النظم الانشائية لسبق التجهيز

يمكن تقسيم نظم المبانى سابقة التصنيع الخرسانية من الجانب الانشائى إلى نظم رئيسية (General System) وتنقسم بدورها بمجموعة من النظم غير رئيسيىة (متداخلة-متدرجة-منبثقة) وتعتمد فكرة تصميمها على الأنواع الرئيسية وهذه النظم الرئيسية هى :

1. **الوحدات الطولية**
2. **الوحدات المستوية**
3. **الوحدات الصندوقية**

أولاً : الوحدات الطولية :

هي عبارة عن وحدات نمطية سابقة التجهيز في المصنع أو في مكان مخصص لها في الموقع، وهذه الوحدات يمكن أن تكون من الحديد أو من الخرسانة المسلحة، يتم نقل تلك الوحدات إلى الموقع بعد سبق تجهيزها حيث يمكن تجميعها مع بعضها البعض بإحدى الطرق الخاصة بالوصلات ، سواء كانت جافة أو رطبة لتكوين الهيكل الإنشائي للمبنى .

وتنقسم الوحدات الطولية إلى نوعين أساسين :

1. وجدات إنشائية Structural Unit
2. وحدات غير إنشائية Non Structural Unit

1-وحدات إنشائية Structural Unit :

يحتاج المبنى إلى نوعين من الوحدات الإنشائية :

- **وحدات الأعمدة والكمرات التي تكون الهيكل الإنشائي للمبنى** : بعد تجميعها ويكمن لتلك الوحدات أما من الحديد أو الخرسانة المسلحة أو خرسانة سابقة الإجهاد وتكون قطاعات الوحدات صغيرة .

شكل (1) يوضح وحدات الأعمدة والكمرات التي تكون الهيكل الإنشائي للمبنى

- **وحدات إنشائية أخرى لتقفيل الفراغات** يمكن أن تكون وحدات طولية لتشكل الأسقف والحوائط بحيث يتم وضع الوحدات بجانب بعضها على الكمرات السابق تركيبها لتقفيل الفراغات .

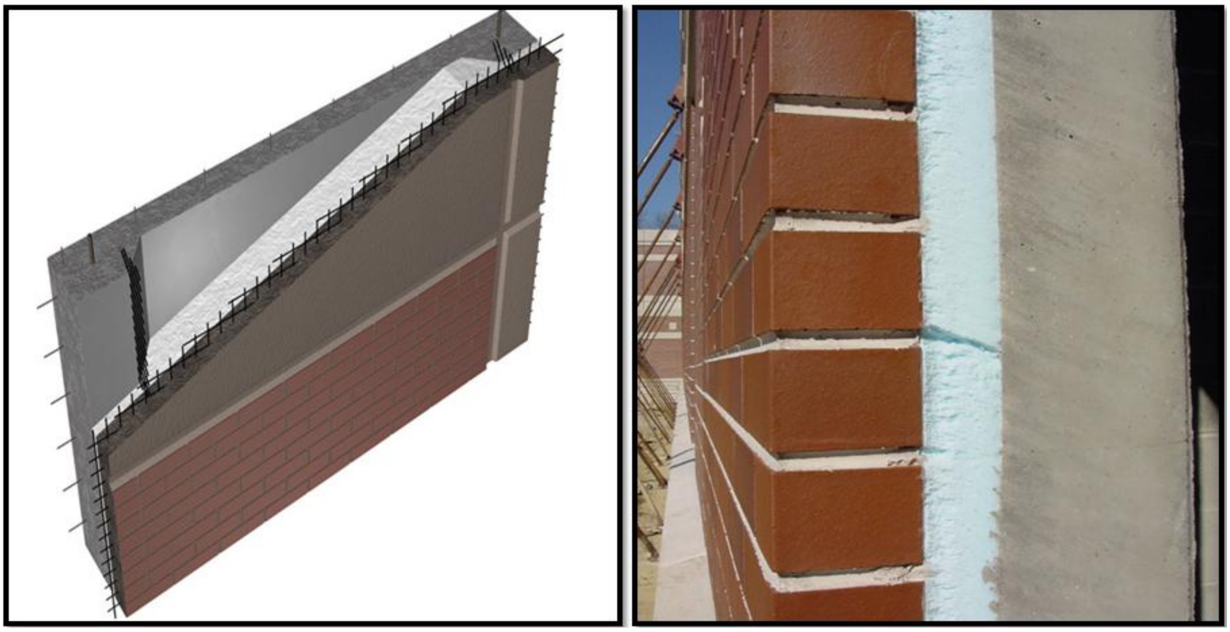
شكل (2) يوضح وحدات إنشائية أخرى لتقفيل الفراغات

2- وحدات غير إنشائية Non Structural Unit :

وهي عبارة عن الحوائط الغير الإنشائية حيث تكون الوظيفة الأساسية لها هي فصل الفراغات داخل المبنى بالإضافة إلى الوظائف الأخرى الخاصة بالعزل الحراري أو الصوتي أو المتطلبات الأخرى .

وتكون هذه الوحدات خفيفة ويجب تصميمها بطريقة تتحمل القوى التي سوف تتعرض لها أثناء الحمل والنقل والتركيب .

شكل (3) يوضح وحدات غير إنشائية



شكل (4) يوضح وحدات غير إنشائية

ثانياً : الوحدات المستوية :

الوحدات المستوية تعتبر من أكثر الطرق شيوعا في البلدان المتقدمة، وهي عبارة عن وحدات من الحوائط والأسقف بأحجام مختلفة طبقاً للتصميم الموضوع يتم تجهيزها في المصنع، ثم تنقل لموقع التنفيذ حيث يتم تجميع الحوائط والأسقف لتكوين الفراغات المختلفة للمنشأ .

وتتراوح أحجام الوحدات المستوية من وحدات صغيرة ومتوسطة إلى وحدات كبيرة .

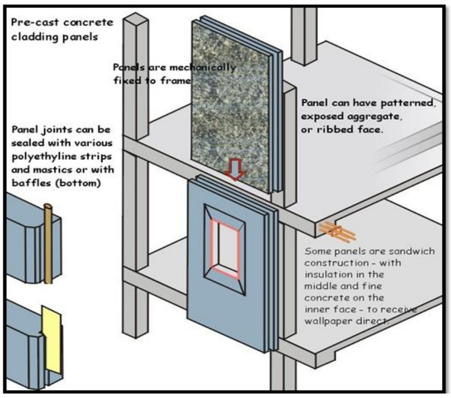
وتختلف أحجام الوحدات المستوية إلى :

وحدات صغيرة الحجم (Small Size Units) :

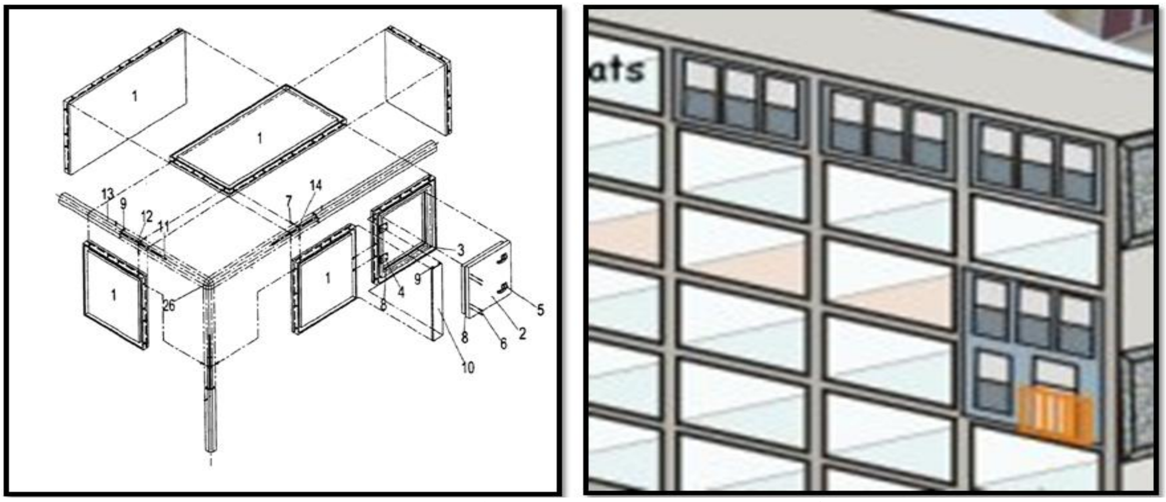
عبارة عن وحدات يتم تجميعها في الموقع لتكوين لفراغات المختلفة، ولا يقل عدد الوحدات المكون لحائط أو سقف غرفة عن 3 وحدات ويكون متوسط أبعاد الوحدة 4 * 2م .

مميزاته: عدم احتياجه إلى معدات كبيرة (شاحنات نقل – أوناش)

عيوبه : الفراغ الواحد يحتاج إلى عدد كبير من الوصلات، حيث زيادة زمن الإنشاء وعمليات التنفيذ فيحتاج إلى عدد أكبر من العمالة وبالتالي زيادة التكلفة الكلية .



شكل (5) يوضح وحدات صغيرة الحجم

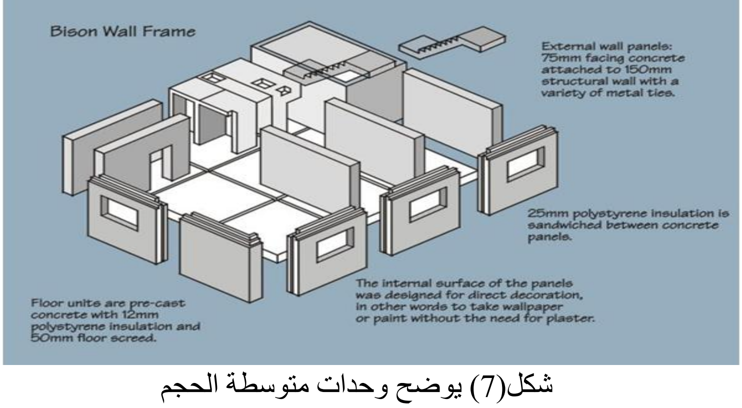


شكل (6) يوضح وحدات صغيرة الحجم

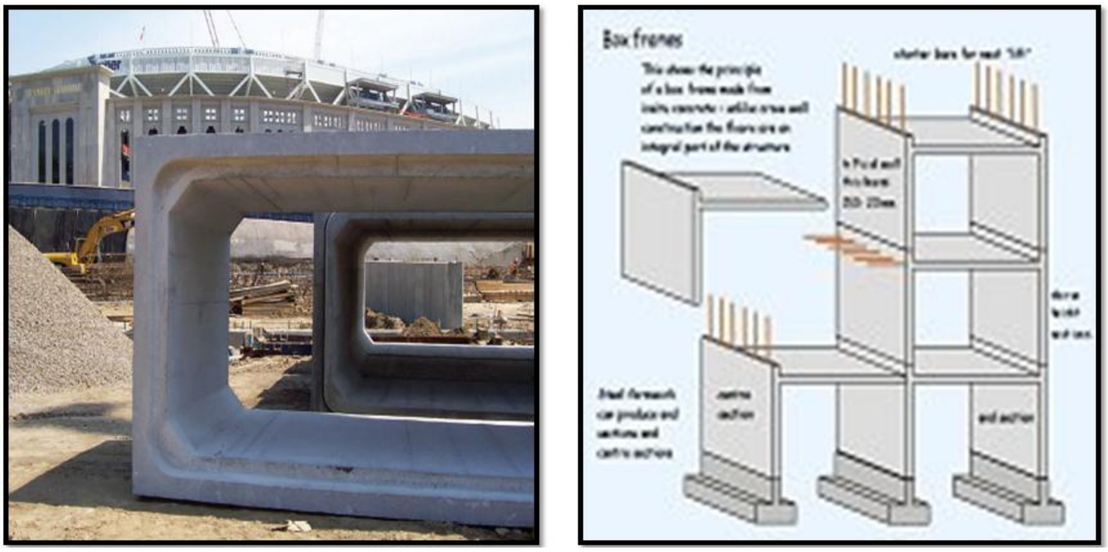
وحدات متوسطة الحجم (Medium Size Units) :

الوحدات متوسطة الحجم عبارة عن وحدات مستوية للحوائط والأسقف، يتم تجميعها في الموقع لتكوين الفراغات المختلفة، بإفتراض ألا تزيد عن وحدتين لتكوين حائط أو سقف غرفة عن ويكون متوسط أبعاد الوحدة 4*4 م .

<u>مميزاته :</u> عدم احتياجه إلى معدات كبيرة (شاحنات نقل – أوناش)، وأيضاً قلة عدد الوصلات ي الفراغ الواحد .



شكل(7) يوضح وحدات متوسطة الحجم



شكل(8) يوضح وحدات متوسطة الحجم

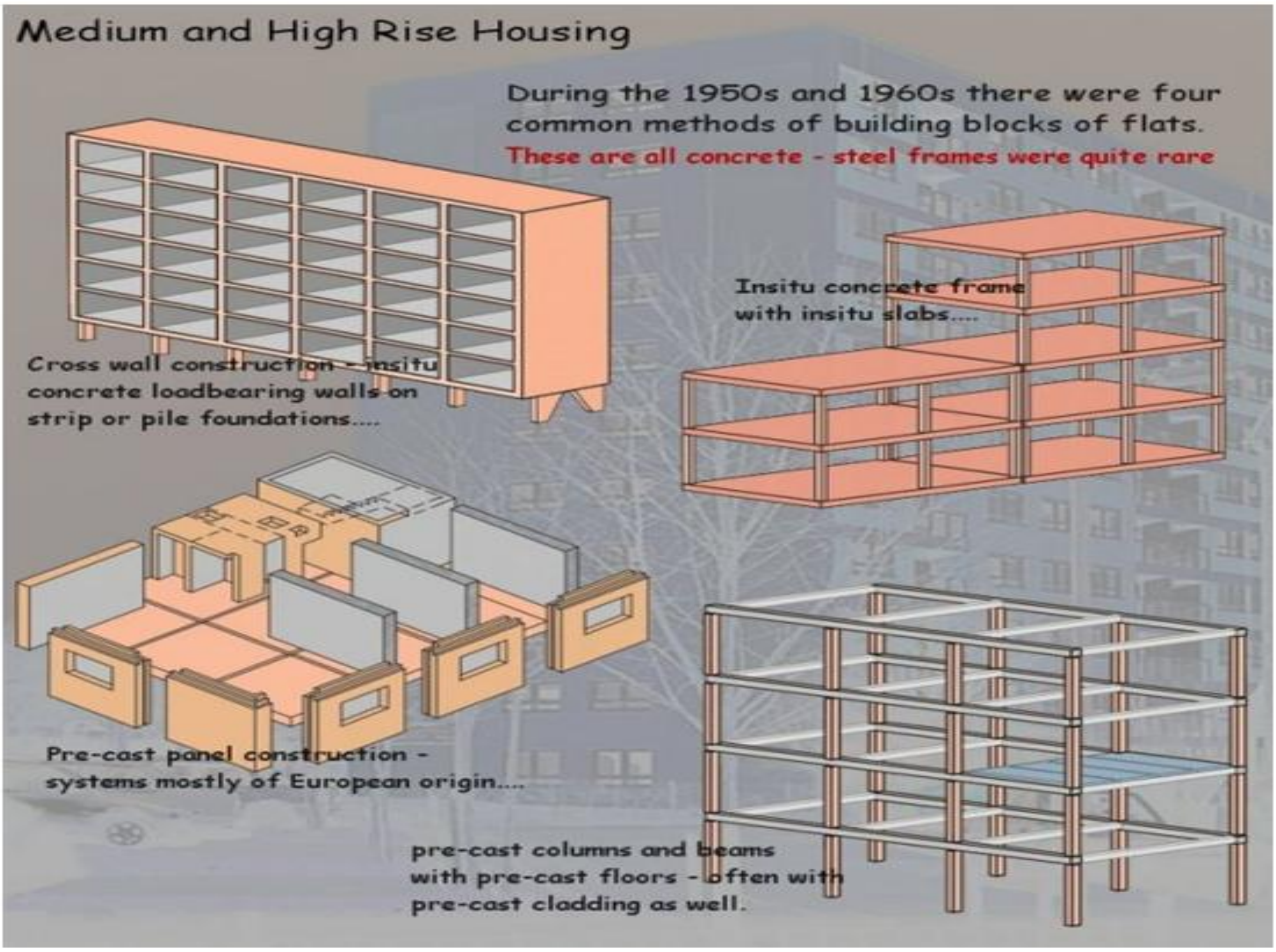
وحدات كبيرة الحجم (Large Size Units) :

هي وحدات مستوية من الحوائط والأسقف يمكنها أن تكون فيما بينها الفراغ الكامل للغرفة الواحدة، أي أن الوحدة الواحدة يمكنها تشكيل حائط لفراغ غرفة 4م * 4م .

