	C30/37	
Char. cyl.-compr. stress		12	16	20	25	30	N/mm²
Char. cube-compr. stress	f_{ck}	15	20	25	30	37	N/mm²
		C35/45	C40/50	C45/55	C50/60	C55/67	
Char. cyl.-compr. stress		35	40	45	50	55	N/mm²
Char. cube-compr. stress	f_{ck}	45	50	55	60	67	N/mm²
		C60/75	C70/85	C80/95	C90/105		
Char. cyl.-compr. stress		60	70	80	90		N/mm²
Char. cube-compr. stress	f_{ck}	75	85	95	105		N/mm²

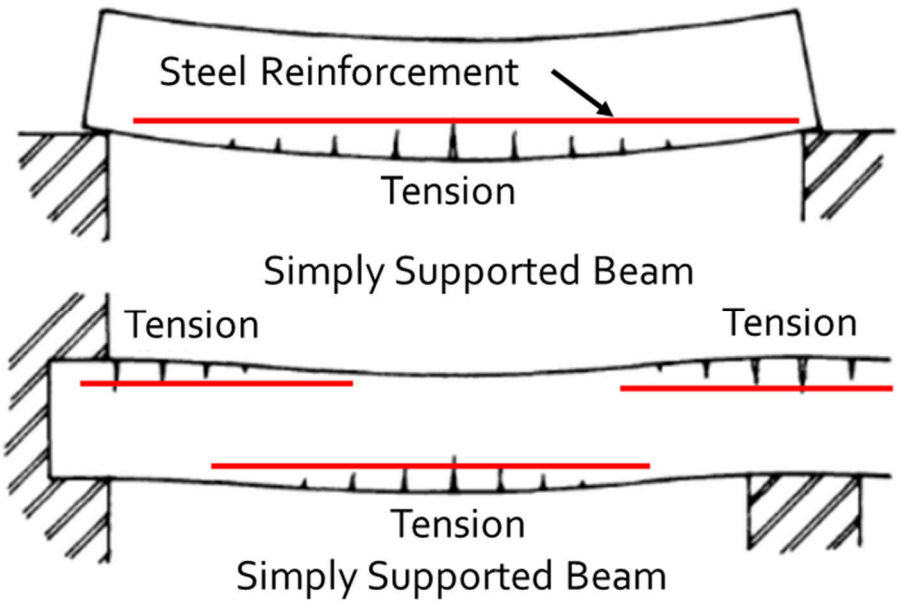


Slandered Concrete Specimens

Review – Reinforced concrete basics

Reinforcement requirements:

- All structural concrete should be reinforced by more than a specific minimum reinforcement however, reinforcement amount shall be limited as excessive reinforcement can initiate brittle, sudden failure.



- Reinforcement include: Main Reinforcement – Tension & Compression; Shear Reinforcement (stirrups); Deflection control Reinforcement; Crack control Reinforcement; Ductility Reinforcement; Hanger Bars.
- Concrete and reinforcement steel must be fully bond together to act as single material when subjected to stresses.

Review – Reinforcement Steel

- Reinforcing steel (rebar) is manufactured in different forms however, currently, all used reinforcement bars are deformed bars, either single or in the form of wire fabrics.
- Rebars are made with different diameters from several steel grades, as shown in the tables. The most important factor in selecting the rebars is the mechanical properties of the material - yield, tensile stresses, and elongation.

- Typically, designers select reinforcement rebars with a yield strength of 420 Mpa. Replacing the assigned steel grade during construction using bars of larger yield stress is not permissible.

Review – Reinforcement Steel

Types and Properties of Reinforcing Bars According to ASTM

ASTM Steel	Type	Grade		Tensile Strength Min., MPa (ksi)	Yield Strength* Min., MPa (ksi)
		US	Metric		
A615	Billet steel bars (plain and deformed)	40 60 75	280 420 520	483 (70) 620 (90) 689 (100)	276 (40) 414 (60) 517 (75)
A616	Rail steel (plain and deformed)	60	420	620 (90)	474 (60)
A617	Axle steel (plain and deformed)	40 60	280 420	483 (70) 620 (90)	276 (40) 414 (60)
A706	Low-alloy steel (deformed Bars)	60	420	552 (80)	414–538 (60–78)

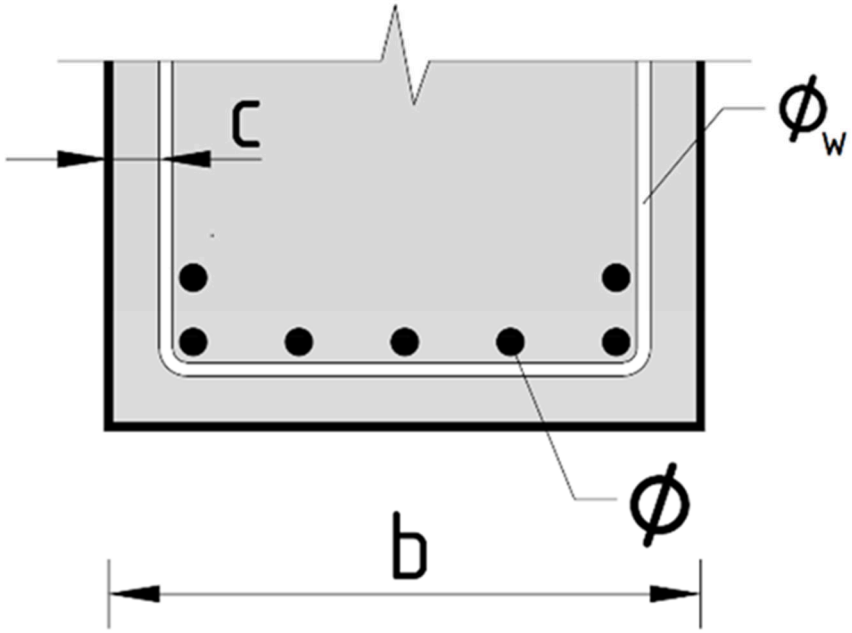
Available sizes in the local market

Diameter(mm)	Section area(mm2)	Weight(kg/m)
6	28.27	0.222
8	50.27	0.395
10	78.54	0.617
12	113.1	0.888
14	153.9	1.21
16	201.1	1.58
18	254.5	2.00
20	314.2	2.47
22	380.1	2.98
25	490.9	3.85
28	615.8	4.83
32	804.2	6.31
36	1018	7.99
40	1257	9.87
50	1964	15.42

5. Details of Reinforcement

- The general notes sheet usually exhibits typical reinforcement details such as cover, reinforcement spacing, standard hooks and bend diameter, and reinforcement splices.

A. Cover. It is essential for the steel bars to be protected by a sufficient layer of concrete, known as 'cover' (C), to protect them from moisture that will rust the steel, and from the heat of any fire that could degrade the steel and lead to a structural collapse. The following table show the minimum required cover according to ACI 318



UNLESS OTHERWISE NOTED, CLEAR CONCRETE COVER TO REINFORCEMENT SHALL BE:

- 75 mm	:FOR FOUNDATIONS IN CONTACT WITH SOIL, BLINDING OR WATER PROOFING.
- 50 mm	:FOR CONCRETE SURFACE IN CONTACT WITH WATER.
- 50 mm	:FOR BASEMENT WALLS.
- 40 mm	:FOR COLUMNS AND BEAMS.
- 25 mm	:FOR SLABS, STAIRS AND WALLS.

