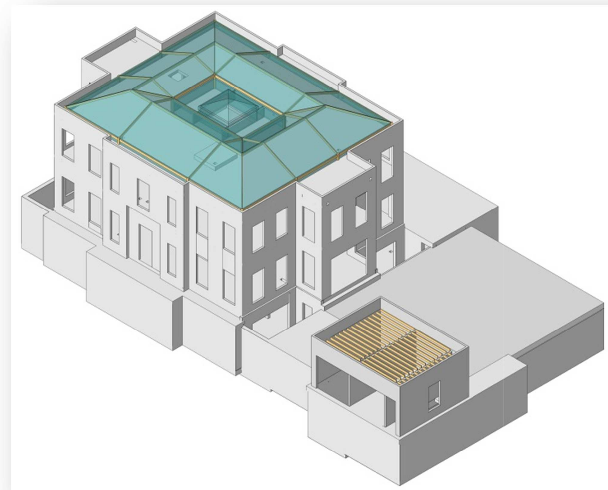
MBP

CROSSACRES, VIRGINIA WATER, SURREY
DESIGN INPUT STATEMENT FOR STRUCTURAL & CIVIL ENGINEERING WORKS



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INTRODUCTION

The Design Input Statement records and describes the proposed structural and civil engineering works that have been designed, detailed and specified for the new build residential development called Crossacres at Virginia Water, Surrey. The statement includes:

- a description of the proposed works
- the design criteria and performance parameters by which structural and civil engineering elements will be designed and detailed
- details of the investigations commissioned for the project and a summary of their findings
- recognition and description of any unusual risks or hazards associated with the design, execution, use or maintenance of the finished works
- an outline specification

The statement should be read in conjunction with the drawings and specifications provided and the information accepted with the same authority. Risks arising from the execution and/or maintenance of the specified works which might reasonably be considered normal or usual for a construction project are not elaborated on as they should be clear and manageable to a competent and experienced contractor; unusual risks are however identified and described where relevant.

THE BRIEF

The proposed design is based on and derived from information gathered and supplied by Octagon and design discussions with the Project Team.

This project will create one new residential property consisting of a single storey basement to include a car park, swimming pool and associated facilities, a games room and employee residential quarters. At ground floor level there are reception rooms and at first floor level are the bedrooms.
The new development will be of reinforced concrete frame construction none of which will be exposed in the finished state. The basement box will be reinforced concrete with a waterproof additive eg. Caltite and will be formed in the most part using a traditional open-cut technique by battering back the existing ground. Where this is not possible temporary sheet piles will be required to retain the soil.

DESIGN AND PERFORMANCE PARAMETERS

The building will accommodate:

- below ground car park, swimming pool, sauna, steam room etc, games room and plant rooms
- ground floor reception rooms and kitchen
- first floor level bed and bath rooms
- new lift serving basement level to first floor
- access to the basement car park will be by either a car lift or a ramp (subject to planning)

Occupancy Loads

The new construction will be designed in accordance with current British Standards, Codes of Practice and Building Regulations, as listed in Appendix A, in addition to specific requirements the occupier may request.

The general design imposed loads for the buildings are scheduled in Table 1.

Category	Use	UDL (kN/m^2)	Concentrated Load (kN)	Comments
A	Residential	1.5	1.4	Refer to BS:6399-1
A	Games / Cinema Room	2.0	2.7	
B	Plant rooms	3.5	4.5	Eg. Rooms with mainframe computers or similar equipment
C4	Gym	5.0	3.6	
F	Car park	2.5	9.0	

Table 1: Occupancy Loads Required by BS 6399: Part 1

Environmental Loads

The building and cladding will be designed to support loads from wind and snow in combination with the occupancy loads scheduled above and the weight and load of the building's construction and finishing. A wind pressure value of $1kN/m^2$ has been used in design.

Fire Rating

The structure will be designed and detailed to achieve the minimum period of fire resistance required by Approved Document B, Table A2, i.e. 60 minutes for loadbearing, structural elements (beams columns and upper floor plates). The roof structure, i.e. rafters and sheeting, does not carry a fire rating.