<u>ميزاته :</u> عدد قليل للوصلات، سرعة تجميع الوحدات وبالتالي تقليل زمن التنفيذ .

<u>عيوبه :</u> يحتاج إلى معدات ثقيلة في الموقع لتتناسب مع أحجامه وأوزانه .

شكل (9) يوضح وحدات كبيره الحجم



شكل (10) يوضح وحدات كبيره الحجم

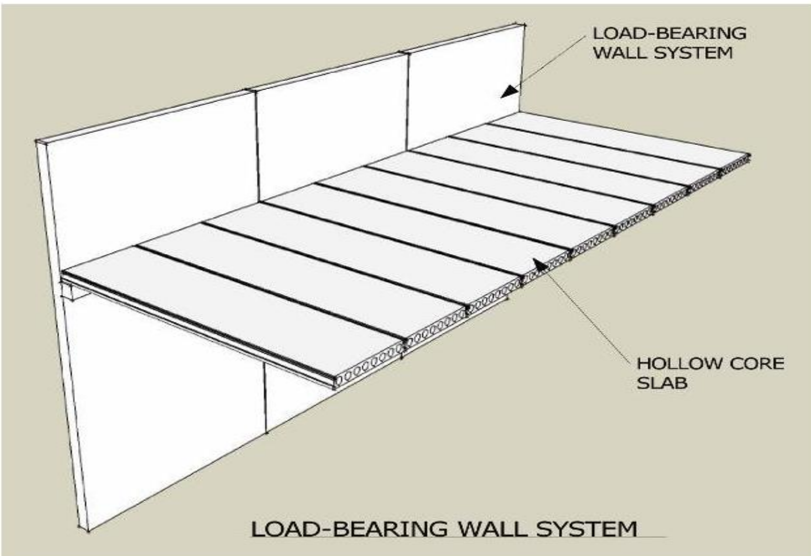
شكل (11) يوضح وحدات كبيره الحجم

وهناك ثلاث أنواع من الوحدات من الناحية الإنشائية :

1- وحدات حوائط حاملة (إنشائية) Load Bearing Walls

وهي وحدات سابقة التجهيز، والتي تكون وظيفتها الأساسية وظيفة إنشائية ، وتشبه الحوائط الحاملة في المباني التقليدية، أي إنها تقوم بنقل الأحمال الواقعة عليها بالإضافة إلى وزنها الأصلي، وهذا يدعو إلى الإختلاف في تصميمها طبقاً للأحمال التي سوف يقوم الحائط بنقلها .

شكل (12) يوضح وحدات حوائط حاملة إنشائية



شكل (13) يوضح وحدات حوائط حاملة إنشائية

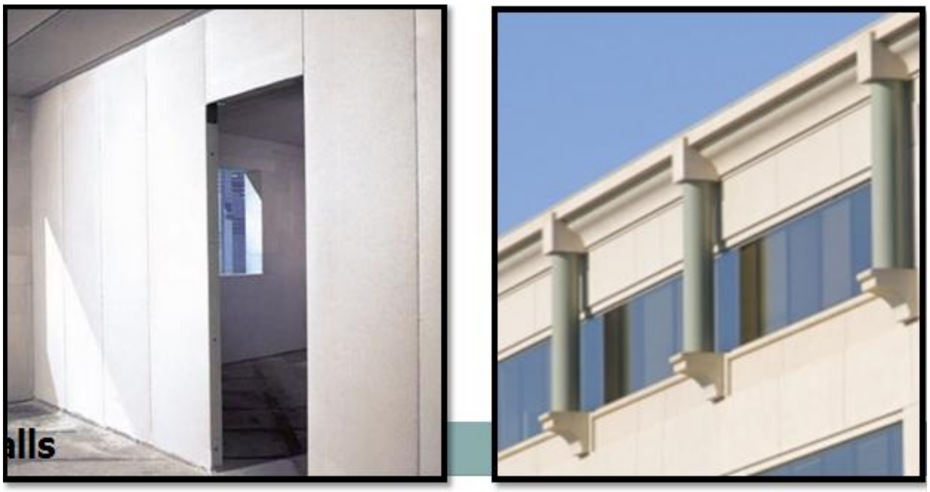
2- وحدات حوائط غير حاملة (غير إنشائية) Non Load Bearing Wall

(Panel & Partition Wall)

هي وحدات الغرض منها غير إنشائي، ويقتصر دورها في المبنى إما على فصل الفراغات المختلفة داخل المبنى، أو لتكوين حوائط خارجية حيث يمكن تصميمها بطريقة تمنع انتقال الحرارة والصوت (Insulation Walls) .

وما دامت تلك الوحدات غير إنشائية فيمكن تصنيعها من مواد خفيفة الوزن مثل البلاستك ، الخشب ، الالومنيوم أو الجبس أو الخرسانة الخفيفة .

مميزاتها : إمكانية تصميمها بمقاسات موحدة بحيث تتحمل أوزانها فقط إضافة إلى القوى التى تتعرض لها أثناء النقل والرفع والتركيب .



شكل (14) يوضح وحدات حوائط غير حاملة غير إنشائية

3- وحدات الاسقف Slab Units:

تقوم هذه الوحدات بوظيفه تغطية الفراغات المختلفة المتكونة بالحوائط السابقة . إضافة إلى أنها أيضا تستخدم كأرضية للأدوار التى تعلوها ، مما يتطلب تصميمها بطريقة تسمح بأداء تلك الوظائف ، وتتحمل القوى التى تتعرض لها .

وتختلف إشكال وسماكات وحدات الأسقف طبقا للمسطح المراد تغطيته والوظيفة المطلوبة ، حيث توجد وحدات مصمتة ذات كمرات ساقطة على شكل حرف (T) ووحدات مفرغة .

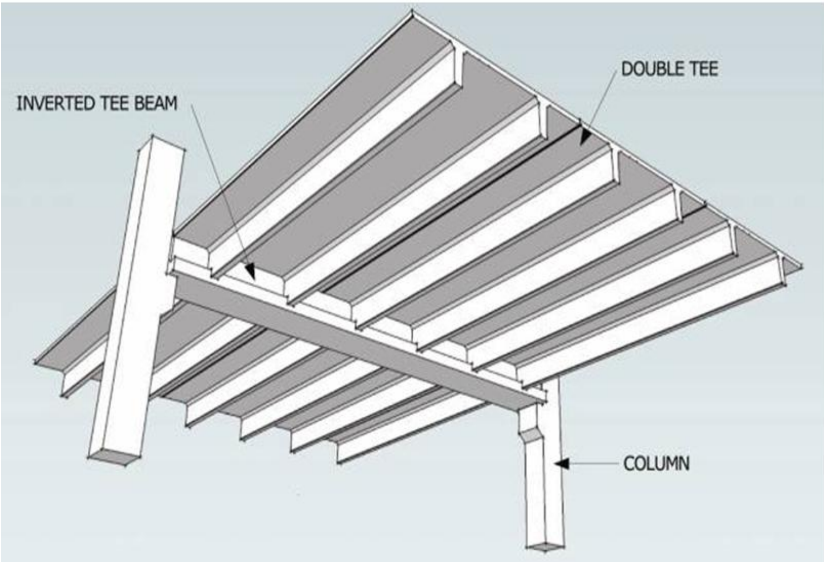
طرق توزيع الحوائط الإنشائية الحاملة :

أ- نظام الحوائط العرضية (العمودية على الواجهة) Cross wall System

ب- نظام الحوائط الطولية (موازي للواجهة) Long wall System

ت- نظام حوائط طولية وعرضية Tow Way Span System

ث- نظام الحوائط والأعمدة Columns & walls



شكل (15) يوضح column-Beam Floor System

أشكال الوحدات المستوية لبلاطات الاسقف :

ا-وحدات مصمتة :

وهى وحدات تصلح لان تكون بلاطات للاسقف أو وحدات للحوائط وان اختلف التصميم الإنشائى بعض الشىء وهذا الشكل المصمت الشائع الاستخدام ، من أهم عيوبة وزنه الكبير .

شكل (16) يوضح وحدات مستوية مصمتة

شكل (17)يوضح وحدات مستوية مصمتة

ب- وحدات مفرغة (بلاطات مفرغة) : Hollow Core

وهى وحدات تصلح أيضا لان تكون بلاطات للاسقف أو وحدات للحوائط ومن مميزات هذا التصميم للبلاطات :

1- تخفيف وزن بلاطة السقف
2- العزل الحرارى الجيد وذلك لوجود الهواء بالداخل
3- العزل الصوتى خاصة إذا كانت تستخدم للأسقف بين الآدوار.

شكل (18)يوضح وحدات مفرغة (بلاطات مفرغة)

شكل (19)يوضح وحدات مفرغة (بلاطات مفرغة)

ج-وحدات صندوقية : Box Units

وهى وحدات غالبا ما تستخدم فى خالة استخدام الوحدات المستوية ذات الحجم الصغير .

فيتم تشكيل الآسقف بهذه الطريقة لسببين :

1- ليكون السطح الداخلى السفلى نظيفا بدون كمرات ظاهرة للكمرات .
2- تخفيف وزن السقف حيث تقوم جوانب الصندوق بدون الكمرة .

شكل (20) يوضح وحدات صندوقية- Box Units

د-وحدات مزدوجة على شكل حرف T:

وفى هذه الحالة يستخدم سقوط الكمرات لتقليل سمك بلاطة السقف فتتوزع الاحمال على الكمرات الساقطة .

شكل (21) يوضح وحدات مزدوجة على شكل حرف T

مميزات طريقه الوحدات المستويه :

1 – سرعة التنفيذ بالمقارنة بطريقة النظام الهيكلى .

2-يمكن أن تحضر الحوائط منتهية تماما من جميع التشطيبات والتركيبات سواء الكهربائية أو الصحية والقصارة والدهان .

عيوب طريقه الوحدات المستوية :

1-كثرة الوصلات خاصة إذا كانت الوحدات من النوع الصغير والمتوسط

2-الاحتياج إلى عمالة فنية مدربة تقوم بإعمال الوصلات

3-اقل مرونة من النظام الهيكلى (يصعب عمل فتحات جديدة أو إجراء أى تغيير فى المسقط الآفقى)

4-عملية ضبط الحوائط الرأسية تحتاج إلى وقت طويل و مهارة عالية ومعدات خاصة

ثالثا : الوحدات الصندوقية (Box Units-Box System)

الوحدات الصندوقية هى عباره عن وحدات مفرغة ثلاثية الابعاد تحتوى على فراغ بداخلها ، يتم تجهيزها فى المصنع وتتكون من جزء او فراغ أو عدة فراغات ، ثم يتم نقلها إلى الموقع ليتم تجميعها لتنتج الشكل النهائى للفراغ .

شكل (22) يوضح الوحدات الصندوقية

حجم الوحدات الصندوقية :(Size Of Box Units)

تنقسم الوحدات الصندوقية من حيث الحجم إلى عدة مصاسات و هى كالتالى :

ا-الوحدة الصندوقية الصغيرة :(Small Size Units – Ring Units)

و هى عبارة عن شرائح من وحدات على شكل صندوق مغلق الحوائط والأسقف و الأرضيات ، حيث تصب كوحدة واحدة ، ويتم تجميعها بجانب بعضها لتكون الفراغ المطلوب .

شكل (23) يوضح الوحدات الصندوقية الصغيرة

مميزات الحجم الصغير من الوحدات الصندوقية :

1-مرونه كبيرة عالية فى التصميم

2-تعطى مقاسات متعددة وتغطى معظم المقاسات المطلوبة

3-سهولة نقل الوحدات من المصنع إلى الموقع

4-سهولة التشغيل فى الموقع مع استخدام أوناش ذات قوة رفع معقولة

عيوب الحجم الصغير من الوحدات الصندوقية :

1-كثرة الوصلات فى الفراغ الواحد نتيجة للحاجة إلى عدد كبير لتكوين الفراغ

2-تحتاج إلى عمالة فنية مدربة لتجميع الوحدات

3-تحتاج إلى وقت كبير فى عملية الإنشاء

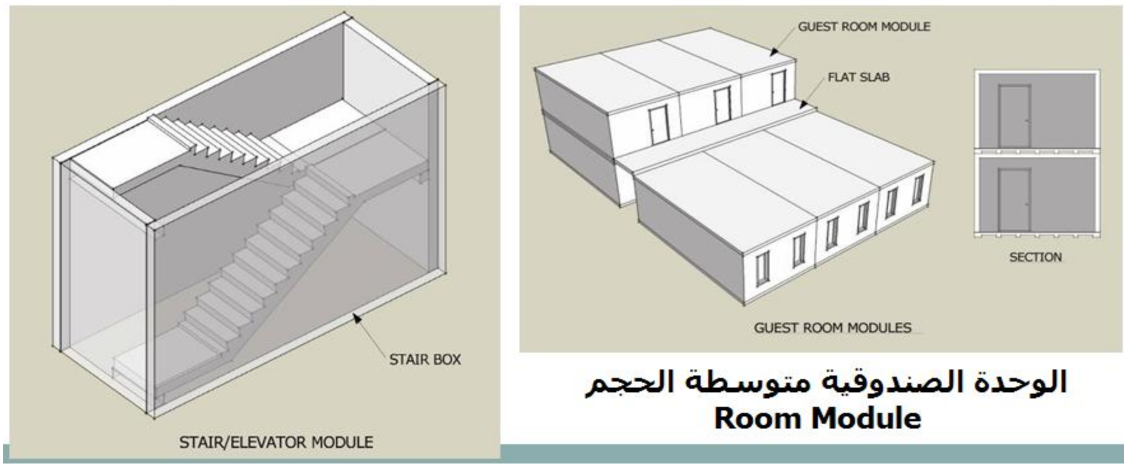
ب-الوحده الصندوقية متوسطة الحجم (حجم الغرفة):(Room Module)

وهى عبارة عن حجم يساوى حجم غرفة النوم حيث يمكن تجميعها بشكل أو بآخر طبقا للتصميم لتكوين الوحدات السكنية .