Cover standard and construction methods

ACI 318

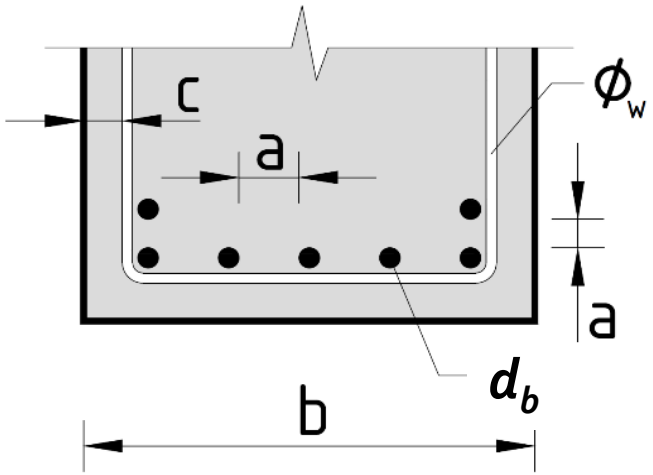
Table 20.6.1.3.1—Specified concrete cover for cast-in-place nonprestressed concrete members

Concrete exposure	Member	Reinforcement	Specified cover, mm
Cast against and permanently in contact with ground	All	All	75
Exposed to weather or in contact with ground	All	No. 19 through No. 57 bars	50
		No. 16 bar, MW200 or MD200 wire, and smaller	40
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 43 and No. 57 bars	40
		No. 36 bar and smaller	20
	Beams, columns, pedestals, and tension ties	Primary reinforcement, stirrups, ties, spirals, and hoops	40

Concrete cover can be provided by special cover blocks as shown in the photos.

5. Details of Reinforcement

B. Spacing limits for reinforcement (a)



- The minimum clear spacing between parallel bars in a layer shall be at least the greatest of d_b, $4/3d_{agg}$, and 25 mm.

d_{agg} : maximum aggregate size .

- Where parallel reinforcement is placed in two or more layers, bars in the upper layers shall be placed directly above bars in the bottom layer with clear distance between layers not less than 25 mm.

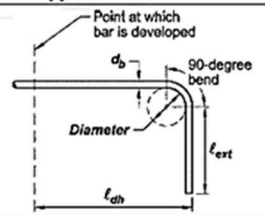
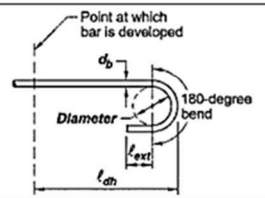
AGGREGATES

MAXIMUM AGGREGATE SIZE SHALL BE 20 mm.

- In spirally reinforced or tied reinforced compression members, clear distance between longitudinal bars shall be not less than $1.5d_b$, $4/3d_{agg}$ nor less than 40 mm.

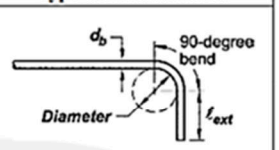
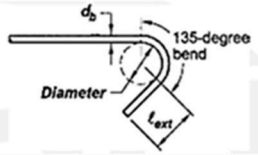
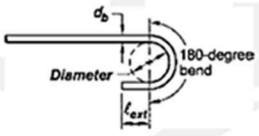
5. Details of Reinforcement

Table 25.3.1—Standard hook geometry for development of deformed bars in tension

Type of standard hook	Bar size	Minimum inside bend diameter, mm	Straight extension[1] ℓ_{ext}, mm	Type of standard hook
90-degree hook	No. 10 through No. 25	$6d_b$	$12d_b$	
	No. 29 through No. 36	$8d_b$		
	No. 43 and No. 57	$10d_b$		
180-degree hook	No. 10 through No. 25	$6d_b$	Greater of $4d_b$ and 65 mm	
	No. 29 through No. 36	$8d_b$		
	No. 43 and No. 57	$10d_b$		

[1]A standard hook for deformed bars in tension includes the specific inside bend diameter and straight extension length. It shall be permitted to use a longer straight extension at the end of a hook. A longer extension shall not be considered to increase the anchorage capacity of the hook.

Table 25.3.2—Minimum inside bend diameters and standard hook geometry for stirrups, ties, and hoops

Type of standard hook	Bar size	Minimum inside bend diameter, mm	Straight extension[1] ℓ_{ext}, mm	Type of standard hook
90-degree hook	No. 10 through No. 16	$4d_b$	Greater of $6d_b$ and 75 mm	
	No. 19 through No. 25	$6d_b$	$12d_b$	
135-degree hook	No. 10 through No. 16	$4d_b$	Greater of $6d_b$ and 75 mm	
	No. 19 through No. 25	$6d_b$		
180-degree hook	No. 10 through No. 16	$4d_b$	Greater of $4d_b$ and 65 mm	
	No. 19 through No. 25	$6d_b$		

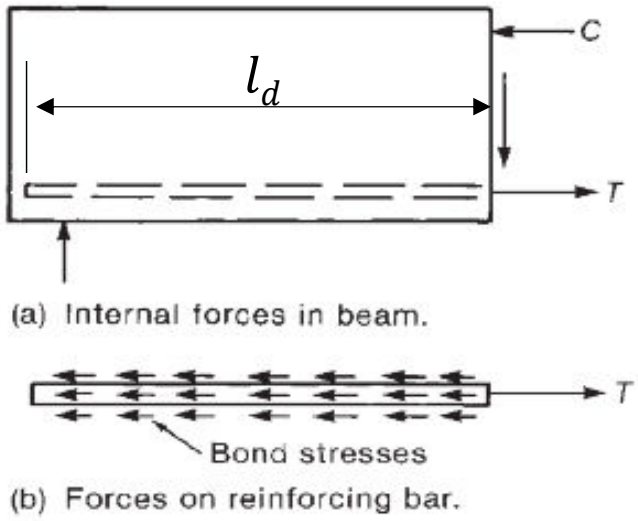
[1]A standard hook for stirrups, ties, and hoops includes the specific inside bend diameter and straight extension length. It shall be permitted to use a longer straight extension at the end of a hook. A longer extension shall not be considered to increase the anchorage capacity of the hook.

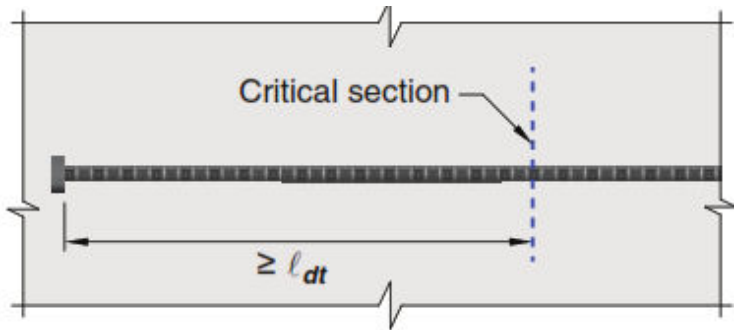
C. Standard hooks and bend diameter

- Hooks are anchorage means. They ensure a complete bond between steel and concrete and reduce the requirement of the development length (l_{dh}). Hooks are specifically critical in seismic design and detailing.
- The general notes sheet usually refers to the rebar hooks and bend diameters based on the code's recommendations in the tables (ACI 318).

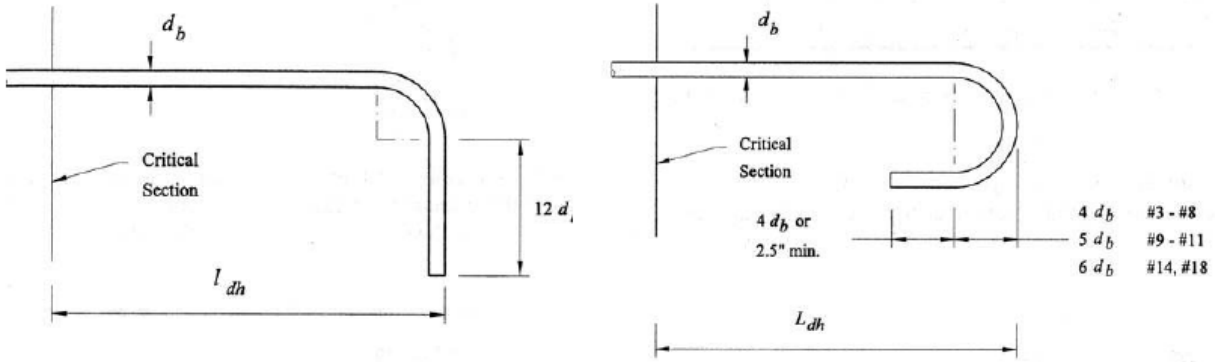
Development length

- Development length (l_d, l_{dh}) is the shortest distance the steel bar shall be embedded in concrete to attain yield stress without slipping.
- Calculated tension or compression reinforcement at any section shall be developed on each side by embedment length; hook, headed deformed bar, mechanical device, or a combination thereof.