Disproportionate Collapse

The new building matches the criteria for Disproportionate Collapse set out in Approved Document A, July 2004 and will be designed and detailed to accommodate the requirements of a Class 1 building, i.e. Residential buildings not exceeding 4 storeys.

However, the horizontal ties provided in an RC frame building by virtue of the slab reinforcement will thus meet the requirements of a Class 2A building.

Construction Parameters

To achieve the programme for design and construction the proposed scheme aims for an efficient construction phase. That is, consistent and, to a degree, repetitive construction materials and details, capable of progressing continually and smoothly. Standard and readily-available components and materials are specified where possible and pre-constructed or pre-fabricated components will be installed where practical. While construction techniques will be industry-typical any variations to these will be for the benefit of the construction and be fully detailed.

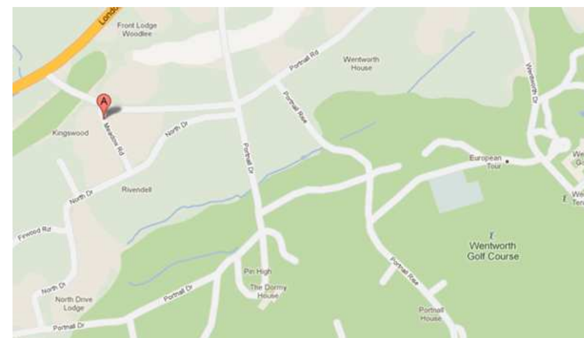
THE SITE

Crossacres lies within a roughly triangular shaped plot of land on an exclusive estate in Surrey, adjacent to the prestigious Wentworth Golf Club, at Grid Reference 497272E 167764N. Meadow Road and North Drive form the western and southern boundaries respectively whilst Portnall Drive forms the eastern boundary. A residential property lies to the north.

The site is currently occupied by a load-bearing masonry residential building arranged over two floors with a stand-alone garage block, both of which will be completely demolished and removed prior to works starting on the new development.

A water main which runs through the site will be diverted as part of the enabling works package to be carried out prior to commencement of the new building

The plot has a number of trees, of various species and maturity, many of which have Tree Protection Orders, which the proposed works must accommodate and respect in design and construction.



Site Geology

A site geological investigation comprising borehole confirmed the site to be underlain by River Terrace Gravels over Windlesham Formation. The general near-surface strata were determined from the boreholes to be as Figure 1.

Ground water monitoring was carried out as part of the site investigation works. No short-term standing water levels were observed except for one reading at 13.2m. Subsequent return visits were made and no water was recorded.

The recommendations from the investigation are that the soils can support a bearing pressure of 200kN/m^2.

An analysis of the sulphate content in the soils results in an ACEC class of AC-1s and a Design Sulphate class of DS-2. This corresponds to the Design Chemical Class, DC-1.

No demonstrable contamination was found as part of the contamination tests which were carried out on the soils.

The site investigation report describes the potential for low to moderate magnitudes of ground heave caused as a result of unloading the existing soils during the basement dig.

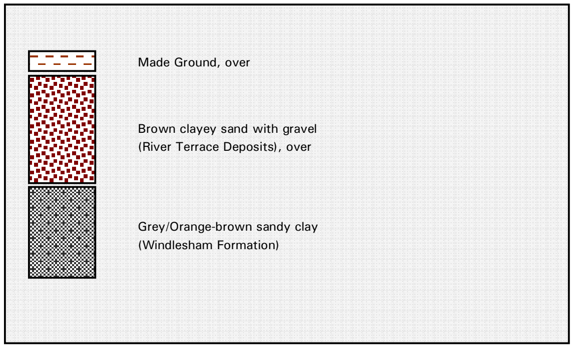


Figure 1: Near Surface Soil Profile

STRUCTURAL WORKS

Sub-Structure

The site geology supports a raft foundation formed approximately 4m below existing ground level, where the permissible increase in bearing pressure is 200kN/m^2. A reinforced concrete raft slab is proposed to support the structural columns, walls and lift shaft at basement level.