الوحدة = نصف أو غرفة نوم كاملة

وحدتين = فراغ المعيشة

الوحدة = فراغ للمطبخ أو الحمام أو الفراغين معا .



شكل (24) يوضح الوحده الصندوقية متوسطة الحجم

شكل (25) يوضح Room Module

مميزات الحجم المتوسط من الوحدات الصندوقية :

1-مرونة كبيرة عالية فى تجميع الوحدات .

2-سهولة نقل الوحدات من المصنع إلى الموقع

3-تحتاج إلى وقت أقل فى عملية الإنشاء من الحجم السابق

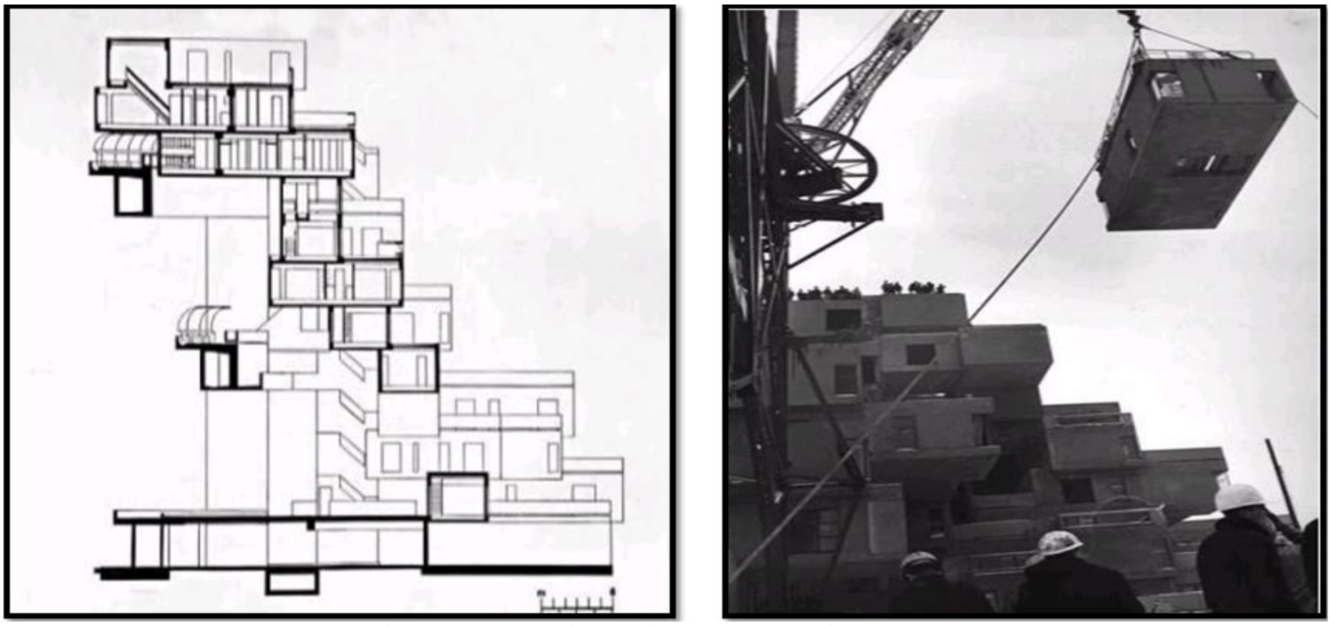
عيوب الحجم المتوسط من الوحدات الصندوقية :

1-وجود الوصلات فى الوحدة السكنية الواحدة

2-يحد هذاالحجم من أبعاد الغرف المختلفة ويصعب استخدام الموديل للفراغات الصغيرة كالحمامات والمطابخ .

ج-الوحده الصندوقية كبيرة الحجم : (Large Box System)

وهى عبارة عن وحدات تحتوى على جزء من مسكن أو وحدات تحتوى على المسكن بأكملة .



شكل (26) يوضح الوحده الصندوقية كبيرة الحجم

شكل (27) يوضح الوحده الصندوقية كبيرة الحجم

شكل (28) يوضح Large Units System

مميزات الحجم الكبير من الوحدات الصندوقية :

1-عدد قليل من الوصلات ، حيث أن الوصلات تتركز بين الوحدات وبعضها .

2-سرعة الإنشاء ، حيث تأتى الوحدة السكنية على أجزاء كبيرة أو كوحدة واحدة أيضا كاملة التشطيب والتجهيز

عيوب الحجم الكبير من الوحدات الصندوقية :

1-صعوبة النقل لكبر الحجم الفراغى للوحدة

2-تحتاج إلى معدات و أوناش كبيرة الحجم لزيادة وزن الوحدة

3-وحددات غير مرنة عند عملية الجمع من الخارج ، حيث تقتصر المرونة على الوحدة من الداخل فقط باستخدام القواطع الخفيفة لفصل الفراغات .

الأنواع الإنشائية للوحدات الصندوقية : (Structural Types Of Box Syste)

وتنقسم إلى نوعين وهما :

ا-الوحدة الصندوقية الغير إنشائية : (Dependent Box)

أى أن الموديول الصندوقى لا يحمل إلا نفسة – أى أنه محمول على إنشاء مستقل تكون مهمتة نقل الأحمال إلى الأساس .

وهناك عدة طرق لهذا النوع من التصميم وهى :

ا-طريقه التعليق :Suspendent Box

- التعليق المباشر (الملاصقة) .
- باستخدام كابلات أو أحبال من الحديد للتعليق .
- التثبيت فى الإنشاء المساعد .

ب-طريقة انزلاق الصندوق داخل الإنشاء : Plug-in Box

وهذا النظام يتكون من إنشاء هيكلى مصنوع من الحديد أو الخرسانة طبقا للتصميم الموضوع ، وبعد الإنتهاء من إقامته ترفع الوحدات الصندوقية بالروافع والاوناش الخاصة ويتم وضعها داخل الإنشاء بطريقة الانزلاق إلى الداخل .

Plug-in Box System

شكل (30) يوضح Plug-in Box

Plug-in Box System

شكل (31) يوضح Plug-in Box

مميزات نظام الوحدات الصندوقية الغير إنشائية :

- الارتفاع بالمبنى إلى عدد كبير من الأدوار
- إمكلنية التوحيد القياسى عن طريق أنتاج وحدة قياسية موديولية يمكن تكرارها
- نقل كل موديول لحملة الخاص فقط فى الإنشاء المساعد
- إمكانية الإحلال والتبادل بين الوحدات دون التأثير على الشكل العام للمبنى

عيوب نظام الوحدات الصندوقية غير إنشائية :

- تكلفة كبيرة بسبب وجود نوعين من الإنشاء فى المبنى الواحد

2-الوحدات الصندوقية الانشائية المستقلة : Independent Box(Monolithic Unit)

وفى هذا النوع تتحول الوحدة الصندوقية إلى عنصر إنشائى ، أى أنها تنقل بالإضافة إلى وزنها وزن جميع الوحدات التى فوقها . (مثل الحوائط الحاملة).

وهناك أربع طرق لتجميع ورص الوحدات وهى :

- الرص المنتظم Stack on Regularly
- الطريقه التبادلية Stack on Alternately
- الطريقة الكابولية Stack on Cantilever
- الطريقة المركبة فى التجميع Stack on Mixed

مميزات نظام الوحدات الصندوقية الإنشائية :

- وضع الوحدات فوق بعضها مباشرة دون الحاجة إلى إنشاء مساعد
- إمكانية عمل تغييرات فى الواجهة والقطاع

عيوب نظام الوحدات الصندوقية الإنشائية :

- محدودية ارتفاع المبنى بسبب زيادة الأحمال
- صعوبة عملية الإحلال والتبديل الموديولى ، وذلك بسبب استحالةنقل لوحدات من وإلى المبنى لأنها وحدات حاملة إنشائيا .

الوصلات : Joints

الوصلة هى سطح الالتقاء أو الاتصال بين وحدتين منفصلتين أو متشابهتين فى المادة المصنوعة منها الوحدات ، وتعتبر نهاية وحدة وبداية أخرى ، وحيث أن الوصلة هى منطقة لالتقاء بين أجزاء المبنى فيجب أن تعالج بشكل سليم .

وترجع أهمية الوصلات فى نظام الوحدات المستوية إلى أنها ضرورية لتجميع أجزاء الوحدات ، من حيث أن الفكرة الأساسية للمبانى سابقة التصنيع هى تجزئة المبنى إلى وحدات صغيرة .

وتزداد أهمية الوصلات فى الوحدات المستوية الصغيرة والمتوسطة الحجم حيث تلعب دورا هاما فى مقابل جميع القوى التى يتعرض لها المبنى ، لذا لابد من الاهتمام بها لضمان عمل جميع الوحدات مع بعضها البعض كوحدة واحدة .

وتنقسم الوصلات إلى نوعين :

الوصلات المؤقتة :

وهى وصلات تستخدم بصغة مؤقتة لصلب وحدات الحوائط ، أو تثبيت الأسقف إلى أن يتم عمل الوصلات النهائية الدائمة ، وتكون أهميتها بالغة عند ضبط راسية وربط بلاطات الأسقف.

وصلات الحوائط المؤقتة : عبارة عن ركائز وصليات حديدية (شداد / شكال معدنى) ويجب أن يكون قوية بحيث لا تسمح للحائط بالتحرك إلى ان توضع الأسقف عليها ، ثم توضع بعد العمل الوصلات الدائمة بين الحوائط و الأسقف.


شكل (33) يوضح الوصلات المؤقتة

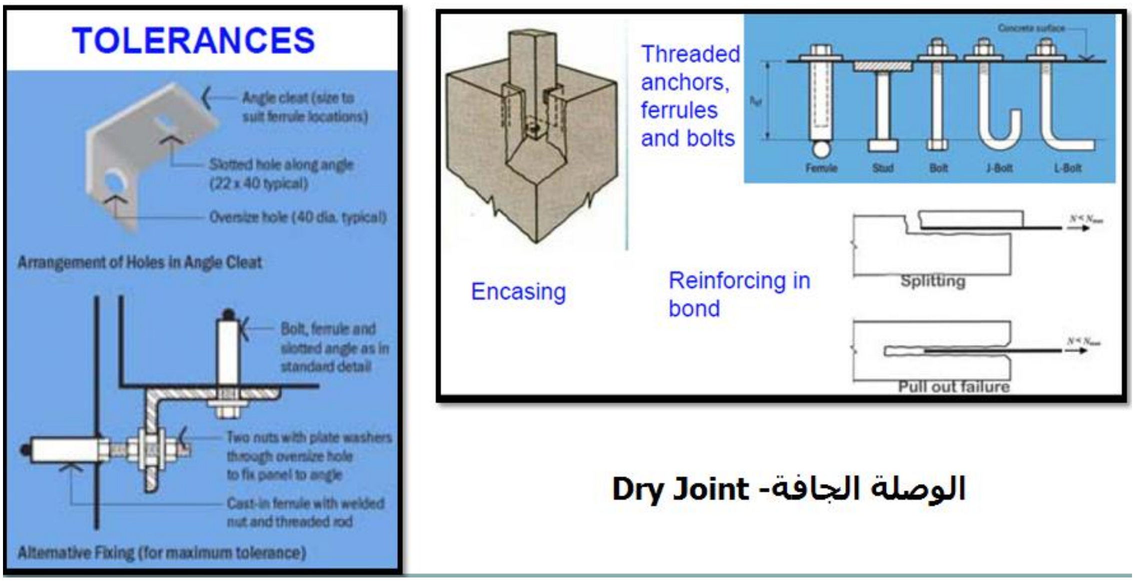
شكل (34) يوضح الوصلات المؤقتة

الوصلات الدائمة :

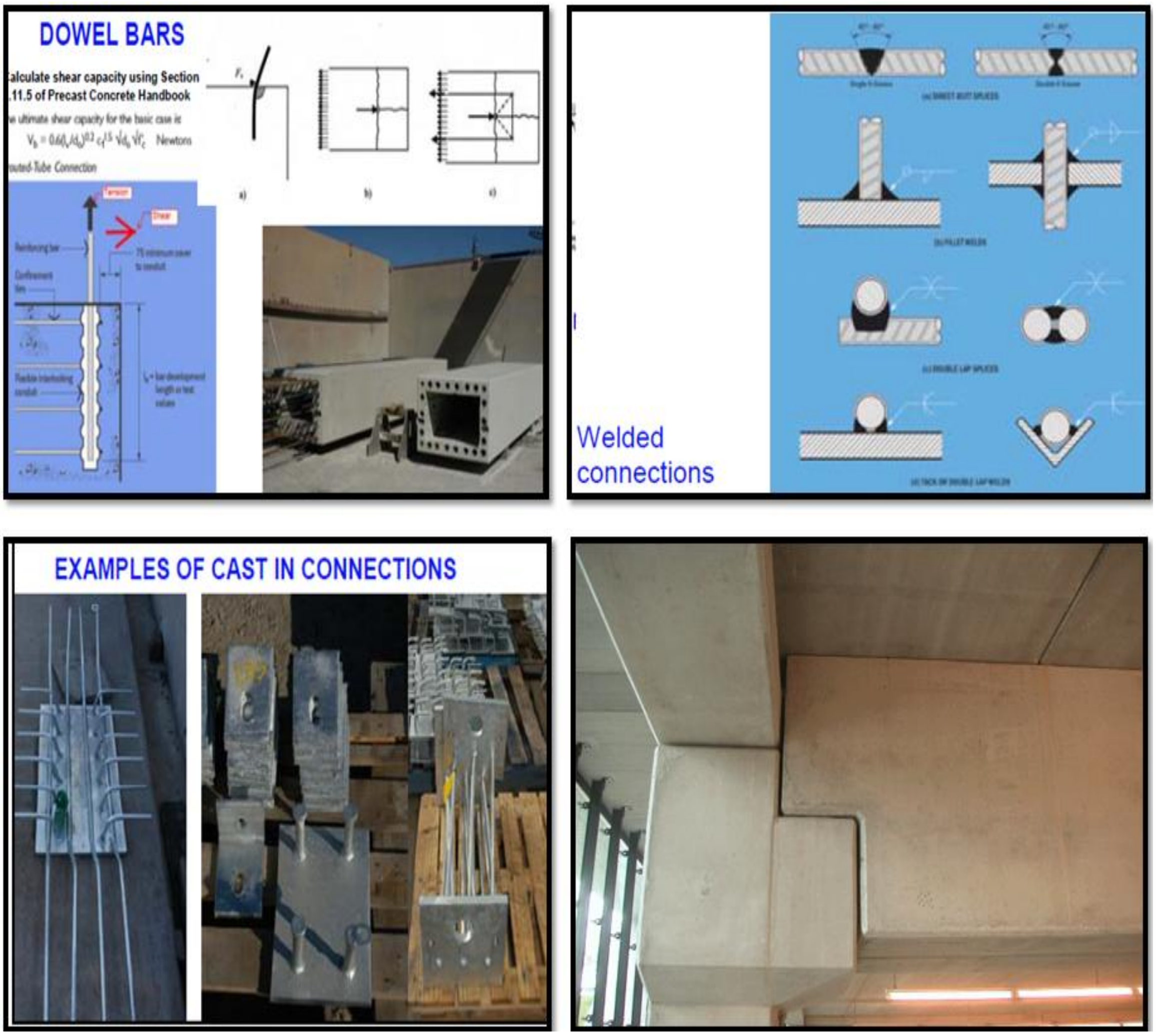
تختلف أنواع الوصلات الدائمة طبقا للتصميم ولأنواع القوى التى تؤثر على عمل هذه الوصلات