Development of headed deformed bar



Development of hocked bars

5. Details of Reinforcement

D. Splices of reinforcing bars

- Just as it is impossible to place all the concrete in one operation, it is also impossible to place full length, continuous reinforcing bars in most structures.
- Splices in reinforcement are also necessary because of manufacturing, fabricating, transporting, or placing limitations.

Bar Splice requirements from the general notes sheet

(a) WHERE BAR LENGTH IS NOT SPECIFIED, LONGEST PRACTICABLE BAR LENGTH SHALL BE EMPLOYED WITH STAGGERED LAP SPLICES. LAP LENGTH SHALL BE A MINIMUM OF 60 TIMES THE BAR DIAMETER, UNLESS OTHERWISE NOTED.

BAR DIAMETER (mm)	BARS IN TENSION	BARS IN COMPRESSION
10	600	600
12	750	750
14	850	850
16	1000	1000
18	1100	1100
20	1200	1200
25	1500	1500
32	2000	2000

AT ANY SECTION. NOT MORE THAN 50% OF THE REINFORCEMENT SHALL BE SPLICED.

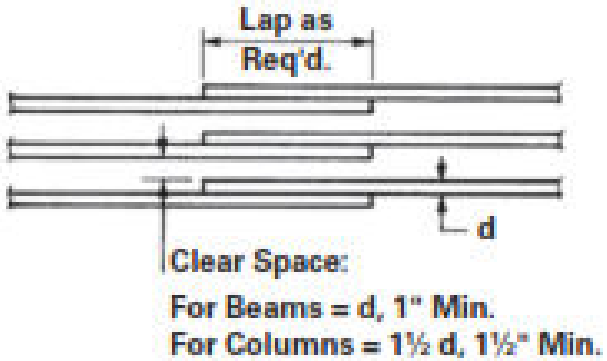
(b) REINFORCEMENT BARS MAY BE MECHANICALLY SPLICED, COUPLERS SHALL BE TENSION- COMPRESSION TYPE. MECHANICAL SPLICE SHALL DEVELOP IN TENSION OR COMPRESSION AT LEAST 125% OF THE SPECIFIED YIELD STRENGTH OF THE BAR.

Types of Splices

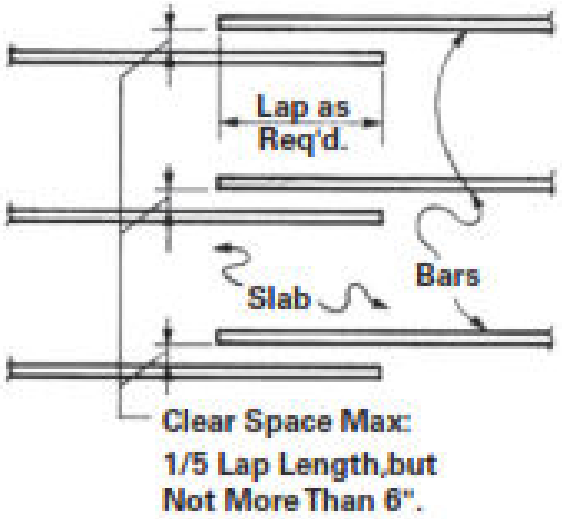
- **Lap Splices**

- Lap splices may be made with the bars either spaced or in contact (See Figure). Generally, the lap splice is more economical and therefore, more commonly used.

- The length of lap varies with the concrete strength, the yield strength of the reinforcing steel, bar spacing, concrete cover, and the bar size. Typically > $40d_b$.



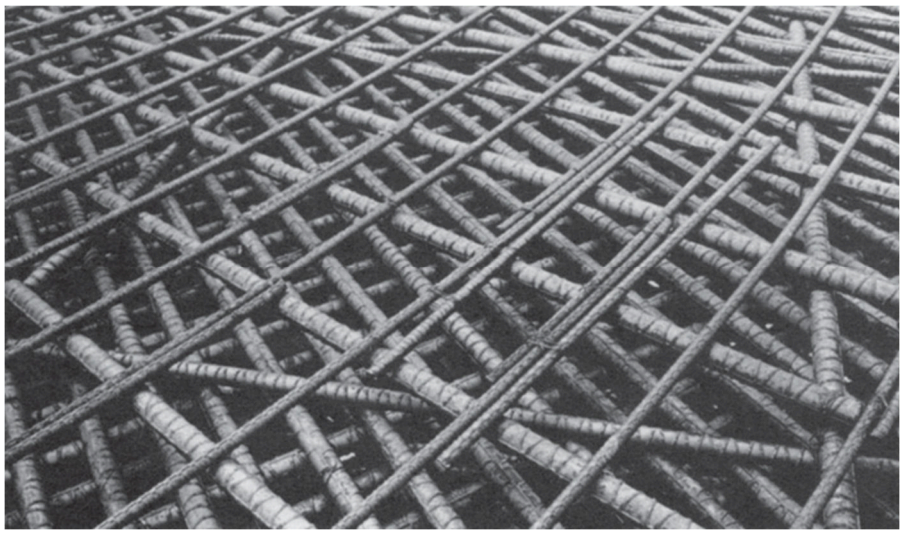
Contact Lap Splice
(Preferred)

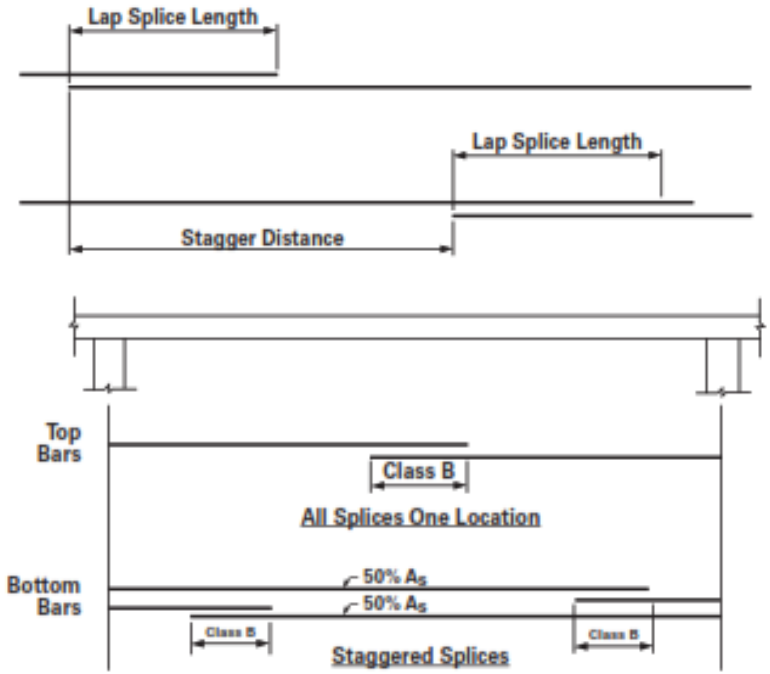


Non-Contact Lap Splice
(Not Preferred)

Types of Splices

- Staggered Splices. Laps between bars should normally be staggered and not located in areas of high moments/forces (e.g. plastic hinges). They should normally be arranged symmetrically in any section. However, All secondary reinforcement may be lapped at the same location.
- It is the Engineer's responsibility to provide for properly designed splices and to show their location and details on the structural drawings.