The new building will be constructed in a traditional “bottom-up” sequence starting with the reinforced concrete basement box, using an open-cut technique. The basement retaining walls, ground, first and roof slabs will follow.

The reinforced concrete basement box will be detailed such that it will achieve a grade 2 in accordance with BS 8102:2009. However, to achieve standards akin to residential occupancy a waterproof additive e.g. Caltite will be specified for the concrete mix and further protection will be provided internally by way of a ventilated drained cavity as specified by the architect, which will help it achieve grade 3.

The roof over the garage will be constructed using either precast concrete planks or in-situ concrete with a waterproofing additive and will have an asphalt covering below the external landscaping as specified by the architect.

This element of the work will involve demolition works and forming deep excavations using a batter of the existing soils. Around some of the tree protection zones, it will be necessary to incorporate a temporary retaining wall, this can be designed to cantilever or be propped during construction.
There will be a need to remove large volumes of spoil and handling, placing and working wet concrete.

No unusual risks have been identified for this element of work which should be familiar to a suitably-experienced contractor.

Super-Structure

The ground floor will extend over the entire footprint of the basement box and will be a reinforced concrete suspended flat slab spanning between the perimeter walls and internal columns and walls. Steps will be formed in the slab to suit the changes in level between the external and internal areas.

The structure above ground level will be a reinforced concrete frame comprising structural columns internally and walls internally and around the perimeter, which support an in-situ reinforced concrete slab on each level.

The frame will be stabilised by the combined performance of the RC lift shaft walls, acting as a vertical cantilevered tube, and the perimeter RC walls.

This element of work will involve handling and placing reinforcement; handling, preparing and removing formwork and falsework; craning, working at height and with lifting and handling plant. None of the operations involve unusual risks or activities that will be unfamiliar to a suitably-experience contractor

Envelope
The external elevations will be of cavity wall construction formed of a 140thk RC wall inner leaf and masonry outer leaf supported off of the ground floor slab. The use of a concrete inner leaf instead of more traditional blockwork obviates the need for windposts as the walls will be designed to span between slab levels. Also the requirement for heavy lintels to span the large window openings will be reduced.

This element of work will involve working at height near the edge of the structure. No unusual risks have been identified for this element of work which should be familiar to a suitably-experienced contractor.

Finishes & Applied Treatments
The finished slab soffits is to be smooth and flat as is typical of BS8110 Type A. The finish is not of sufficient quality to be left exposed and it is understood that a suspended ceiling will be used throughout.

This element of work will involve applying a wet coating overhead and at height therefore there is a potential for it to become an irritant to the skin and eyes so due care must be taken and appropriate protective clothing worn.

CIVIL WORKS

Existing Drainage

It is assumed that all the existing below ground drainage network will be removed during the demolition and excavation phases of the project.

Proposed Drainage

The design of the new drainage system is outlined as follows:

The foul water drainage is collected below the north eastern corner of the new basement slab via a number of manholes where it falls by gravity to a pumping station located towards the east of the site. The waste is then pumped towards the southern boundary where the drain will be connected to the existing outfall.

The storm water drainage gets collected around the building perimeter and will run below ground level towards the northern site boundary via a rainwater harvesting tank, to an infiltration blanket approximately 17m by 14m in plan dimension, where it will percolate into the soils.

This work will involve excavating trenches and pits and working within them to place and connect new drainage lines and chambers. None will be excessively deep and this work should not involve unusual risks or activities that will be unfamiliar to a suitably-experience contractor.

ENVIRONMENTAL IMPACT AND SUSTAINABLITY

The Construction Sector is a major consumer of land and raw materials and, in the UK, 90% of the non-energy minerals extracted, approximately 260 million tonnes, are used to supply the construction industry. This extraction generates dust, noise, requires heavy machinery and generates extensive volumes of waste. The DTI estimated that around 70 million tonnes of construction material and demolition arisings end up as waste and that 13 million tonnes of this had been delivered to site and then disposed of unused.