وهناك طريقتان أساسيتان لعمل الوصلات :

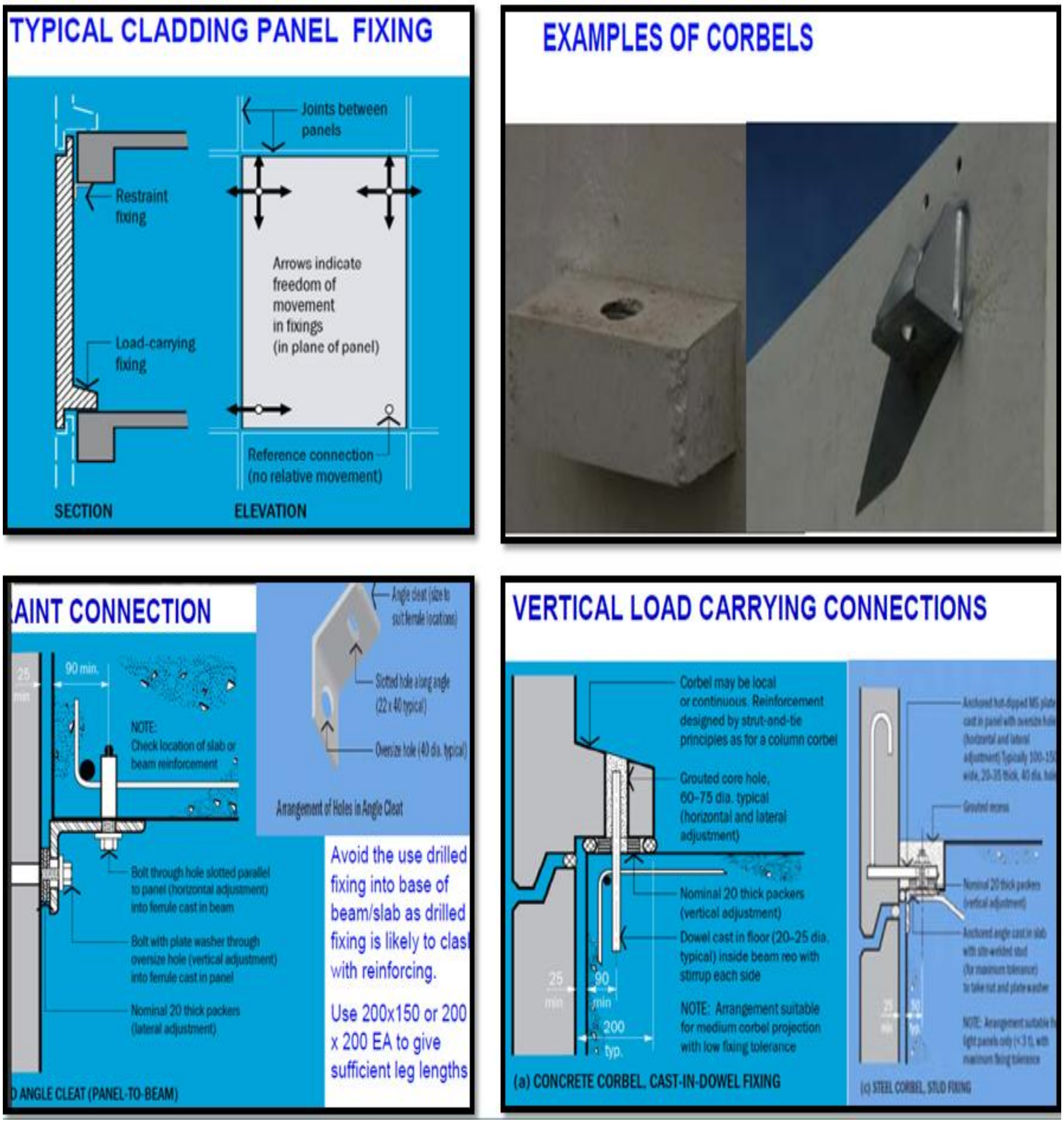
1-الوصلات الجافة Dry Joint



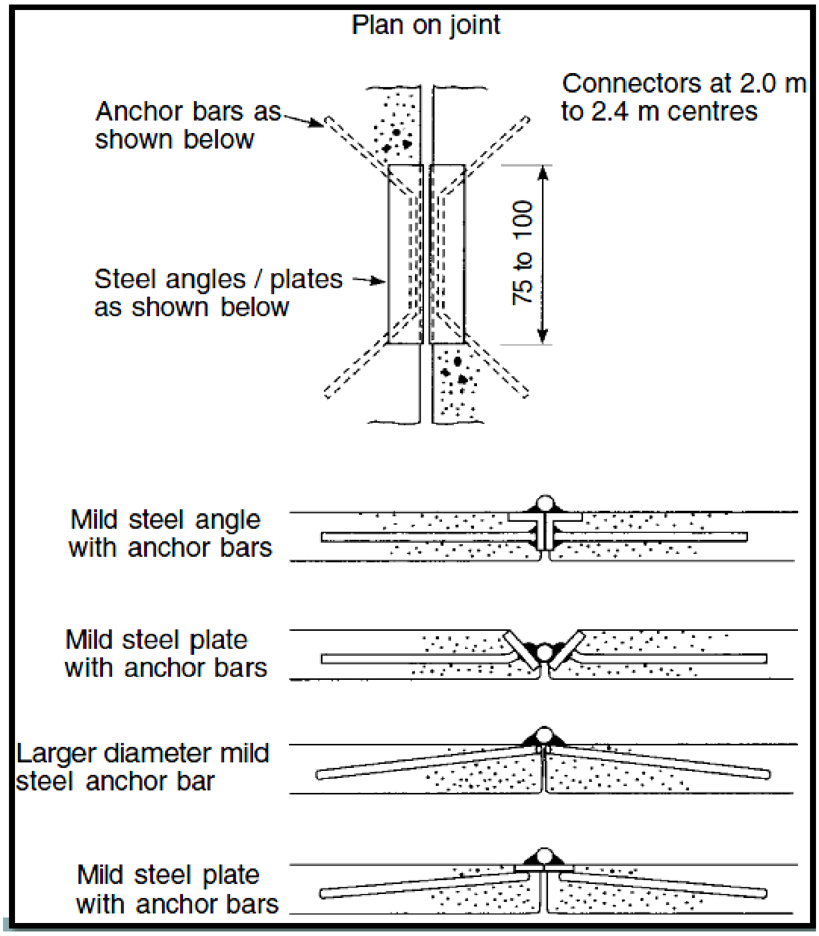
شكل (35) يوضح الوصله الجافة



شكل (36) يوضح الوصله الجافة

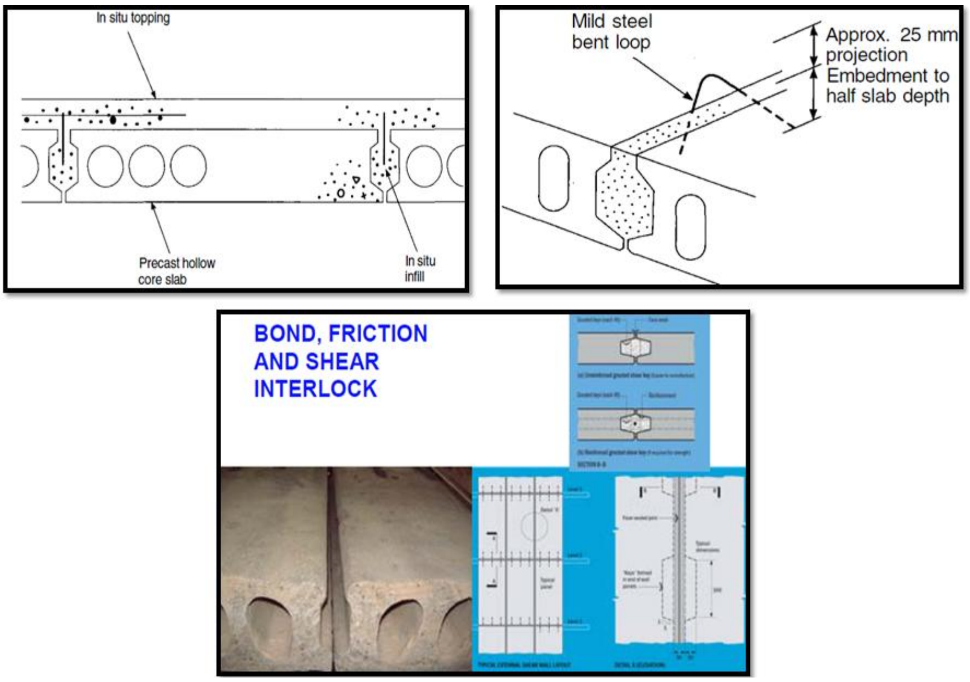


شكل (37) يوضح الوصله الجافة

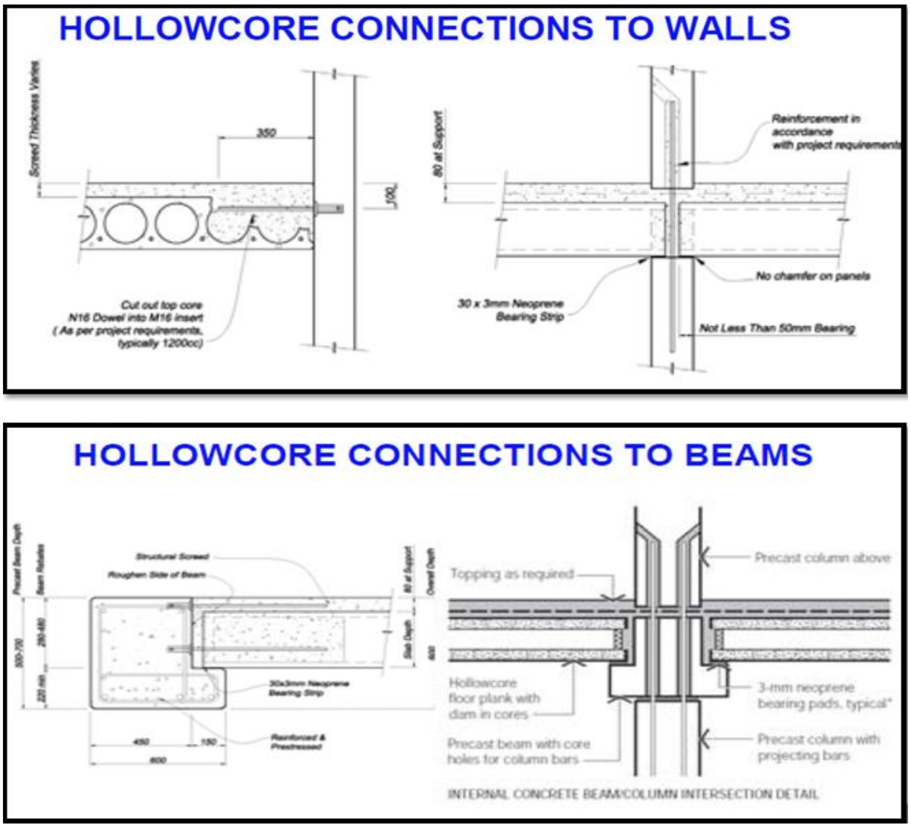


شكل (38) يوضح الوصله الجافة

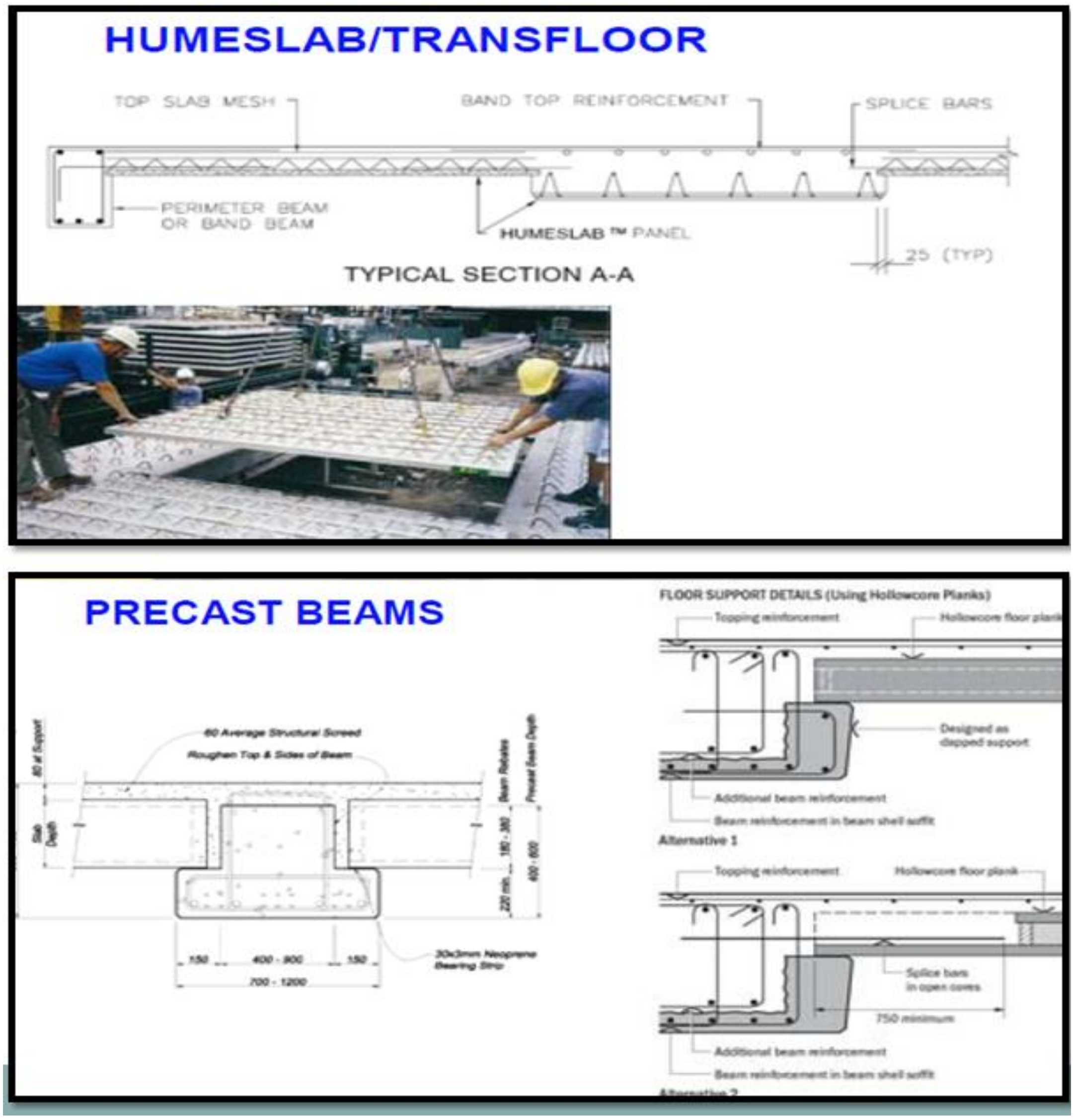
2-الوصلات الرطبة Wet Joint



شكل (39) يوضح الوصله الرطبة



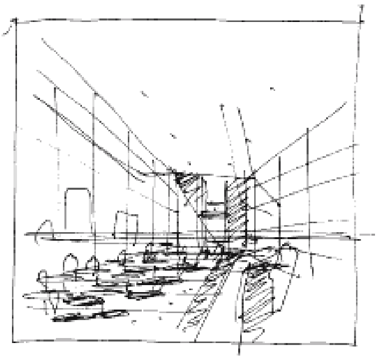
شكل (40) يوضح الوصله الرطبة



شكل (41) يوضح الوصله الرطبة

الأمثلـــــــــــــــــــة

- **المثال الأول (مبنى SID BUILDING, ARHUS):**



Sketch

الموقع :