Types of Splices

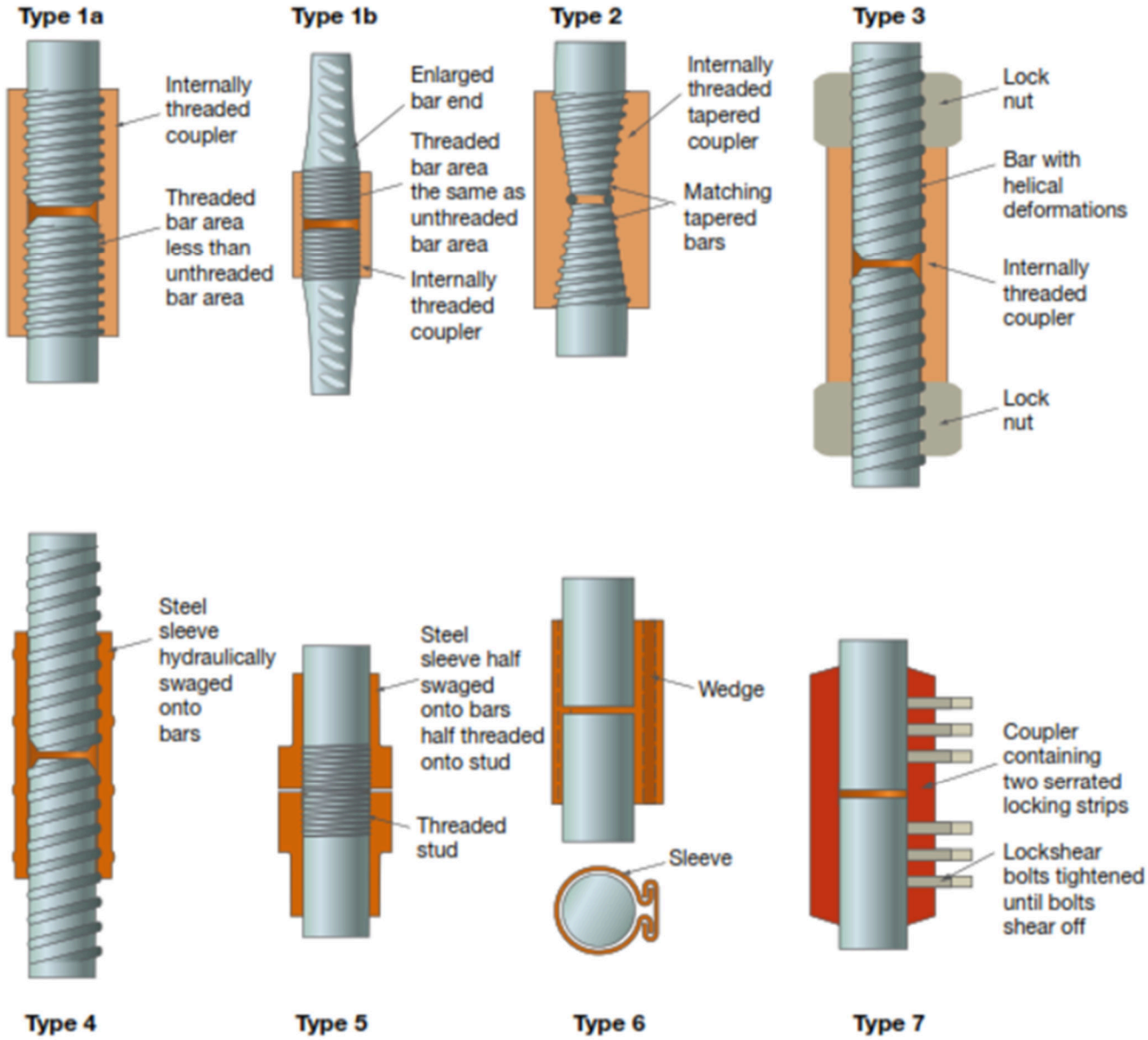
- **Mechanical Splices**

- Lap splices may cause congestion at the splice locations and make their use impractical. This is particularly true for columns reinforced with large, closely spaced bars and for horizontal splices in girder bars.

- There are two general types of mechanical splices coupler, tension compression mechanical splices and compression-only mechanical splices, which are also known as end-bearing mechanical splices.

- When mechanical splice couplers are used, the Engineer should indicate the acceptable types and any special end preparation required for the reinforcing bars.

Couplers Types



Types of Splices

- **Welded Lap Splice**

- In general, manual arc welding in the field is not recommended. However, if necessary, field-welded splices are accomplished by electric arc welding the reinforcing bars together.

- For projects of all sizes, manual arc welding will usually be the most costly method, due to direct and indirect costs of proper inspection

6.Foundation Notes

THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE STABILITY OF ALL EXCAVATIONS AND EMBANKMENTS AND SHALL PROVIDE ALL NECESSARY PLANKING, STRUTTING OR OTHER TEMPORARY WORKS REQUIRED TO MAINTAIN THE STABILITY OF EARTHWORKS. THE CONTRACTOR SHALL PROVIDE ALL MEASURES AND PRECAUTIONS NECESSARY TO PREVENT SETTLEMENT OR DAMAGE OF ADJACENT EXISTING OR NEW CONSTRUCTION.

IT IS NOT WARRANTED THAT THE SUBSURFACE CONDITIONS DESCRIBED ON DRAWINGS, SPECIFICATIONS, TEST BOREHOLES OR TEST PITS ARE REPRESENTATIVE OF THE MATERIALS AND CONDITIONS AT OTHER LOCATIONS, TIMES AND GREATER DEPTHS THAN INDICATED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO THOROUGHLY INVESTIGATE THE SUBSOIL CONDITIONS AND TO ENSURE THAT BEARING CAPACITY IS ACHIEVED AT SITE WITH RESPECT TO THE PROPOSED FOUNDATION LEVEL.

BASED ON SOIL INVESTIGATION REPORT REF (SI 17/935-MODIFIED) DATED (OCTOBER, 2017) PREPARED BY THE GEOTECHNICAL & MATERIAL TESTING CENTER (GMT). THE FOLLOWING POINTS SHALL BE CONSIDERED:

1 FOOTINGS ARE DESIGNED FOR A NET ALLOWABLE BEARING CAPACITY OF 400 kPa AND A GROSS ALLOWABLE BEARING CAPACITY OF 550 kPa ON VERY WEAK TO MODERATELY WEAK LIMESTONE WITH MARL FILLING THE FRACTURES FOR AREAS OUTSIDE BUILDING CORE AREA AND BUILDING BASEMENT WALLS AND A GROSS ALLOWABLE BEARING CAPACITY OF 650 kPa BELOW BUILDING CORE AREA AND BUILDING BASEMENT WALLS. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO ENSURE THAT THIS BEARING CAPACITY IS ACHIEVED AT SITE WITH RESPECT TO THE LOCATION OF FOUNDATION.

THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY AFTER FOUNDATION EXCAVATION AND BEFORE FOUNDATION CONSTRUCTION TO INSPECT THE EXCAVATION AND CONFIRM THAT THE REQUIRED FOUNDING STRATA

NO FOUNDATION WORK SHALL BE PERFORMED UNTIL ALL FOUNDATION WORK IS COORDINATED WITH ALL UNDERGROUND UTILITIES.

FOUNDATION ON BACKFILL IS NOT ALLOWED. BACKFILL AND FILL NEXT TO FOOTINGS, UNDER SUBFLOORS SHALL BE COMPACTED BY MECHANICAL TAMPERS OR AS APPROVED BY THE ENGINEER.

FOOTINGS THAT ARE VERY CLOSE TO EACH OTHER, SHALL NOT IN ANY CASE, BE CAST AS ONE FOOTING, THE REINFORCED CONCRETE SHALL BE SEPARATED USING SOLID CEMENT BLOCKS OR POLYSTYRENE IF THE DISTANCE BETWEEN FOOTINGS DOES NOT ALLOW FOR SHUTTERING.

UNLESS OTHERWISE NOTED, FOUNDATIONS ARE TO BE CENTERED BELOW COLUMNS AND WALLS.

COLUMNS, WALLS AND FOOTINGS ARE DESIGNED TO CARRY THE LOADS OF MAXIMUM EIGHTEEN FLOORS INCLUDING FIVE CELLARS, ONE BASEMENT, GROUND FLOOR, TEN TYPICAL FLOORS AND ROOF.

Summary

- Earthworks and excavation protection requirements.
- Design bearing capacity.
- Max. number of floors.
- Notes to contractor indicating that soil report data may not represent actual site condition and contractor shall call the geotechnical engineer to verify the foundation layer and its bearing capacity.

7.Backfill notes

BACKFILL BEHIND WALLS SHALL MEET THE SOIL REPORT RECOMMENDATIONS.

SOIL OR SOIL-ROCK MIXTURE FREE FROM ORGANIC MATTER AND DELETERIOUS SUBSTANCES.