The processes used to manufacture many construction materials, particularly brick, cement (which accounts for 10-15% of the materials in concrete) and steelwork, involve very high temperatures with consequent high energy-use and emission of greenhouse and other gases and wastes.

Furthermore, the manufacture and transportation of building materials accounts for about 25% of the energy consumed by this sector.

In the face of these facts it appears that the processes involved in the construction of new buildings are a major contributor to the emissions of greenhouse gases and global warming. Moreover, that construction in reinforced concrete is particularly detrimental to the environment.

However, the processes of construction and the use of concrete in particular, when considered with the context of our industries, environment and occupation and use of buildings, are not so detrimental as they appear and can, in fact, contribute positively to sustainable development.

For example, the operational use of buildings accounts for 50% of CO_2 emissions generated in the UK while transport accounts for a further 30%. Concrete production, on the other hand, accounts for just 2.5% of the CO_2 emissions generated in the UK, of which 4.8% is due to cement production. This suggests that it is in the operation of buildings where savings and reductions in CO_2 emissions should be looked for and it is here that the selection of construction materials and techniques can be influential.

It is important, therefore, that sustainability is considered over the lifecycle of a building, i.e. construction, use and demolition rather than just in materials used for its construction. There are a number of themes relating to sustainability that can be reviewed when a new construction is being considered, including:

- Re-using existing structures
- Designing and specifying for minimum waste
- Designing and detailing lean construction
- Minimising energy used in construction
- Minimising energy in use
- Avoiding pollution
- Recycling

There is no opportunity for any of the existing building to be reused in this project for it to respond successfully to the brief. This building will be a reinforced concrete structure with masonry cladding, which, when considered against the themes listed, will prove to contribute favourably to sustainability. New buildings, constructed with better materials and to higher standards can be better insulated and consume less energy than existing.

Concrete Production
Concrete is a manufactured mix of three constituents: cement, aggregate and water.

In the manufacture of cement alternative fuels are being used for the kilns, including used tyres (which can burn kilns without flames or fumes), waste solvents, refuse-derived fuels, sewage pellets, meat and bone meal and unrecyclable papers and plastics. Through the use of these alternative fuels (known as industrial ecology) and using more efficient equipment the cement manufacturing industry has reduced energy consumption by 21% and CO_2 emissions by 24% in the 15 years since 1990. Cement can also be replaced in the concrete mix with by-products from other industries, such as *pulverised fuel-ash*, a by-product from coal-burning power stations and **ground-granulated blast furnace slag**, a by-product from iron and steel production. Furthermore, the gypsum produced by the de-sulphurisation processes used in coal-fired power stations as part of their acid-rain reduction programme can be substituted in cement manufacture.

These processes have, in recent years, resulted in 100,000 less tonnes of virgin material being quarried for cement manufacture and around 120,000 tonnes of material recycled into cement manufacture rather than being sent to landfill.

Aggregate is usually prepared from quarried virgin material but recycled material is increasingly used, including crushed concrete from demolished buildings.

The manufacture of concrete uses 170litres of water per kg (the manufacture of constructional steel uses, by comparison, 3400 litres per kg) much of which is not directly contained in the concrete mix but rather is associated with the preparation and transportation of concrete, particularly for washing equipment and wagons between batches and deliveries. By this each wagon will be washed with between 400 & 1200 litres of water per day, which is then sent to waste. Through the use of chemical stabilisers and by modifying the design of the concrete mix it is now possible to use this wash water in the manufacture of fresh concrete, thereby removing the practice of washing out delivery wagons at site or on their return to the plant and the need to manage and dispose of another waste by-product.

All of these techniques and processes will be available and, where possible, prescribed for the manufacture of the concrete to be used for this building.

Concrete in Performance

Reinforced concrete offers many benefits to building structures and can naturally contribute to sustainability:

- Good span-to-depth ratio - enabling open-plan spaces to be created
- Inherent durability - applied protection systems are not required
- Inherent fire protection - applied protection coatings are not required
- Inherent sound insulation - applied insulation often not required

- Flexibility in form - complex and integrated structures can be cast
- Thermal Mass - controls temperature and reduces energy consumption

By considered selection of the structural layout and structural elements it is relatively easily to take advantage of these inherent qualities and to contribute positively to the sustainability of the building.