يمكنك أن تجد المبنى بالسيارة, خذ الطريق السريع E45 لآرهوس ثم اتجه يساراً لطريق آبي الدائري رقم 2. توجد بناية SID على طول الطريق بين تقاطع الطريقين سيلكيبورجفيج وفيبورجفيج. هناك الكثير من مساحات انتظار السيارات المجاورة للمبنى وهناك الكثير من الأتوبيسات من مركز المدينة حتى موقع المبنى.

الانطباع الأول :

تم اتباع في المبنى SID نهج جديد اتصميم المكتب الرئيسي . بينما هيكل العديد من المباني اليوم كثيرا ما تختفي وراء غمد التكنولوجيا , ألواح من الزجاج الرقيق والكسوة, ويستمد مبنى SID تطوره من وضوحه للغاية " بيت من ورق " الذي يتضح في هيكل الواجهه, جميع طوابقه عاليه, نماذج الخرسانة السوداء ذات عرض مختلف مكدسة فوق بعضها البعض في مجموعة متنوعة الأنماط, بالتناوب مع الشبابيك في إطارات ألومنيوم والتي هي ايضا بارتفاع جميع الطوابق . ومن الواضح أنه في لعبة مع الجاذبية, إن الانطباع العام واحد من البساطة والوحي بينما وفي الوقت نفسه يعطي التنوع للواجهة مظهر مثير للاهتمام. الوحدة النمطية المربعة الساقطة من الطابق الأوسط مثلت المدخل الرئيسي, موازية للمركز. وحدات المنزل المربعة تكون قاعة المؤتمرات الرئيسية والمقصف . يبث شعار SID الكبير في الجزء الأمامي من مربع البث صورة قوية نحو طريق آبي الدائري.

Architectural Statement

The building is arranged around a transverse zone, dividing the property into three main areas. In the centre are the foyer and the central atrium with the main staircase and elevator. The central area also contains the main conference room with several classrooms and smaller conference rooms on the upper floors. The participating branches of the organization are sited at each end of the building, on either side of the atrium. The atrium is flanked by two core units, painted in red. The core units contain toilets, kitchenettes, copying facilities and cloakrooms.

The scheme went through a major revision when finalising the overall height. The building, housing several trade unions, was to have four floors and that is how the building was scaled and proportioned. But at a later stage the building owner reduced it to three floors as some of the unions were not able to move in on time. It looked squat and out of proportion when it was built but a year later the additional floor was put on.

Grey-black pigmented panels

Discussion

Jrgen Sndermark

We were very concerned with the style of the building. Should it be glass curtain walling, powder coated aluminium cladding or a more integrated structural approach and one that related to the surrounding landscape and responded to the adjacent building that was being designed. Our choice was concrete because it was an organic material derived from reconstituted rock, it can be cast easily and moulded into curved and angles shapes. Moreover concrete was the most economic choice.

We decided on a black facade to match the colour of the black metal-clad fascia of the adjacent building which was on the same plot. Our client owned both buildings and also built them. They are NCC the biggest construction company in Denmark. What we did not want to construct was a building on the same lines as our neighbor which emphasised the horizontal. Ours would accentuate the vertical.

The concept of sandwich panel construction was explored, and especially how the panels could be dovetailed, one on top of the other, to form a wall of colour with random window openings. Between the walls would span the floors, the roof and the staircase landings to create one precast monolithic composition. In Scandinavia sandwich panel construction is popular for residential buildings, and with our structural engineers we devised a programme that gave us the freedom to place panels more or less where we wanted, without compromising structural integrity. The panels stack together acting as a diaphragm wall with the floors the stabilising restraints. The load path from top to bottom flows around the window openings even if the panels above and below were stacked asymmetrically. This was a concept that we had been developing on other projects but this is the first time it has been tried on such a scale.

The inner load-bearing element of the sandwich panel was cast as grey and given a paint finish.

We planned the storey-high windows openings based on four window frame sizes and then spread them in a random arrangement along each floor and over the entire elevation. We saved a lot of money on the facade because the openings where not priced. The savings we made we spent enhancing the window

Sketch elevation

Storey-high panels and window openings

design so that you could not tell the difference in frame thickness from those that opened and those that were fixed. This was quite an innovation. The only outwards feature on the flat elevation is the cantilevered seminar room hanging over the main entrance. It doubles as a canteen for staff and employees and is framed in steel and clad in aluminium.

The building is 12m wide with a central corridor and offices on both sides, some are open plan some are cellular. As you enter the building and walk into the lobby you are in a lofty light-filled atrium, with white-washed walls and a colourful staircase rising up to the third floor. The free-standing wall, four floors tall is penetrated with random window opening creating a giant collage of the sun, moon and sky and the changing light that floats by. This free-standing wall appears very slender and fragile. The wall panels are braced horizontally and tied to one another by steel channels and steel plates cast in the top and bottom of the units. These connections have been neatly hidden from view.

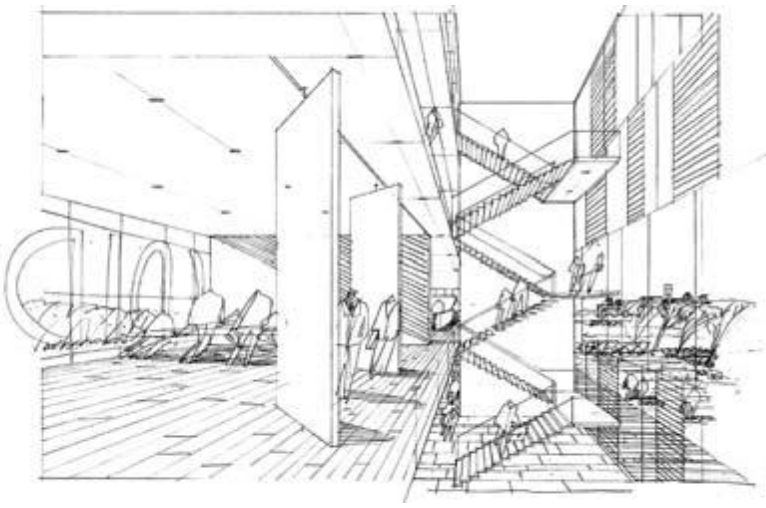
One of the interesting phenomena that occur with these black pigmented panels is that they will fade with time in a random way. The precast manufacturer advised us about it and we also knew this from other panels we had designed with pigmented concrete. It was intriguing that the fade would not be the same between panels although they may start off with the same colour. So as the building ages the surface subtly changes tone year by year. It is a unique character of pigmented concrete. We specified a charcoal grey, almost a black but as you can see four years on, some are still charcoal, others have faded so much that they are mid-grey. The south-east elevation which receives the highest amount of sunlight has faded more that the others. The concrete is perfectly weather-tight and sound.

We prefer to work with natural organic materials like copper, zinc, lead and wood and concrete of course because as they weather they metamorphose in colour. We do not want buildings that have a cosmetic surface that is artificial and superficially decorative with no depth of architectural integrity. They are like the glaze on a ceramic dinner plate which is clean when washed, dirty when covered in food and over time gets chipped and cracked and has to be discarded.

The aluminium window frame and the glazing panel will remain the same in colour and appearance with time. They act as counterpoints to the transforming concrete colour. The surface will also read quite differently from close quarters and such a quality is very desirable in our architecture. As you get closer you notice the same thin outline of the aluminium window frames, the lack of any visible window latches for those that open and the protrusion of the window from the building line to ensure that rain drips off the glass without soaking the concrete below it.

Office interior

Internally a black metal staircase with a wooden handrail, a red painted lift wall and white-washed perimeter walls fill the atrium and main entrance space.
The lobby floor is covered in limestone flags. The colours and the internal finishes were finalised after close consultation with the building tenants who are all members of various welfare unions in Denmark. The unions historically identify with red as their corporate colour but did not want a garish, aggressive tint; they preferred a softer tone that conveyed calm and assurance.
The suspended office floors are precast hollow core planks spanning from the perimeter wall to internal precast walls. The planks are screeded over with sand and cement, and the surface covered with a vinyl floor. There are secondary staircases which are the fire escapes, at each end of the building. They are precast with the treads having a terrazzo finish.
On the rear elevation a terrace of white concrete steps that lead down to a narrow but long stretch of grass on which sits an odd piece of dislocated precast concrete with steps, a handrail and a landing going nowhere. Is it a speaker's dais, a platform to practice rallying speeches or a precast sample that was left behind?
No one is quite sure but its intent is quite deliberate.



Concept sketch of atrium

Precast Construction

Neils Worm, Dalton Precast, Arhus

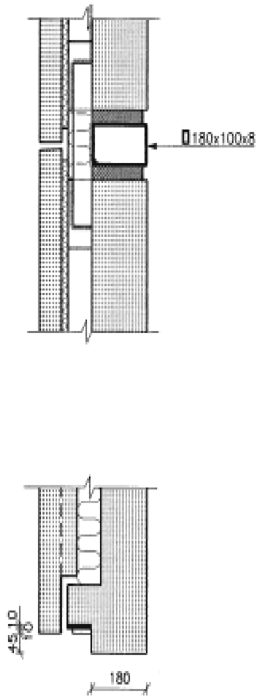
The facade panels are all load-bearing sandwich panel construction with black pigmented facing units 80mm thick, 100mm of insulation then an internal 130mm load-bearing element. The black pigmented concrete is made using white cement, white sand and black pigments and not a grey cement which would seem the obvious choice. It is easier to control the colour using white cement because it is always the same colour whereas grey cement does vary in tint over a period of time. We buy quite a lot of white sand for our factory and used one stockpile of the sand for this project to ensure that is was also a consistent colour. We added

5% pigment as a percentage of the total sand and cement content and used black coarse aggregates. Tests have shown that if you increase the pigment dosage above 6% there is no increase in colour saturation. The weigh-batching of materials has to be precise as it is the whole focus of colour control in concrete production. The weigh machine is checked and regularly calibrated.

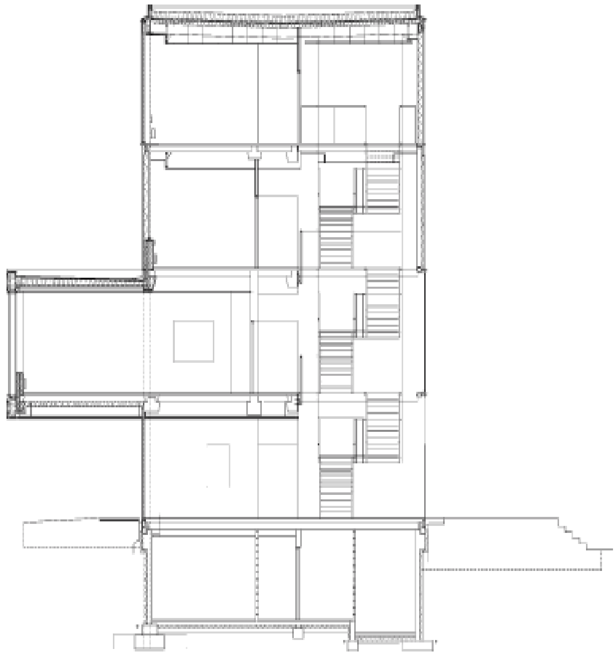
Atrium and staircase

MIX CONSTITUENTS
Black Pigmented Concrete
White cement (360kg/m^3)
White sand (615kg/m^3)
Wallhanin granite 4-8mm (215kg/m^3)
Wallhanin granite 8-16mm (950kg/m^3)
Water/cement-ratio 0.40
Black pigment 5% (18kg/m^3)

Terrazzo Staircase
White cement (532kg/m^3)
Swedish marble 5-8mm (1,662kg/m^3)
Water (242kg/m^3)



Detail: free-standing wall joint



Building section

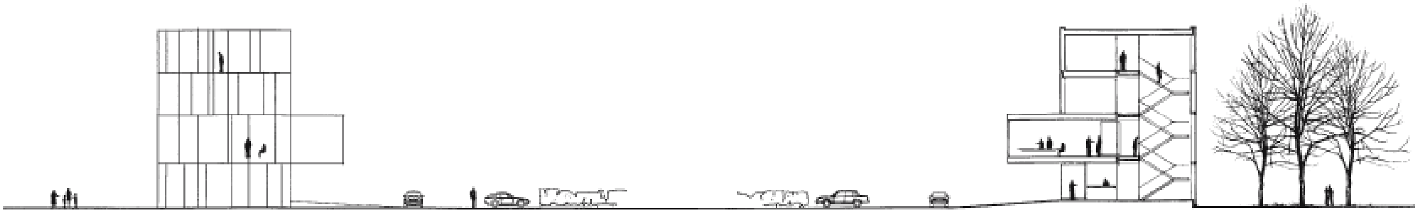
We are very concerned also about the right time to remove the panels from the moulds and to apply the acid wash to the panel. We have found that to reduce the risk of colour difference we must remove the panel from the mould by 6 AM the following day after casting. If we wait until say 11 AM to de-mould the panel the surface colour will be noticeably different and that would be unacceptable to our customers. In addition we acid wash the panels on the day we remove them from the mould and before they are taken outside to cure, in order to reduce the risk of efflorescence.