SHALL NOT CONTAIN ROCKS OR LUMPS OVER 15 cm IN GREATEST DIMENSION.

THE PLASTICITY INDEX FOR THE BACKFILL MATERIAL SHALL NOT BE MORE THAN 10%.

IT SHALL BE PLACED IN LIFTS NOT EXCEEDING 250 mm IN UNCOMPACTED THICKNESS AND COMPACTED TO DENSITY NOT LESS THAN 95% OF THE MAXIMUM DRY DENSITY AS OBTAINED BY MODIFIED PROCTOR COMPACTION TEST (ASTM D 1557).

BACKFILLING INFRONT AND BEHIND RETAINING WALLS SHALL BE DONE SIMULTANEOUSLY, IF APPLICABLE.

BACKFILLING AGAINST CONCRETE WALLS IS NOT ALLOWED UNTIL SUPPORTING SLABS AND OTHER SUPPORTING ELEMENTS, INCLUDING SLAB ON GRADE, ARE IN PLACE, FULLY ANCHORED AND HAVE REACHED FULL DESIGN STRENGTH.

NO FILLING SHALL TAKE PLACE AROUND ANY STRUCTURE UNTIL THE ENGINEER'S APPROVAL TO BACKFILL HAS BEEN OBTAINED.

Summary

- Description of allowable backfill materials.
- Methods of backfilling

8. Blockwork notes

MINIMUM COMPRESSIVE STRENGTH FOR NON-LOAD BEARING HOLLOW BLOCKS SHALL BE 3.5 MPa.

MINIMUM COMPRESSIVE STRENGTH FOR NON-LOAD BEARING SOLID BLOCKS SHALL BE 7.0 MPa.

BLOCK WALLS 10 cm THICKNESS, NOT LOCATED DIRECTLY ON GROUND BEAMS, MAY BE BUILT DIRECTLY ON THE GROUND SLAB.

BLOCK WALLS 15 cm THICKNESS OR MORE, NOT LOCATED DIRECTLY ON GROUND BEAMS, SHALL BE PLACED ON THE DROPPED GROUND SLAB AS SHOWN IN THE TYPICAL DETAILS.

CONCRETE HOLLOW BLOCKS AT ENDS OF ROWS SHALL HAVE CLOSED SIDES TO PREVENT INGRESS OF CONCRETE.

THE CONCRETE BLOCKS SHALL BE FROM AN APPROVED MANUFACTURER WITH APPROPRIATE STRENGTH AND ADEQUATELY CURED AS PER STANDARD SPECIFICATIONS.

ALL BLOCK WALLS EXCEEDING 3.0 m IN CLEAR HEIGHT SHALL BE PROVIDED WITH A STIFFENER BEAM AS SHOWN IN THE TYPICAL DETAILS.

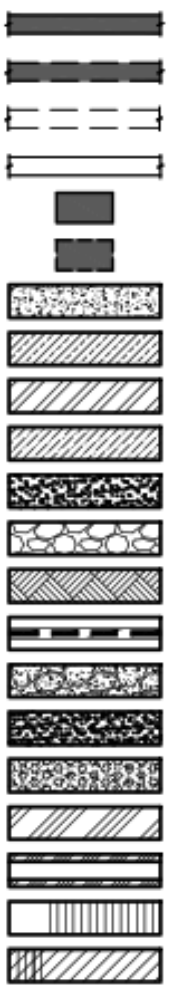
ALL BLOCK WALLS WITH UNBRACED LENGTH EXCEEDING 5.0 m SHALL BE PROVIDED WITH A STIFFENER COLUMN AS SHOWN IN THE TYPICAL DETAILS.

Summary

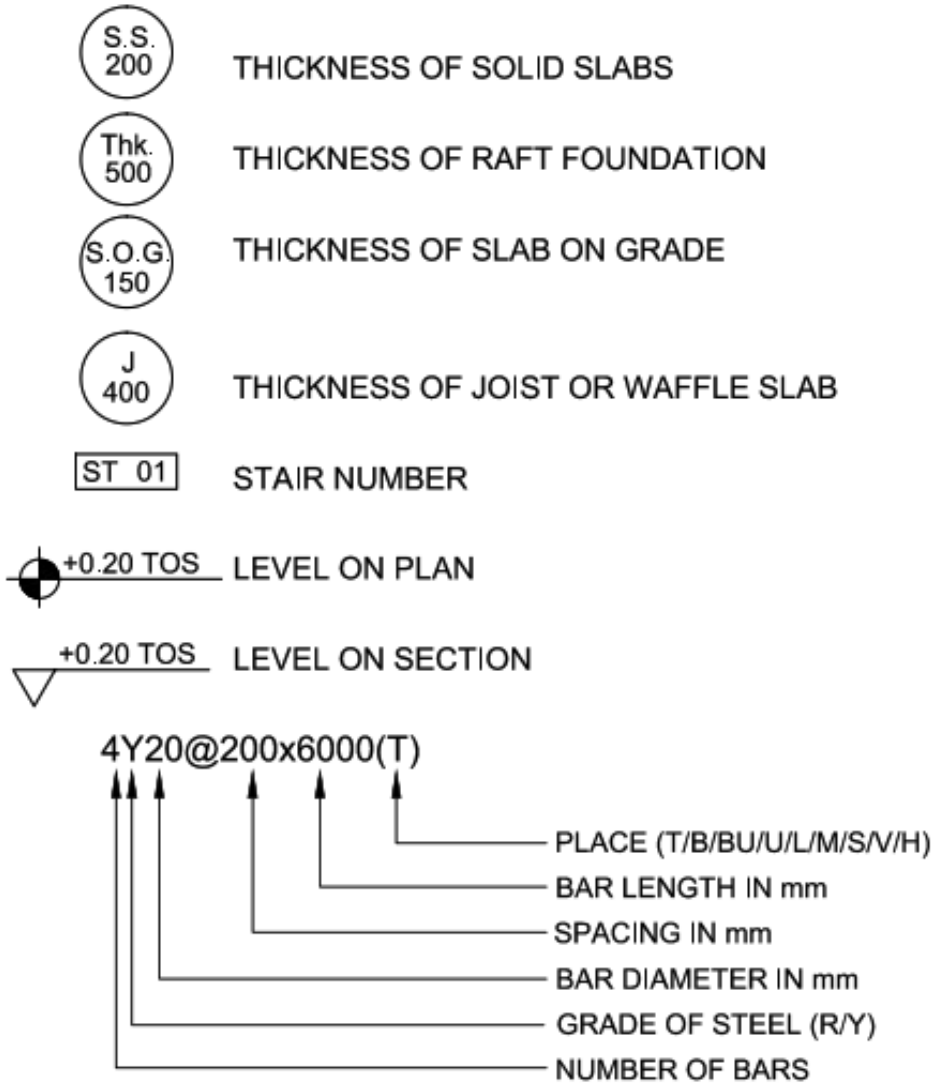
Description of materials and method of construction