Reinforced Concrete is naturally dense and inert material and has a consequent low susceptibility to deterioration or corrosion and, in common buildings and environments needs no added coating or treatment to maintain this resistance. Similarly, it is non-combustible and, as its melting point is between 1800 & 2500°C, it will not breakdown in a fire (common fires, i.e. those not fuelled or accelerated intentionally, rarely reach 1000 °C) so requires no applied protection to satisfy the requirements of Building Regulation B, nor the employment of a sprinkler system to maintain its integrity.

These factors allow for a concrete structure to be used almost bare of applied materials other than decorations, which will contribute to reducing consumption of primary and secondary materials, e.g. paint and insulation and delivery packaging and wrapping, in the completion of the building.

Because reinforced concrete is formed in place it can be shaped and adapted to its most efficient form. For this building flat floor slabs have been selected to achieve the clear spans desired and allowing for uninterrupted distribution of services beneath the slab soffit.

Moreover, reinforced concrete is inherently rigid and connections between horizontal and vertical elements will have a capability that can be used to stabilse a building without introducing bracing elements. Reinforced concrete structures therefore often permit a very lean construction to be achieved, i.e. just enough material to meet the requirements and functions prescribed. In this building the reinforced concrete wall panels, which are introduced in place of blockwork leafs will be used with the lift shaft and columns to stabilise the building.

It is, however, the thermal mass of reinforced concrete structures that can perhaps contribute most to reducing the CO_2 emissions of a building. If left exposed, concrete's capacity to hold high levels of heat (up to 1.3kJ/kgC) will allow a great deal of the heat generated in the building, from the sun, ambient air, computers and office equipment and the occupants to absorbed, usually during the day, heat that will be released during cooler periods, normally over night. This thermal flywheel effect can generate up to 25W/m^2 of coolth. Through considered use of the concrete surfaces in conjunction with natural, or passive, ventilation the thermal build-up in the building can be reduced and the need for mechanical cooling or air conditioning either greatly reduced or omitted completely.

Accompanying the beneficial effect helping control temperatures exposed concrete is that generated by the natural reflectivity of concrete, which can be used to spread and diffuse natural and artificial light and thereby reduce the number of electric lights required.

However, in this project, these last two elements cannot be exploited due to the intended use and finish for the scheme.

By employing these benefits of concrete it is therefore possible to make the structure in this building serve multiple purposes:

- Primary structure
- Stabilising structure
- Cladding

Concrete & Recycling

The manufacture of concrete can involve many recycled materials through the use of cement substitutes and recycled aggregates. In the UK almost all reinforcement bars used in construction is made from recycled steel. While structural steel uses iron ore, which is extracted by a very energy-intensive process, the formation of reinforcement steel uses much less heat, to only melt and reform the source metal, which requires less than half the energy of that for manufacturing structural steel.

Concrete arising from demolished structures is 100% recyclable, although the extraction process means only 70-90% is currently recovered. Reinforcement is separated to be recycled 100% (often into more reinforcement) and the concrete crushed to become, amongst other things, sub-base and compacted fill beneath foundations, roads, railways and runways as well as aggregate in new concrete.

This building, when it comes to the end of its life, can therefore be expected to be highly recycled, i.e. the concrete, blockwork and should all be extracted and re-used in some form.

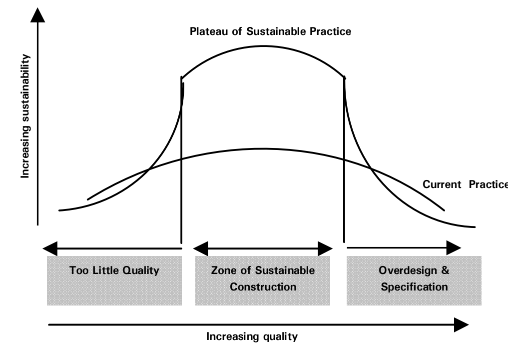
Building Life Cycle & Efficient Design

When considering the environmental impact of a building it is important to consider it over its life cycle. Buildings have a finite lifespan, defined as '…the period for which a structure is to be used for its intended purposes with anticipated maintenance but without major repair being necessary'; these periods have been defined according to the class and use of the structure, which are summarised in the table opposite.

