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Building in sustainability throughout the design process

Truly sustainable buildings are achieved by informed decision-making, constant re-evaluation, and a willingness to change direction as projects progress. Engineer Alex Lynes explains the thought processes behind four recent buildings and offers a checklist for optimising environmental performance from concept design to completion on site

Building a sustainable project isn't simple. As a project evolves through the stages – from brief, to concept and detailed design, through to construction and handover – so too does the team's focus. But what needs to remain consistent throughout all stages is a constant and concerted effort to include room for good decision-making around sustainability. A project can't be made sustainable through the detailed design stage alone, nor can the decision-making be front loaded into the beginning of the project with the hope that the end stages will follow suit without too much effort.

Start big and decide on a direction

Sustainability has to be baked in from the start rather than included as a later addition. Involving the design team in decision-making around sustainability while the project is still a blank canvas means they can discuss and weigh up the pros and cons of layouts, servicing strategy and structural grid. The aim here is to design a building that is efficient overall, rather than a highly optimised floor plan where the structure and services are woven between rooms. Conversely, fixing the structural grid early can lead to columns and downstands in difficult locations with nobody willing to budge.

Thinking about structural materials while developing a brief is important. Early discussions are often all about layouts with no consideration of what the structural frame should be, how the facade is supported or what the service distribution strategy is. Concepts are the important thing here.

A steel frame requires lots of beams and a regular grid. The most efficient structural forms use the slab compositely with the beams limiting the flexibility of openings. The main consideration here is a services distribution with deep beams – while the typical proposed solution is heavier steel beams to keep them above a clear service void, a more sustainable option is obvious but surprisingly seldom taken: pay the designers to closely coordinate the services with openings in deeper beams, using as little as a third of the steel tonnage with deeper and lighter beams.

Concrete needs aligned columns and minimal transfers, thickenings or steps to be efficient because all those things add large amounts of rebar into the concrete. Beams should be deep, and unnecessary upstands should be avoided, requiring a clear servicing strategy and understanding of the floor and wall buildups. Concrete frames can be sustainable but it is also very easy to cater to any request for the shape it takes, spiralling the embodied carbon out of control. Just because you can form everything in concrete, it doesn't mean you should.

CLT is traditionally used for both floors and walls for a complete timber solution and is definitely the most sustainable option. Often aligning the walls with complicated and non-repeating floor layouts or wanting large open areas poses a real challenge when using CLT. A better solution is to use beams and columns that can be in timber or steel or a mixture of the two.

Plan the building with sustainability in mind

Optional spans are especially important for timber and steel construction. Span too far in both cases and you will need to use a lot more material to avoid vibration issues. Spans over 6m in CLT and 7.5m in steel start to be governed by vibration considerations so optimal spans are a few metres shorter. There has been a trend over the last decade to provide larger and larger spans in the interest of "flexibility of use" but there are buildings 100 years old with 6m grids all over the country and used for everything imaginable. It's best to have an honest discussion about whether to embrace the columns sooner rather than later.

The floor slabs are normally the biggest

GUY PARKER-DENNISON/WEBB YATES

Ilford Community Market, originally designed by Webb Yates' architecture and engineering studio Interrobang

Ilford Community Market is a new community food market and hydroponic farm in Ilford town centre with stunning exposed structural elements. Circular-economy principles are central to the scheme, which sequesters carbon through its glue-laminated timber frame. By using low carbon materials, adopting a minimal-impact philosophy and providing numerous community benefits, the project hopes to set a precedent for sustainable urban markets of the future.

AGNESE SANVITO

Kantor Centre of Excellence
Architect: Penoyre & Prasad
Structural engineer: Webb Yates

The Kantor Centre of Excellence is a combined new-build and refurbishment scheme on a tight central London site near King's Cross. The new structure comprises an exposed concrete frame from basement up to podium level supporting a regular grid of five floors of high-strength LVL timber columns and beams working compositely with thin exposed concrete planks. The exposed concrete provides thermal mass which helps the building achieve a high BREEAM Excellent score.

AGNESE SANVITO

York House
Architect dMFK
Structural engineer: Webb Yates

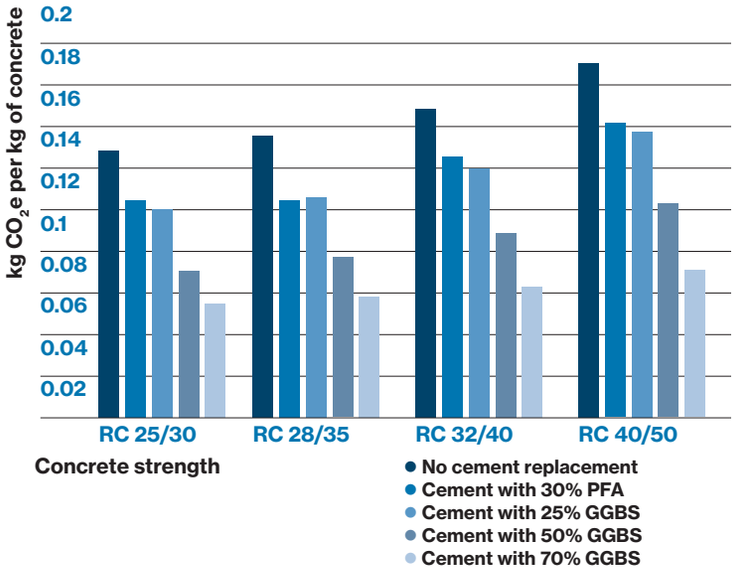
Situated in the heart of London's King's Cross, York House is an eight-storey refurbishment and extension scheme providing flexible co-working space. The building has been significantly refurbished and topped at roof level with a lightweight CLT extension. In the front, a new glulam frame supports a CLT projection, which is clad in a perforated brick lattice set on a 45-degree angle to add stiffness. Energy efficiency was key throughout and has been awarded BREEAM Excellent certification.