9. Symbols

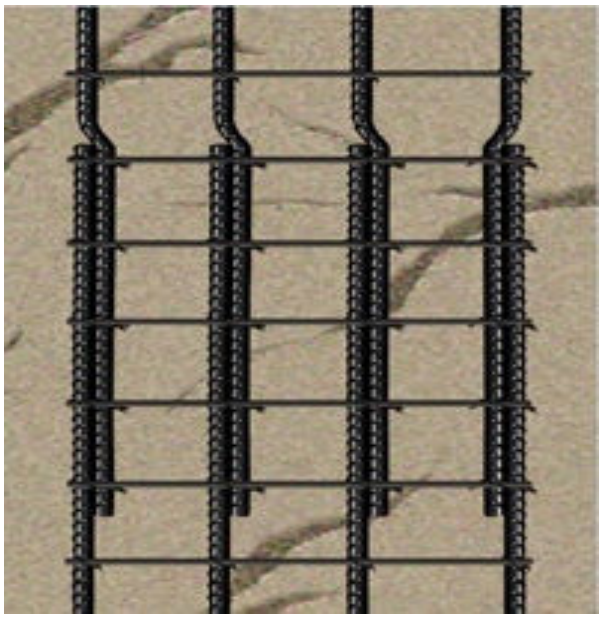
Hatching symbols



Other symbols



Reinforcement Bar Symbols



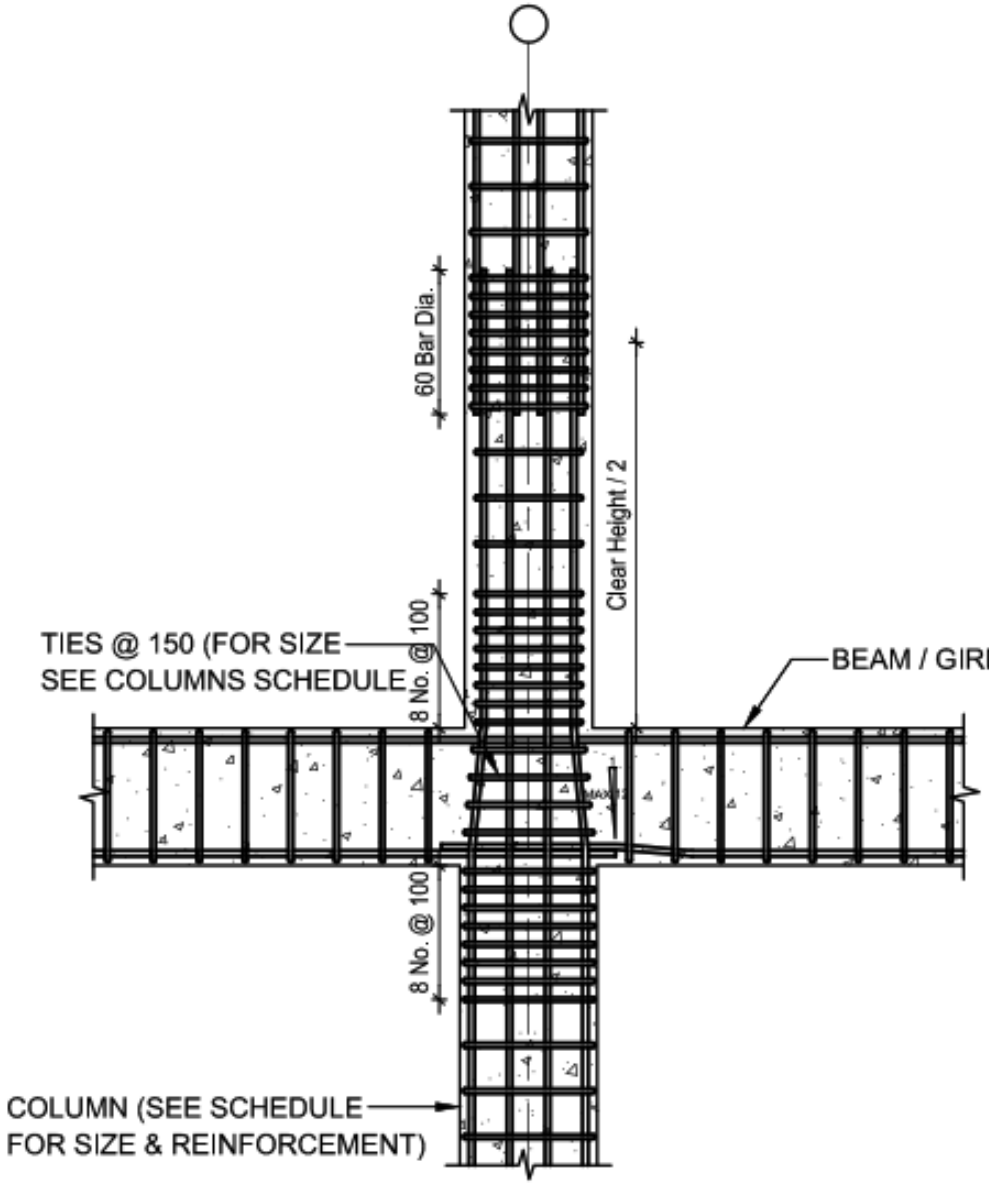
DESCRIPTION	EXAMPLE
Bar bent in elevation	
Bar bent toward observer	
Bar bent away from observer	
Hooked bar in elevation	
Hooked bar in plan	
Bar lapped inside	
Bars lapped (same plane)	
Bar lapped (cranked)	
Bar in section	1.5 x scale, where necessary

10.Abbreviations

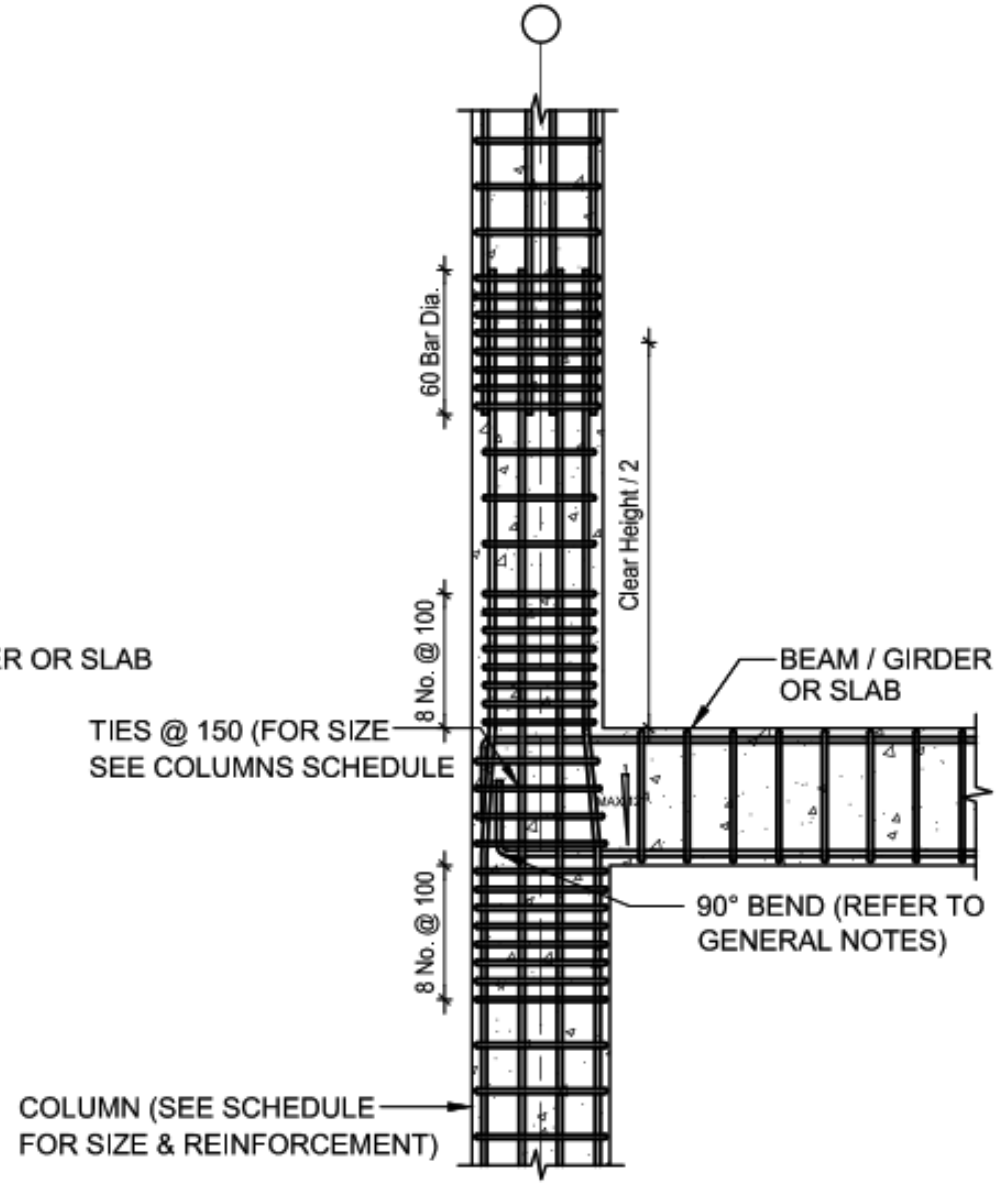
B	BOTTOM BARS
BU	BENT UP BARS
cm	CENTIMETER
C1	COLUMN NUMBER 1
CJ	CONTRACTION JOINT
Dia	DIAMETER
EA	EACH FACE
EJ	EXPANSION JOINT
ES	EACH STEP
EW	EACH WAY
FFL	FINISH FLOOR LEVEL
H	HORIZONTAL BARS
INV	INVERTED
L	L SHAPED TOP BARS
M	MIDDLE BARS
m	METER
MAX	MAXIMUM
MIN	MINIMUM
mm	MILLIMETER
No.	NUMBER
NTS	NOT TO SCALE
PLC	PLANTED COLUMN
R	MILD STEEL BARS
S	STIRRUPS
T	TOP BARS
TOF	TOP LEVEL OF FOUNDATION
TOS	TOP LEVEL OF STRUCTURAL SLAB
TYP	TYPICAL
T&B	TOP AND BOTTOM
U	U SHAPED BARS
V	VERTICAL BARS
VAR	VARIABLE
Y	HIGH YIELD BARS
W1	SHEAR WALL NUMBER 1