Research for the Chartered Institution of Building Surveyors assessed the conditions of three types of construction over their life cycle: one lightweight, one medium and one heavy. Based on climate records and the UKCIP02 scenario for climate change in the 21st Century it was estimated that the lightweight construction would become overheated in 15 years, after which it would require air conditioning to be comfortable: the medium-weight construction would become overheated after 35 years and the heavyweight construction in 55 years.

Class	Required Service Life	Example
1	1-5	Temporary Structures
2	25	Replaceable Structural Parts
3	50	Building & Other Common Structures
4	100	Monumental Buildings Structures, Bridges & Civil Engineering Structures

Moreover, the drive towards better-insulated buildings to reduce heat loss in winter can, in lightweight construction even now, lead to overheating in summer and consequent need for some form of mechanical cooling. The thermal flywheel effect generated by heavyweight construction mitigates swings in internal temperatures and can remove the need for air conditioning.



Using an approach that considers the year-round function of a building over its life cycle can lead to a design and specification that will reduce its CO_2 emissions. Using reinforced concrete for the structure in conjunction with good detailing and appropriate cladding materials can contribute significantly to this aim.

Buildings can fail, when assessed against sustainability criteria, when they are over-designed; or where unnecessary quantities or unnecessarily high-quality materials have been used to meet design requirements in place of good design and specification. They can also be judged to fail through poor quality materials, design and workmanship leading to early repair or replacement. In the figure opposite, a successful building in sustainability criteria will be on the plateau of sustainable construction.

The construction for Crossaces will aim to make best use of its weight and materials in all parameters of its service, to be effectively and efficiently designed, detailed and specified and to aim to be placed in the zone of sustainable construction.

SPECIFICATION

The proposed construction materials, components, workmanship etc. can be specified using the National Building Specification documents. Those sections appropriate to the structural engineering works are scheduled in Appendix B.

It is Michael Barclay Partnership's practice to specify materials and construction-practices that do not cause undue harm to the environment. For example, timber used in temporary and permanent works must be obtained from a certified sustainable source, and be identified as such. The paint specification will, where possible, avoid red lead, zinc chromate or coal-tar content and have a low solvent (VOC) content and offer manufacturers with an Environmental Policy in operation. The contractor will be encouraged to use portland cement replacement materials for the reinforced concrete elements and a chemical-drum wash system for the delivery wagons

APPENDIX A – DESIGN CODES AND STANDARDS

BS648:	SCHEDULE OF WEIGHTS OF BUILDING MATERIALS
BS6399 Pt 1:	Code of Practice for Dead and Imposed Loads
BS6399 Pt 2:	Code of Practice for Wind Loads
BS6399 Pt 3:	Code of Practice for Imposed Roof Loads
BS5268:Pt 2:	Code of Practice for Structural use of Timber
BS5628:Pt 1	Code of Practice for Structural Use of Unreinforced Masonry
BS5628:Pt 2	Code of Practice for Structural Use of Reinforced & Prestressed Masonry
BS5950: Pt 1:	Design of Steel Structures
BS8004: Pt. 1	Code of Practice for Foundations
BS8110: Pt 1:	Structural Use of Concrete

The Building Regulations 1991: Approved Documents A, B, C, E, H, K & N

APPENDIX B - SCHEDULE OF NBS SECTIONS

Demolition	C20
Excavating And Filling	D20
In Situ Concrete Construction Generally	E05
In Situ Concrete Mixes, Casting And Curing	E10
Formwork For In Situ Concrete	E20
Reinforcement For In-Situ Concrete	E30
Designed Joints In In-Situ Concrete	E40
Worked Finishes To In Situ Concrete	E41
Accessories Cast Into In-Situ Concrete	E42

Appendix C - Specialist Data