It is generally understood at least amongst precasters, that after a period of time the panels will harmonise in colour as they carbonate. It may take six months or more. Unfortunately most of our customers will not accept any difference in surface appearance of panel, no matter what assurances we give them. So we strive to keep the casting, the mould removal and acid washing to a strict regime to avoid any surface colour differences. We were blessed with a very enlightened architect on the SID Building. Not only did they understand our problems in manufacture, they actually used the subtle variation of colour tone to enhance the quality of the architecture. They were the exceptions to the rule. Our major problem is precasting black or any pigmented concrete in winter months. We don’t attempt it. During the cold season within two days of leaving the panels in the stockyard they are covered in efflorescence, which is very difficult to remove.

With all our pigmented precast panels we tell our customers that we are unable to guarantee the colour consistency because there are so many factors we cannot control, such as external temperature, rain, sunshine and drying winds which effect surface colour. It is interesting that many more architects now prefer the subtle variations in colour tone of the panels since the SID Building was completed.

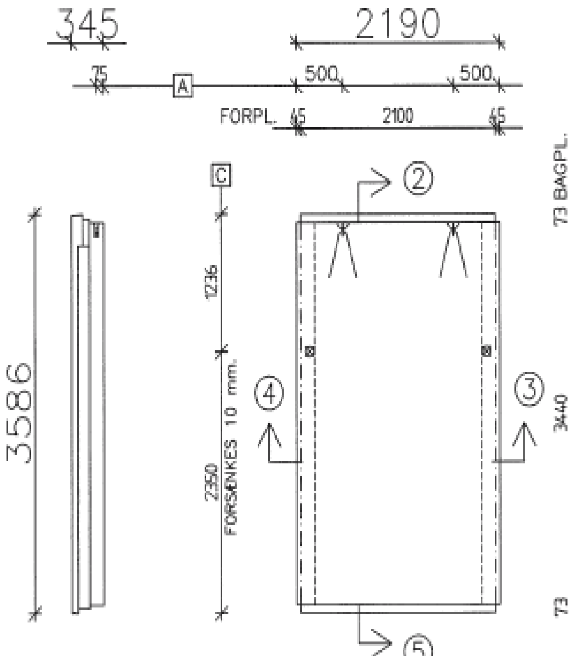
To achieve a very consistent black concrete the only way is to use single sized black aggregates and expose it on the surface. We can do this quite cheaply by retarding the concrete in the mould and then water jetting the surface to remove the cement paste to expose the coarse aggregates. This will give a textured concrete surface and not the smooth face you get with acid washing, but cheap to produce. It is an expensive operation to handle a large sandwich panel and carefully lower the face into the acid bath, then clean the surface with water without soaking the insulation and backing panel with acid or water.
The panels on the SID Building were cast in five sizes: they were all 3.5m high and either 1.2m, 1.5m, 1.8m, 2.2m or 2.7m long. There were special corner units made which formed part of the returns for both elevations to avoid a vertical joint line at the edge. The edge was given a recess using a 10mm by 10mm rebate to emphasise the corner line. In all we supplied 122 units to the projects and later supplied single skin fascia panels when the fourth floor was added on a year later.

Erection of corner panel

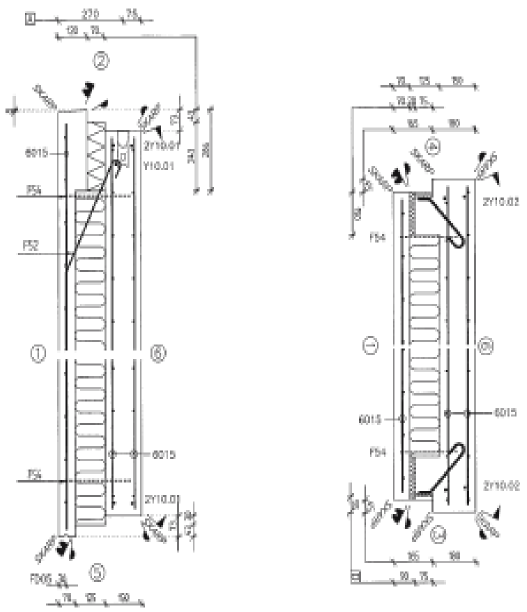


Concept sketches

PROJECT DATA
Client: SID Arhus
Architect: 3XNielsen
Structural Engineer: COWI
Services Engineer: COWI
Contractor: NCC Construction Denmark
Precast Manufacturer: Dalton Ltd
Completion: 2000
Floor Area: 2,600m^2

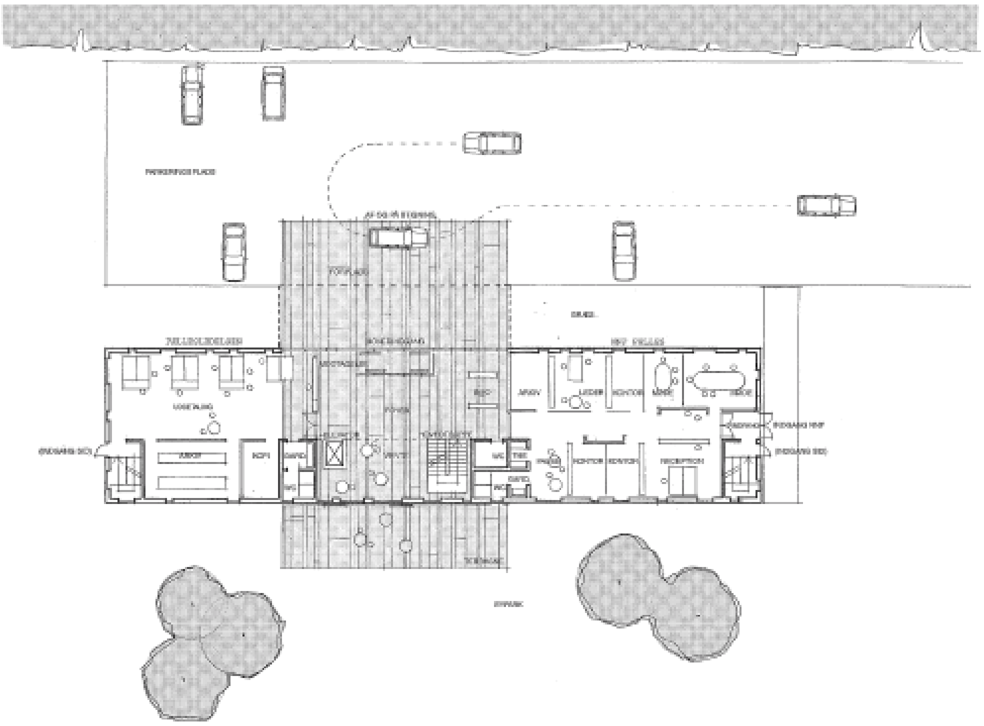


Typical sandwich panel construction



Upper: Interior floor construction
Lower: Rear and end elevation perspective

Front elevation



Site plan

- **The second example (MEXICAN EMBASSY, BERLIN):**
  Teodoro Gonzalez de León and Francisco Serrano

Location

The embassy is located on Klingelhoferstrasse in the heart of Berlin. It is about a 20 minute taxi ride from Tegel Airport and a 40 minute taxi journey from Schonefeld Airport. You can also take Bus Line 100 from Zoologischer Garten Railway Station.

Architectural Statement

The new Embassy of Mexico is located on Klingelhoferstrase in the region of Tiergarten, a green belt space with a famous memorial that marks the historical axis of Berlin. The building occupies a plot of 1,300m2 bordered by Rauchstrase to the north and adjacent to the celebrated curved green frontage of the Scandinavian consulates. Along the street frontage the white facade is dominated by a series of 18m high vertical blade beams that are angled in repose and curvilinear in formation, framed by a vast portal structure. Where the two planes of the blade walls overlap, the minor one tucks behind the major one to form the entrance vestibule. The gaps between the blade beams produce remarkable transparency, yet seen at an angle they create a solid visual barrier, developing a monumental dynamic.

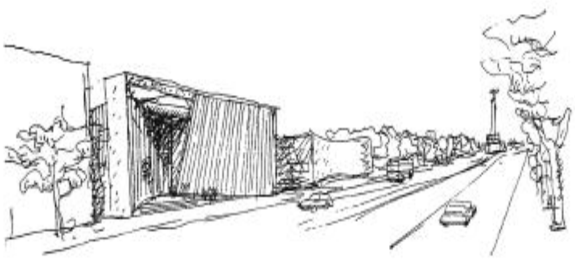
The openness of expression, the symmetry and transparency of the lamina wall, the height and scale of the building symbolise the spirit of Mexican architecture. The entrance vestibule leads into a lightfilled central atrium, a luminous white walled concrete drum 18m high and 14m in diameter which could be described as a vast chiminea with a glass topped roof or a concrete colander with portholes. A cascading planter terrace to one side of the atrium sits below glass link bridges that lead from the glass walled lift to the upper floors via doorways cut into the drum wall. The cylindrical atrium is the vertical axis and hub of the building, a conduit unifying the spaces within the building. The double-storey high reception area adjoining the atrium creates multi-functional spaces for receptions and cultural events. North of the atrium on the ground floor is the information centre, the public consultations rooms and the library. On the first floor there is the consulate department. The upper floors located along the north and front elevation of the building contain the administrative offices and the office of the Ambassador. There is a garden terrace on the roof with good views of the surrounding area. There are no plant rooms or mechanical boxes to obstruct the roof panorama; they are all housed in the basement which has an underground car park. The new building not only services all the consulate needs but accommodates conferences, exhibitions, cinema, theatre, music performances and diplomatic receptions.

The architects Teodoro Gonzalez de Leon and Francisco Serrano won the design competition ahead of eight of Mexico’s finest architects. The building had to represent Mexican values, the realities of a modern evolving society and to integrate itself into the urban environment of the Tiergarten district. Since its opening in November 2000 the building has received thousands of visitors and has been quickly added to the list of fine modern buildings to be seen on architectural tours of Berlin. It has had a positive effect on bilateral relations with Germany and has undoubtedly helped to improve commerce and trade between these two nations.

Architectural Discussion
Heinz-Dieter Witte & Pirkko Helena Petrovic, Assmann Beraten und Planen

In the mid 1990s Gonzalez de Leon then in his seventies and Francisco Serrano in his sixties teamed up to enter the Mexican Embassy design competition. Gonzalez de Leon, who had worked with Le Corbusier in Paris in his formative years, upon his return to Mexico in the 1950s soon established his reputation for the design of large public and residential buildings. Francisco Serrano who had started in his father’s practice was responsible for extending and developing the campus of Mexico University and had built many hotels and office buildings in Mexico over the years.

Design sketch



Entrance

The planning regulations restricted the height of the building to 18m, so that it would conform to the scale of the adjacent Scandinavian Embassy complex.

The site was bounded on two sides by streets. The concept was to create a dynamic facade made out of thin blade elements that curved in two planes; the material was bush-hammered white concrete. The interior space was to be open and vast with a style that was typically Mexican. The focal point is the four-storey high atrium designed as a white-walled cylinder of concrete which is perforated on the southwestern face by portholes of plexi-glass. The portholes and the glass-canopied roof maximise the sunlight into the atrium and the terrace of planters for ferns and evergreens on the ground floor. The atrium connects the lift to all the upper floors and at ground level it leads onto the double-storey high exhibition hall and reception areas that can be interlinked to create a larger function area. Throughout the building the exposed walls and beam surfaces are made of white bushhammered concrete. For this material resembles a natural stone of Mexico, its surface improves light reflection and keeps the building cool in summer.

The vertical blades were precast but the portal frame and the atrium cylinder were cast in situ to exactly the same finish as the precast concrete. The quality of the in situ finish was so remarkable that it was difficult to distinguish from the precast panels. A sample of white bush hammered precast concrete and the mix design details were given to each of the tenderers with the tender documents. As the representative of the Mexican architects we made the planning application and carried out the contract administration duties. As part of our induction we made two trips to Mexico for workshop, design briefings and to visit the architects building to get a feel for what they required. The surface tooling of concrete in Mexico is all done manually by stone masons. To replicate the same effect in Berlin it was the original plan to bring over Mexican stonemasons and have them carry out all the bush hammering but it was not a success. The precast manufacturer chose to employ local labour and use pneumatic impact hammers to create the exposed aggregate finish the architect required.

The series of facade blade beams to the front and side elevation were precast north of Berlin and transported two at a time and erected in place. The front blades were tilted to a prescribed angle and connected at intervals to the edge of floor slabs and tied to an enormous in situ capping beam over the top of the structure. Each blade beam had a unique profile and length although the thickness and width were the same. They were angled differently against the building and located in a gentle curve. The blade beams on the side elevation were of uniform height and were in vertical alignment.

The portholes cast into the in situ drum wall were made of plexi-glass, the inside vacuum was kept moist-free by the inclusion of silica gel crystals. The ceilings were covered with gypsum plaster board, the offices were carpeted with a special fabric, the ground floor was laid with yellow/grey marble and the facades received anti-graffiti coating close to ground level. The services are contained behind a false ceiling, lighting is on the wall and not overhead, floor screed was laid over the under floor heating pipes. The outstanding aspect of the exposed concrete was the edge details of the drum wall panels.

Form top to bottom:
Forming the drum of the atrium
Concrete drum wall and portholes
Bush hammering
Erecting blade beams
Blade beam connections

Precast Construction
Christian Rymarczyk, Geithner Bau

The factory is located in Gros-Ziethen some 70km north-east of Berlin. All the precast elements were made here, including the 18m long blade beams. The concrete mix was based on what the ready mixed supplier produced for casting the in situ drum walls. We had to keep to the recipe to ensure a close colour match with the rest of the building, which was cast in situ.

The white cement was supplied by Dyckerhoff cement, the sand fines and coarse aggregates consist of a crushed white marble from the Lagerfeld quarries.

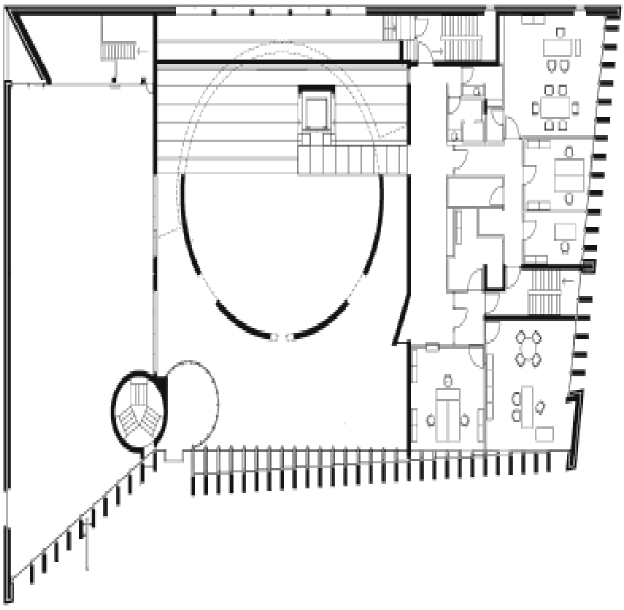
The coarse aggregate size ranged from 8-35mm, the fines from 0-2mm. The distribution of particle sizes throughout the sand and coarse material was kept constant for all the precast work. The cement content and water/cement ratio were fixed for every cubic metre of concrete that was batched, and plasticiser was added to ensure uniformity of flow.