تعريف للاختصارات المستعملة في اللوحات الإنشائية

11.Typical Details

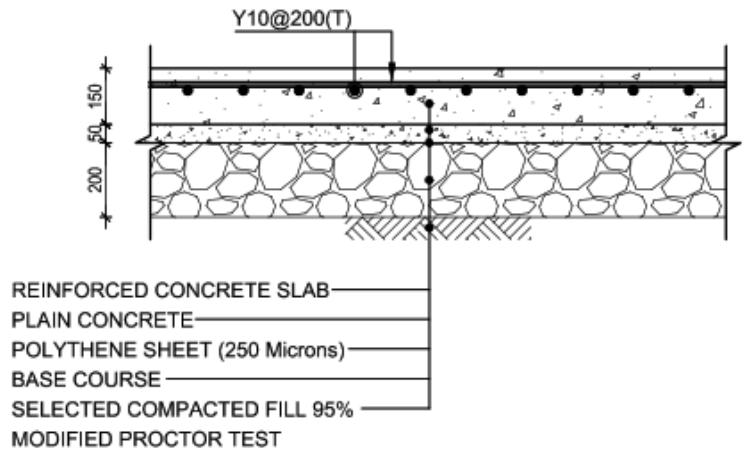


A1-INTERIOR BEAM-COLUMN JOINT

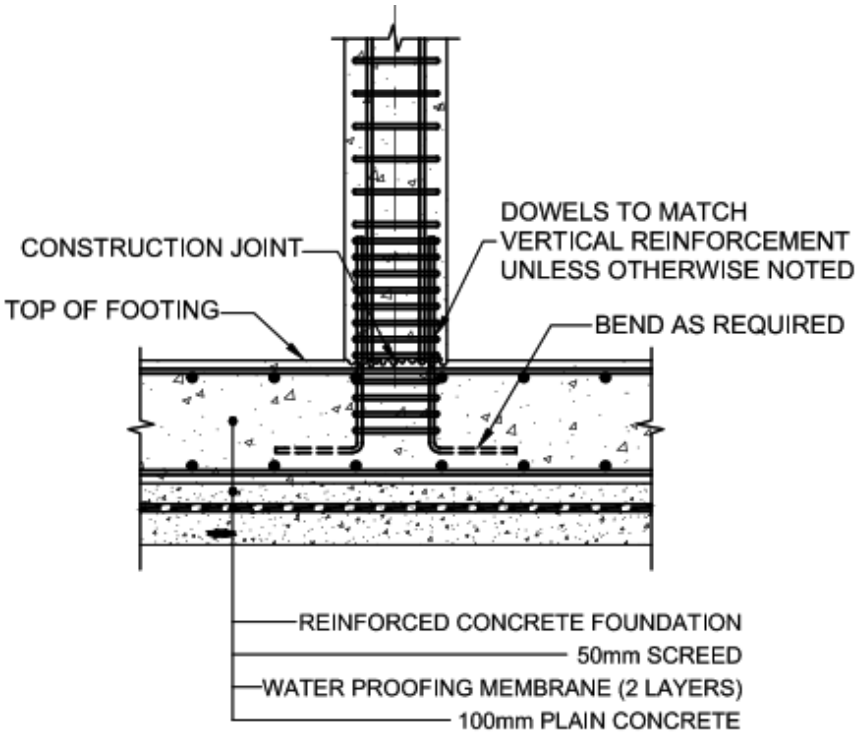


A2-EXTERIOR BEAM-COLUMN JOINT

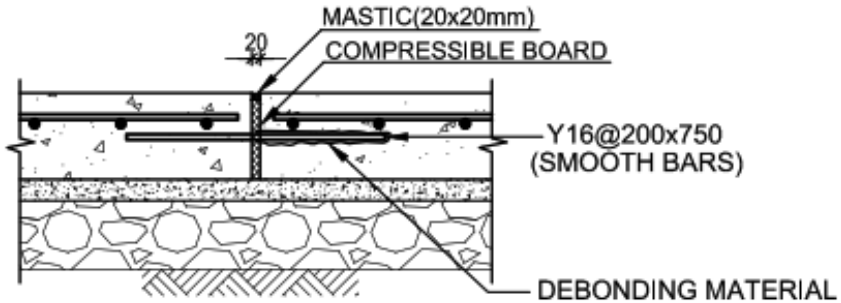
11.Typical Details



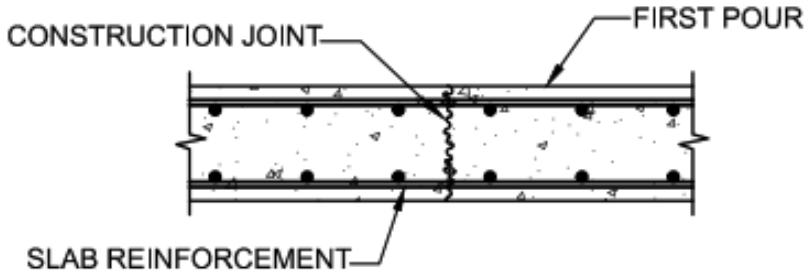
J1-TYPICAL SECTION THROUGH 150mm SLAB ON GRADE