AGNESE SANVITO

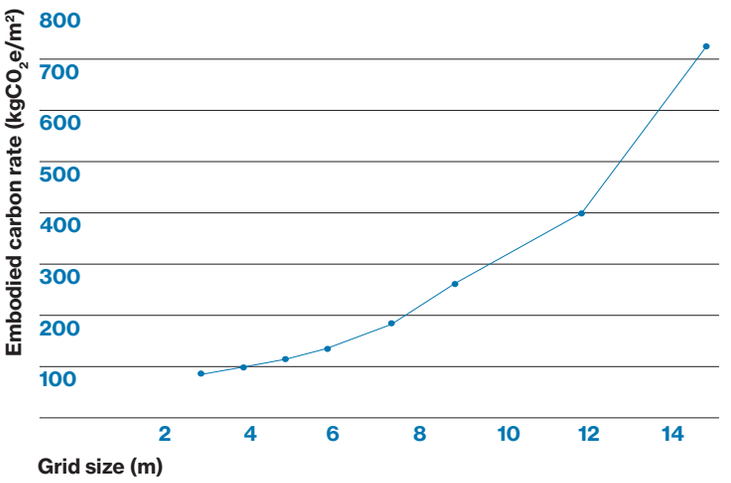
15 Clerkenwell Close
Architect: Groupwork
Structural engineer: Webb Yates

15 Clerkenwell Close is a mixed-use six-storey building with a stone facade. What may appear as a traditional concrete frame clad in stone has a little surprise in store for the keen eye. A closer inspection of the columns will reveal ammonoid fossils, drilled wedge holes and saw grooves indicating that part of the story has not been told. Concrete columns and clip on stone have been rejected in favour of a simple system of external solid stone load-bearing columns.

Concrete types comparison graph
Source: Webb Yates



Steel deck embodied carbon rate for grid sizes
Source: Webb Yates



contributor to total embodied carbon and there is a view that concrete is the only solution here. Many would argue that this is not the case but even if it is, the priority can be turned to specifying the minimum thickness required to meet the various project requirements. From experience this is typically 75-100mm – much less than is normally used.

Keeping a clear head and remembering the principles set out at the start is key as the scheme is developed and coordinated. Many projects benefit from taking a step back several times during the design process to check the building still makes sense. When going into the details, it can become clear that a decision made earlier in the project's design is causing more issues than expected. Being honest here and able to own up to this and change your mind is the best way out.

Often many small decisions can add up to a really terrible building. "Oh, it's just one extra trimming steel" can eventually get you to a point where you're so far away from all the great plans and ideas at the start that it seems you may as well give up and pour concrete over the lot!

Leave time to design the details

During detailed design, buildability, procurement and fabrication take centre stage. Finding contractors with experience in building sustainable buildings can be very helpful but the design team understands the building and the different options available for it in much greater detail at this point. Focusing on finding the perfect contractor or subcontractor to build the entire building can end up putting blinkers on the design.

Details should be developed to make assembly as quick as possible, working with the contractor well before starting construction. Make time in the programme for 'Stage 4.5' as it's known in the IStructE's Plan of Work 2020. This is where the contractor and the design team work together to finalise the design, avoiding unbuildable details and late requests from the contractor to change products after they have started work on site.

Keep measuring, keep improving

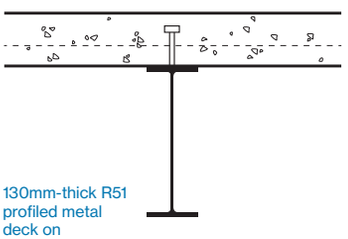
No matter what proposed building type or main materials you end up choosing, it is critical to keep assessing and critiquing as you go along. Comparing options both in terms of cost, programme and embodied carbon should be the standard, and questioning each aspect should be encouraged. Whether this is increasing the cement replacement content in the concrete or using a few more different sizes of steel beam across a floor, there are still options for reducing the embodied carbon during detailed design.

During construction, this measurement and assessing process should be led by the contractor who is more in control of the exact suppliers, products and processes used. Building detailed sustainability requirements into the tender documents is essential to ensure this so that the desired benchmarks can be met.

Whether the project is a small back extension, a large housing development or a flagship Grade A office, it is possible to build it sustainably as long as the design team are given scope and time to be creative and explore the options to optimise the design.

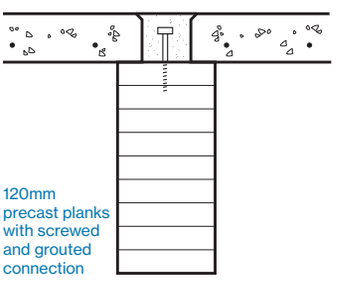
Alex Lynes is an associate at Webb Yates Engineers

Option 1
Concrete deck on steel beams at 3m centres



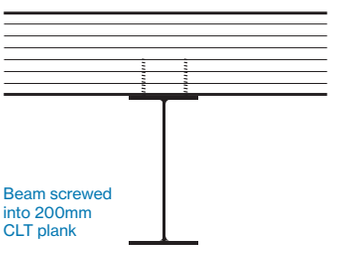
130mm-thick R51 profiled metal deck on composite beams

Option 2
Concrete planks on glulam beams at 3m centres



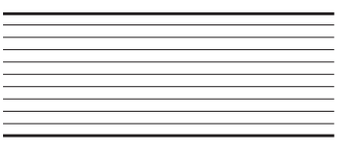
120mm precast planks with screwed and grouted connection

Option 3
CLT planks on steel beams



Beam screwed into 200mm CLT plank

Option 4
CLT planks



300mm CLT planks