The materials are weigh-batched in one cubic metre lots. The water is controlled to within 1 litre of specification and aggregates to about 10%. Grading curves and sieve analysis are carried out regularly to monitor material quality and wet density and water content tests are conducted on the fresh concrete to check the actual water content in the mix. The precast elements are inspected when they are removed from the moulds, and if there are too many surface imperfections for example due to blow holes, they are discarded. On the Mexican Embassy contract not a single precast beam was rejected. It helps that the surface was bush hammered as this removed a lot of minor surface irregularities.

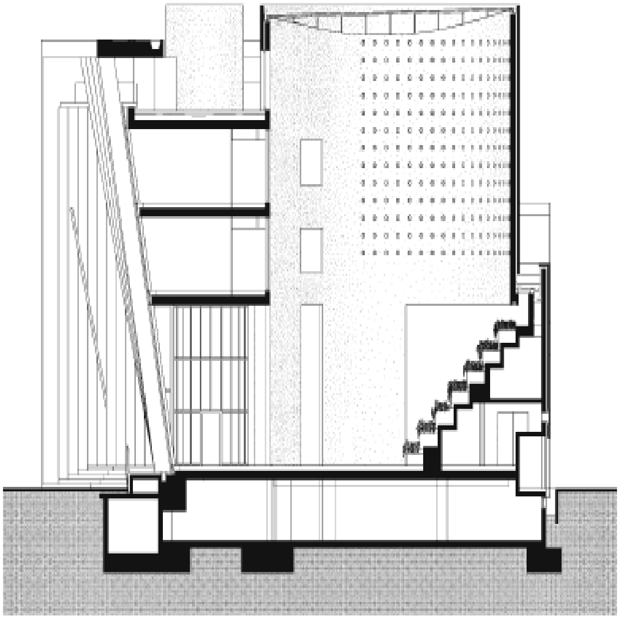
The concrete was mixed in a horizontal turbine mixer in a purpose-built batching plant. Concrete was discharged into a skips that moved on rails to the covered formwork yard. The blade beams were 250mm thick and 900mm wide and were made in wood lined 18m long beam moulds. It required four skip loads to fill each mould which took 30 minutes. Internal poker vibrators and clamp-on external vibrators compacted the concrete. For heights of up to 1.4m conventional concrete mixes are used but for larger panels which are free-standing selfcompacting concrete is specified. Most of our cladding panels are cast on the flat.

Self-compacting concrete is two to three times more expensive. It is not the cost of the specially graded sands and filler that we buy in and have to carefully monitor, it is the amount of testing work that makes it so expensive. For conventional concrete mixes we deploy a technician for 30 minutes per mix per day, on self compacting it is 2 to 3 hours/day/mix. We are currently casting over 2,500 monolithic blocks of black self compacting concrete e for a memorial garden in Berlin dedicated to the holocaust and designed by the architect Eisenman. Each piece weighs between 5 and 10 tonnes and stands up to 5m high.

Portal framed blade beam elevations



Ground floor plan



Section through atrium space

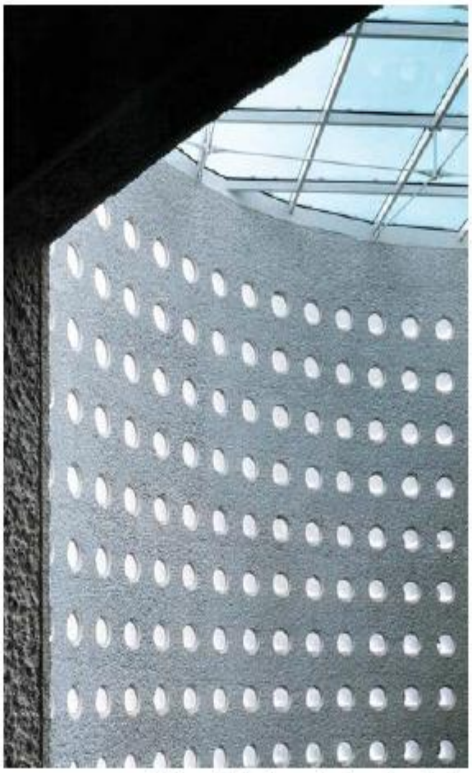
When the beams are removed from the forms they are inspected and taken to the treatment area for bush hammering. The work starts once the concrete is

7 days old. First a shallow saw cut is made a set distance from the edge or corner of the panel to create a margin. Two teams of operatives both start bush hammering from the middle of the beam and work their way to each end. It takes about 15 hours to bush hammer and finish a beam, each operative achieving 5m2/day. We employed 15 men to carry out the bush hammering work in the stockyard.

Two 18m beams are taken to site by lorry and erected into position using two mobile cranes. One crane lifts the beam off the lorry in the horizontal position using nylon ropes, the other picks up the beam from the top end via the protruding reinforcement bars and positions it on the foundation plinth at the correct angle.

It is held in place until the bolts are secured and it is connected to the edge of the floor slab. When the major wall of blade beams were in position the formwork for the long, wide capping beam was assembled, then cast with white in situ concrete and bush hammered on site. The minor blade wall which sits below the capping beam connects to the underside of the concrete roof slab.

Entrance lobby



White walled atrium cylinder and portholes

PROJECT DATA
Client: United States of Mexico
Architect: Teodoro Gonzalez de Leon and Francisco Serrano
Architect’s Representative in Berlin: Assmann Beraten und Planen
Structural Engineer: Assmann Beraten und Planen
Services Engineer: Assmann Beraten und Planen
Main Contractor: Groth Gruppe GmbH
Concrete Subcontractor: Hochtief AG
Precast Manufacturer: Geithner Bau
Completion: 2000
Construction Time: 11 months

Glass canopy over atrium

'Blade wall' elevation on the side street

Main elevation

- **The third example (HOMER ROAD, SOLIHULL):**
  Foggo Associates

Location

The site on Homer Road is an easy walk from Solihull train station which can be reached by trains from Birmingham New Street and London Marylebone. Solihull is served by good motorway links from the south via the M5 and M40, from the east and London via the M1/M6 and from the north via the M6. It is a 20 minute car journey from Birmingham City Airport and The National Exhibition Centre.

Architectural Statement

Homer Road was designed as a speculative office development providing 6,000m2 of usable floor space spread over three storeys. The brief was for a high quality headquarters office building, maximising the openness and flexibility of the internal space and a low energy strategy.

Flexibility of the configuration and layout of the internal accommodation was a major design consideration. The building must be capable of being fitted out for both open plan or cellular space, offering secure and separate zoned areas within a floor using demountable partitions and provide security between floors for different departments or groups of companies.

Architecturally the aim was to create an elegant, transparent pavilion building with the ground floor floating above the natural slope of the site and the car parking. The building is surrounded by mature and semi-mature screen planting to provide a visual break from Homer Road, the road to the south of the site, and a footpath running adjacent to the long north-west elevation that leads to Tudor Grange Park. The main entrance is located on the shorter north-east elevation at the corner of Homer Road and the footpath, and has been opened up to become the focus of the new building and a gateway to the park. The building is arranged on three rectangular floors each one 60m by 37.5m in plan with the building positioned closer to the junction of Homer Road and the footpath next to the site. The frontage reinforces the informal building line of the street. The floors are arranged in two 15m plates separated by cores and an atrium space. The atrium allows daylight into the heart of the building and is animated by glass lifts located at one end. There are two service cores at each end of the building, and they contain the fire escape stairs, toilets and service risers.

As part of the low energy strategy, an exposed concrete soffit was designed for thermal mass damping which also avoids the cost of a false ceiling. As the office space required to be used on a 24 hour basis it was necessary to introduce chilled beam ceilings and a displacement air system to optimise internal comfort conditions and integrate this into the exposed concrete soffit. The internal space exploits the precision and sculptural qualities of precast concrete construction.

The design of the external elements has been carefully developed using naturally finished, high quality materials. The elevations of the building are neutral, the transparency of the glazed elevation reflects the natural parkland setting. The atrium and the restaurant on the ground floor provide informal meeting spaces and are used extensively for group discussions by National Grid Transco who have occupied the building since it was opened

Architectural Discussion
Steve Baker, Architect

The building was initially designed as a speculative development but very soon it became apparent that it was to be occupied by a group within the client organisation. Effectively the fitting out was purpose-built but the base building had to be designed to be flexible and adaptable throughout its useful life. The tenant was involved in the project from day one, so that we had to meet the client's brief as well as tenant requirements. The client was SecondSite Property Holdings Ltd, the property arm of National Grid Transco, the major gas supplier in the UK. They build on their own surplus land and sell the developments, usually to investment companies and pension funds.

Our first impression of the site was not inspiring. The plot, which had previously accommodated three Edwardian villas, is on a road leading into the town centre that was fronted with a hotchpotch of utilitarian, predominantly brick clad, residential buildings, hotels, a magistrates court and a police station with little architectural merit amongst them. Our immediate concern was that the local planning authority may not have been receptive to change or new ideas. Those fears were soon dispelled at our initial meeting with the senior planning officer who was a very enthusiastic supporter of the building and our design strategy from the outset.

Homer Road elevation

South-west long elevation and undercroft

Ramped main entrance

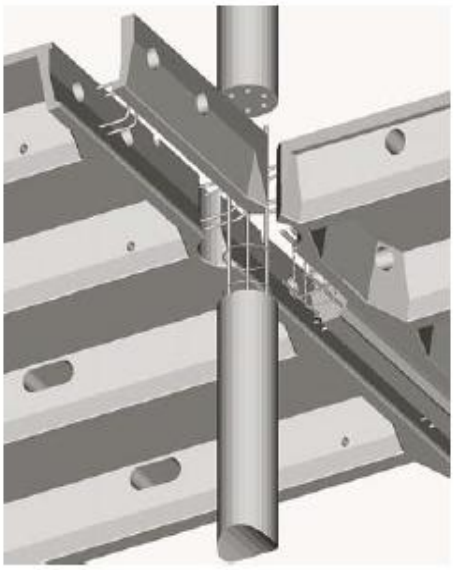
The building layout, the internal organisation and the external elevations were based on a 1.5m module. Having been given the target of 6,000m2 of floor space, we studied a large number of options for floor plates, number of floors, large plan, small plan, low rise and high rise, and finally decided in favour of three floors on a rectangular footprint.

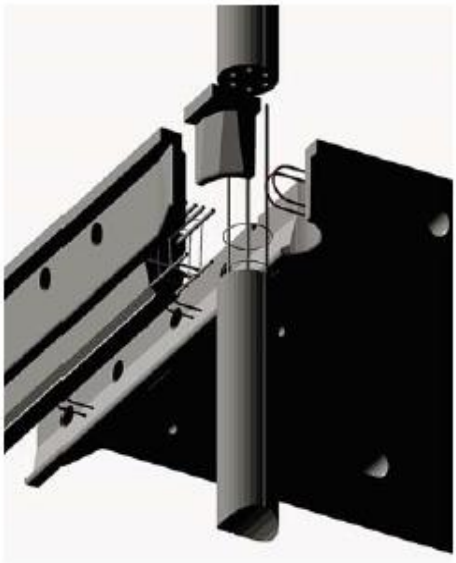
For an effective low energy building, a precast concrete structure with night time ventilation to cool the exposed structure is a logical solution. With a tenant requiring 24 hour occupancy of a building, night time cooling of the structure is no longer viable and mechanical cooling had to be installed. We developed the precast concrete structure to accommodate an integrated multi-service ceiling tile incorporating artificial lighting, acoustic panels, chilled beams and ceilings in lieu of a traditional false ceiling. The refinement of the precast elements, the modelling of the structural shapes and the high degree of repetition of units that was achieved was due to our close working relationship with the precast manufacturer.

The finish of the precast units was a key issue. We would have preferred the concrete to be unpainted but that may have caused a problem with uniformity of colour which can prove difficult during manufacture.

This could lead to a higher number of rejects and further losses against chipped and damaged units, which would be reflected in a higher unit price. The painted solution was ultimately the optimum and most costeffective one because surface colour is not critical and any minor repairs could be masked by the paint – it was also preferred by the client and tenant.

An office building in such a location outside a major city would not normally be capable of sustaining the cost of a high quality glass curtain wall system. We were able to make it fit the budget by keeping the details simple, modular and highly repetitive. There is fritting at high level for solar shading and there are internal blinds that can tilt and turn to control directional sunlight. By not having a false ceiling, running the services within the precast coffers and





passing circulating air through purpose-made holes in the edge beams of the atrium and building perimeter, we increased the daylight entering the building.
The transparent glass maximises the views out of the building and reveals the edge beams and precast columns. We worked very hard to detail the edge beams to express the structure along the perimeter of the building.

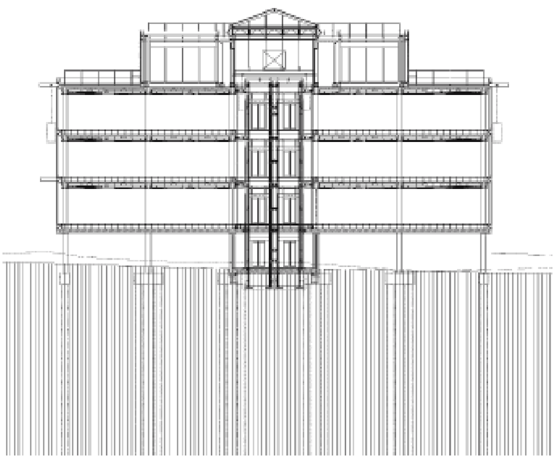
From left to right:
Isometric of atrium corner and floor
Internal and external corner connection

Precast and Structural Considerations
Kimbell Grady, Structural Engineer

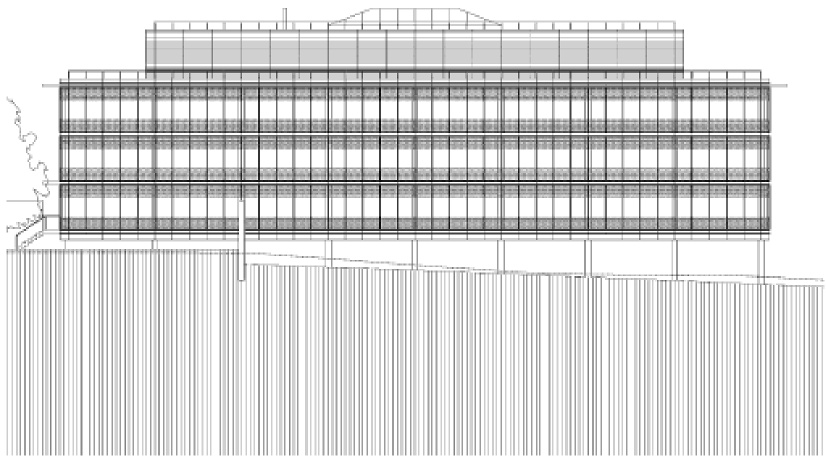
Because of the building's 7.5m column grid, one of our aspirations was to significantly reduce the amount of in situ concrete work that would be exposed, as such spans did not give the best surface finish.