F6-TYPICAL CONSTRUCTION JOINT BETWEEN COLUMN & FOUNDATION



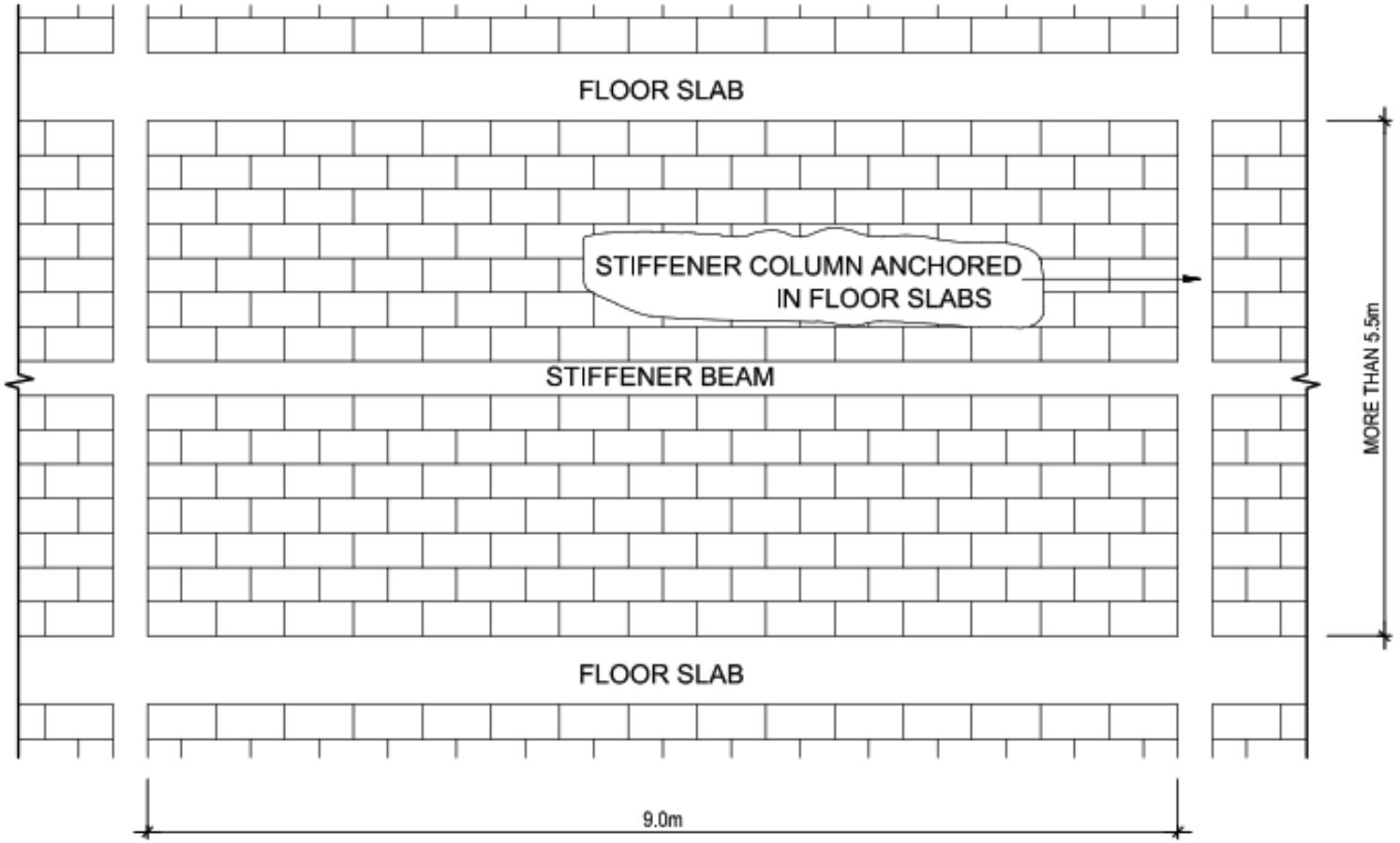
F1-SLAB ON GRADE EXPANSION JOINT DETAIL

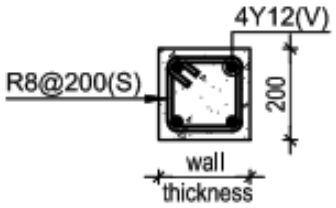


F2-STRUCTURAL SLAB CONSTRUCTION JOINT DETAIL

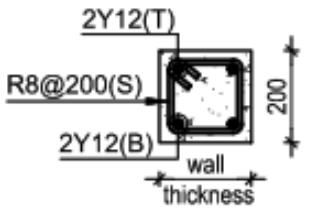
11.Typical Details

Typical block wall details



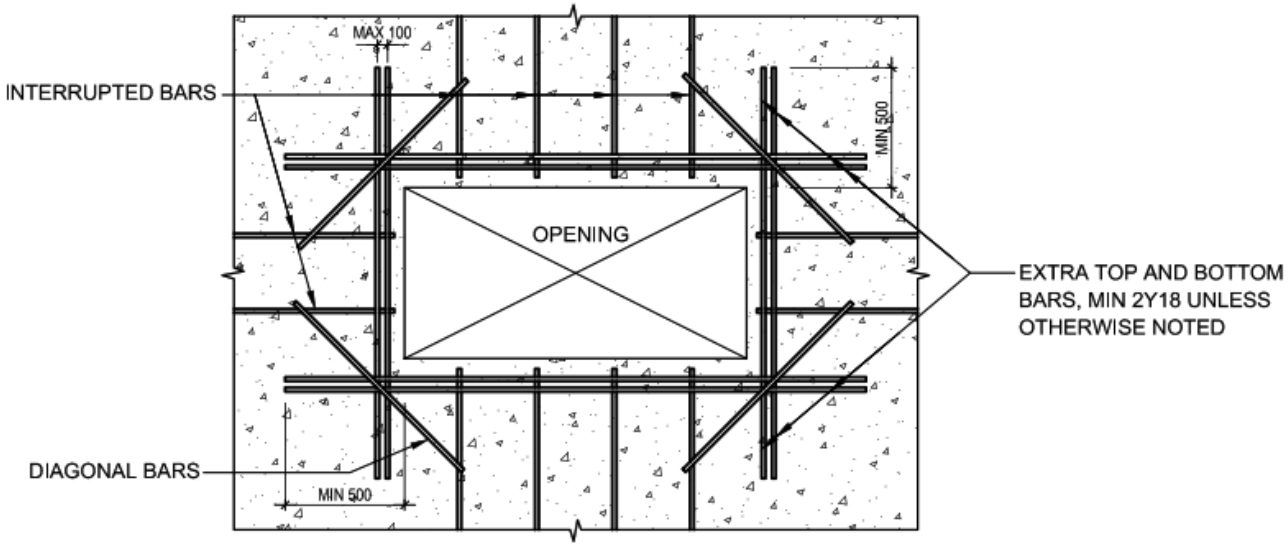


G1-STIFFENER COLUMN TYPICAL DETAIL

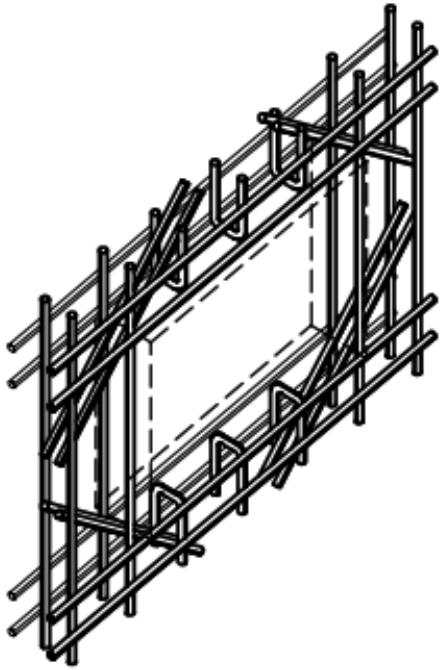


G2-STIFFENER BEAM TYPICAL DETAIL

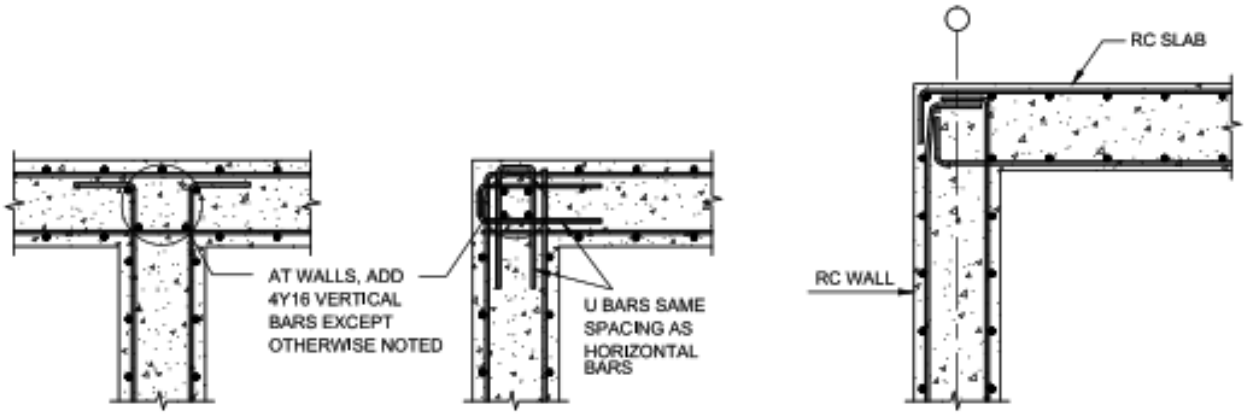
11.Typical Details



B1-RECTANGULAR OPENING



FOR ALL WALL OPENINGS USE 2Y16 AND FIX DIAGONAL 2Y16X1500 BARS IN BOTH FACES, AT EACH CORNER



E1-PLAN E2-PLAN E3-SECTION

E-WALL CORNERS AND INTERSECTIONS