We set out to design the floors so that the entire soffit would be covered with precast elements including the edge and corner conditions around the building perimeter and the atrium. At first this design generated a large number of moulds which would be uneconomic. The modular floor and the repetition of the profiled soffit using double T and single T beams spanning onto a wider-shaped primary beam, were the results of further design development. We refined the rib and beam shapes until we were down to just seven types of moulds. The only in situ concrete visible was a 150m wide strip on the line of the primary beams, between the two halves of the precast beam shells.
The single Ts could be cast in the double T master moulds by blocking off one end; other units could also be adapted by adjusting other master moulds. The

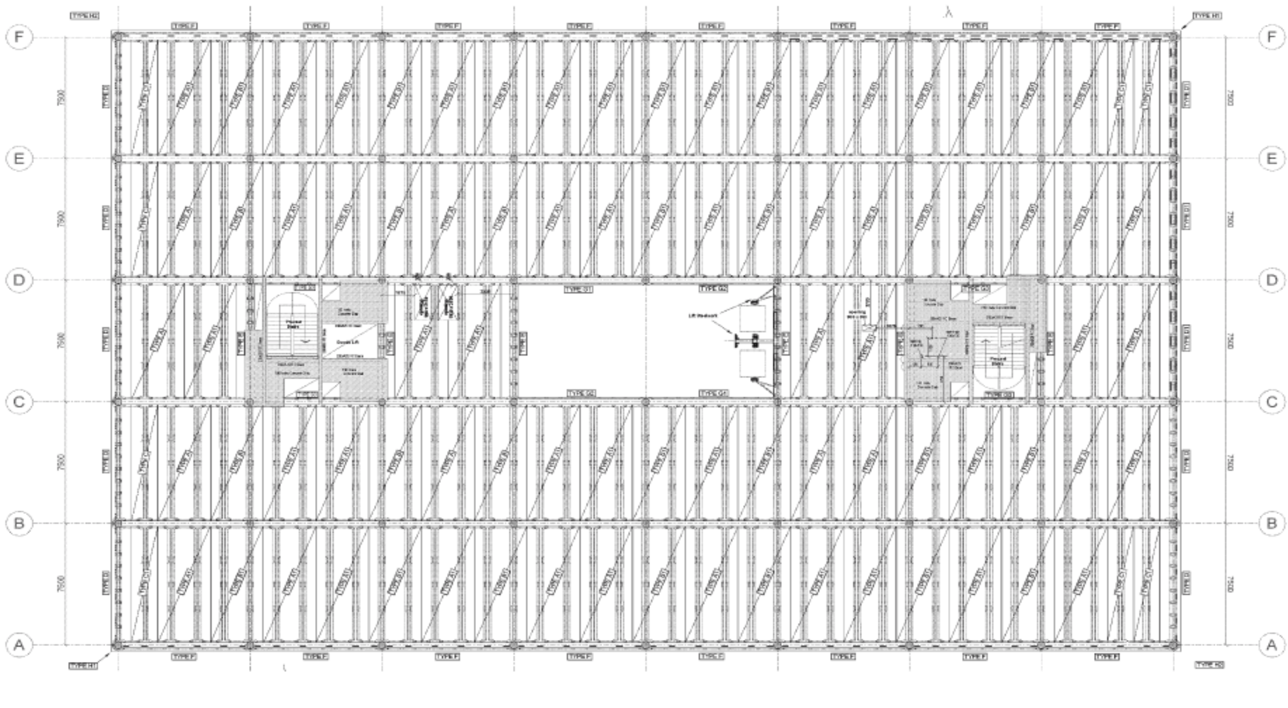
endplates of the double Ts and single Ts form one half of the primary beam shell that they span onto. The primary beams are then formed with in situ concrete after rebar has been positioned to complete the structural floor. It is a neat structural solution and very efficient with primary and secondary beams having an overall depth of 550mm with the slab 100mm thin and the secondary ribs running at 1.5m centres. We prepared a series of isometric drawings showing how the precast floor elements and in situ columns come together and issued them to SCC, the precast manufacturer. By introducing in situ concrete into the primary beams and columns we designed a sway frame to eliminate shear walls. In this way the contractor had complete freedom to start precast



Typical section



North-west elevation



Precast double T and single T floor layout

Erection of fascia panels

Precast beam mould

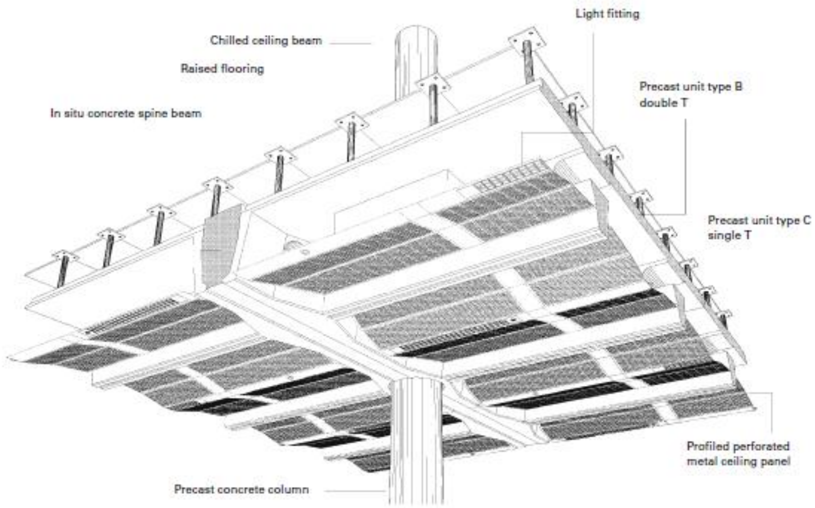
erection on any part of the structure. A braced structure with shear walls would have required temporary bracing during erection and a more restricted sequence of work.

The precast manufacturer pleasantly surprised us by electing to precast the columns in single-storey lengths and connect them using grouting tubes cast into the columns. The starter bars of the lower column sleeve into ducts cast in the base of the upper column and the void is filled using the grout tubes. SCC had used this technique successfully on a number of precast car parks they have built and found it to be quicker. The grout holes on the column were concealed within the depth of the raised floor.

There is no basement to the building but there is an undercroft below the raised ground floor which was for a car park. The suspended ground floor was a cast in situ flat slab, so that while the pile caps to the CFA piled foundations and the ground floor were being constructed, parallel working was achieved with the precast columns and first floor double T being fabricated off-site.

There was no topping concrete to the precast units to tie them together, so the longitudinal edges of the double T had a groove which formed a shallow channel with an adjacent unit. Along the edge were cast-in steel loops at regular intervals, and a single rebar was then threaded through the overlapping loops and the channel grouted up. It is a system that has been used before and it works very well. There is no differential movement between precast units under load and we can develop diaphragm action using the in situ stitches in the primary beams, columns and between the rib units. Being precast it was precisely made and when they were in position on the staging they gave a flush soffit line. It was easy to see if a unit was slightly out of true level or line, and adjustment could be made on the propping. The tight detailing and refinement of the system paid off. The most critical area for tolerances was the primary beam and column connection. We did not want the column to be pushed out of verticality due to cumulative tolerances of the precast units. We ensured that there was enough play around each column to cater for this. If you look carefully you may notice that the columns and preformed holes they had to fit in the primary beams are not always concentric. There was enough of a shadow gap for that not be noticeable unless you stood directly below it and looked up.

SCC made the moulds out of ply rather than steel as we wanted sharp edges, neat fold line in the splays and good definition on the chamfered corners. The steel shutters tend to give a rounded edge and corners because of the nature of the fabrication. The plywood moulds were placed on vibrating tables to vibrate the fresh grey concrete mix. A few units had minor surface defects, blow holes were repaired and filled and masked by the white concrete paint that was applied on site later on.

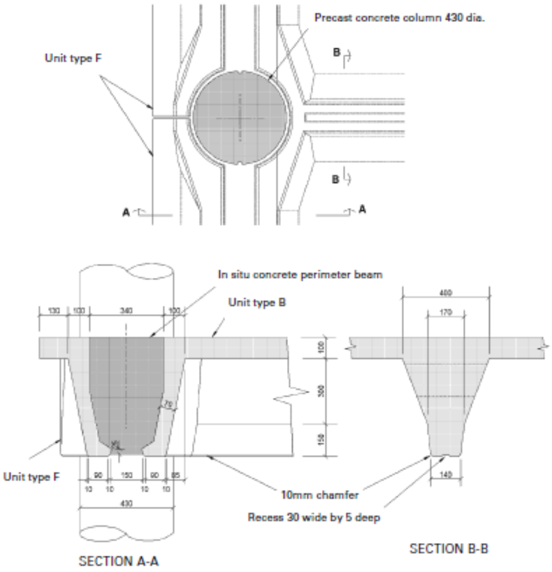


Isometric of floor and ceiling details

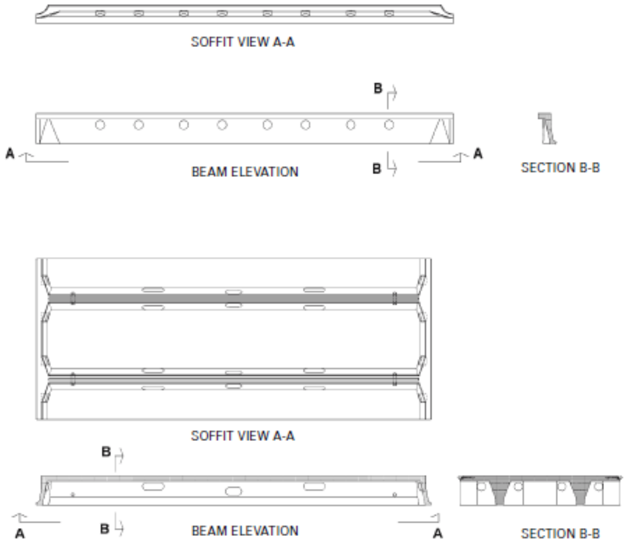
Precast structure exposed behind glass curtain wall

PROJECT DATA

Client: SecondSite Property Holdings
Architects/Engineers/Cost Consultants: Foggo Associates
Construction Manager: Bovis Lend Lease
Precast Manufacturer: SCC Ltd
Landscape Consultants: Hyland Edgar Driver
Completion: 2003
Construction Time: 16 months
Contract Value (including fitting out): 11,784,000 GBP
Gross Internal Area: 7,843m²



Details of in situ/precast stitch



Details of precast double T panels

Exposed precast beam soffit at atrium corner and slotted ceiling panel

Stacked precast floor panels

الاشتراطات والمعايير الفنية لإقامة مصانع بيع الخرسانة الجاهزة

تمهيد

كان اعتماد معظم المشاريع على استخدام الخرسانة الجاهزة في تنفيذ الهياكل الخرسانية ، ونتيجة لذلك فقد ظهرت بعض العيوب الإنشائية في المنشآت الخرسانية والتي ترجع أسبابها إلى غياب الرقابة الفنية على جودة الخرسانة المنتجة ، وعدم معرفة المواطنين بالمواصفات والاشتراطات الفنية لهذه الخلطات ، وتكبد أصحاب هذه المشاريع مبالغ طائلة لوضع حلول مناسبة لإصلاح هذه المشاكل ، بالإضافة إلى القضايا التي استنزفت الكثير من الجهد والمال والوقت.

ولذلك فقد برزت الحاجة إلى وضع الأسس والمعايير الفنية التي من شأنها رفع المستوى الفني لتنفيذ المشاريع من خلال الأخذ في الاعتبار أهمية الجودة الفنية للخلطات الخرسانية المستخدمة في البناء.

- **اشتراطات الموقع:**

1- تتم إقامة مصانع الخرسانة الجاهزة في المناطق الصناعية الواقعة داخل حدود المخططات الهيكلية للمدن والقرى ، مع الأخذ في الاعتبار أن تحدد الأمانات والبلديات مواقع لهذه الاستعمالات داخل مخططات المناطق الصناعية عند إعدادها.

2- في حالة كون الموقع خارج حدود المخططات الهيكلية للمدن والقرى يتم التنسيق مع الجهة المختصة بوزارة الشئون البلدية والقروية ووزارة المواصلات ، لأخذ موافقتها على الموقع ، وفي حالة عدم وجود مخططات هيكلية لبعض القرى تؤخذ الحدود الخارجية للكتلة العمرانية أساساً للدراسة ، أما إذا كانت الأرض زراعية فيتم تطبيق التعليمات الصادرة بخصوص الأراضي الزراعية.

3- يراعى عند اختيار الموقع (إذا كان داخل حدود المخطط الهيكلي) استعمالات الأراضي الراهنة والمقترحة ، وشبكات الطرق ، واتجاهات النمو العمراني ، وضوابط التنمية في المدينة أو القرية ، واتجاه الرياح السائدة ، وعند الترخيص بإقامة المصنع في هذه الحالة تقوم البلدية بإعطاء صاحب المصنع ترخيصاً لمدة زمنية محدودة بحيث لا تقل عن خمس سنوات ، ولا تزيد عن عشر سنوات ، بعدها يغلق المصنع في حالة تعارضه مع هذه الاعتبارات.

4- أن يكون توزيع مواقع مصانع الخرسانة في جهات مختلفة من المدينة وبشكل متساو ما أمكن ذلك بما يضمن المحافظة على جودة المنتج حسب ما ورد بالمواصفات القياسية السعودية رقم 95/١٠٦٨ "الخرسانة الجاهزة الخلط. " .

5- ألا تقل مساحة الموقع عن ١٠،٠٠٠ م^{٢} (عشرة آلاف متر مربع) في المناطق الصناعية الواقعة في المدن المنبسطة ، ولا تقل عن ٥،٠٠٠ م^{٢} (خمسة آلاف متر مربع) في المناطق الصناعية الواقعة في المناطق الجبلية.

6- مراعاة سهولة الوصول إلى الموقع بحيث يتصل بطرق مواصلات سهلة ومسفلتة ، على أن يكون الدخول والخروج من وإلى المصنع من بوابة واحدة ، إضافة إلى مخارج الطوارئ.

7- ألا ينتج عن إقامة المصنع أي مشاكل أو اختناقات مرورية.

8- عدم السماح بإقامة مصانع الخرسانة على الأراضي الزراعية المملوكة للأفراد داخل حدود المخطط الهيكلي للمدن والقرى ، وإذا اقتضت المصلحة العامة ذلك فيجب عندئذ التنسيق مع الجهة المختصة بهذه الوزارة ووزارة الزراعة والمياه لأخذ موافقتها بعد تحديد الحاجة الفعلية والموقع.

9- يقوم صاحب المصنع إذا كان مصنعه داخل حدود المخططات الهيكلية للمدن والقرى بتعبيد الطريق الذي يؤدي إلى المصنع ويربطه بالطريق العام إذا لم يكن معبداً.