JP Associates

Arboriculture | Trees & Development | Land & Habitat

Technical Paper

The Shading of Buildings and Open Spaces by Trees

A guide to achieving the right relationship between new residential buildings, their gardens and trees

Please note:
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BS 5837 2012 - Trees in Relation to Design, Demolition and Construction - Recommendations states that any proposed buildings should be designed to take account of existing trees, allowing for their ultimate size and the effects this will have on light availability.

Trees and hedges vary in the amounts of sunlight and daylight they allow to pass through their canopies. The majority of tree species will cast partial shade and with deciduous trees this will vary according to the season. However, dense evergreen belts of trees or high coniferous hedges will allow little light to penetrate and the shade they cast will be more like a solid object such as a building or wall.

It should be remembered that trees can provide valuable screening and privacy to new buildings - for example by reducing overlooking by neighbours, or mitigating against undesirable views or busy roads. When it comes to gardens and open spaces people vary in their preferences. These areas should be designed so that they receive direct sunlight for at least part of the day but most people would accept or welcome some areas of partial shade under trees.

Relationship between trees and buildings

The amount of daylight received by buildings depends on the location, type and management of the trees. The tree:building relationship should allow for reasonable levels of light in accordance with 'Building Research Establishment (BRE) Document 209 - Site Layout Planning for Daylight and Sunlight: a Guide to Good Practice'.

In cloudy climates diffused light from the sky is the main source of daylight. Good site planning should ensure there is sufficient area of visible sky to give good interior light with windows of a reasonable size. An unobstructed vertical wall will receive 40 per cent of the amount of diffused light received by a horizontal surface.

If hills or buildings obscure the sky up to an angle of 25 per cent above the horizontal, the amount of light received by a vertical surface will be only 27 per cent of that received by an unobstructed horizontal surface. A 1m2 skylight on a flat roof would thus receive nearly four times as much diffused light as a similar size window in a vertical wall in a typical urban location.

BS 5837 guidelines

The trees that need to be considered in a constraints or shading study are the more significant ones that are being retained on a development site, as well as those on neighbouring land that stand sufficiently close to the site boundary that they may affect the amount of light into the site.

BS 5837 specifies that the constraints information should be plotted on a plan, including an indication of the potential obstruction of sunlight caused by a tree or trees. The BS 5837 shade area is represented by a segment with radius from the centre of the stem equal to the height of the tree, drawn from due north west to due east, depicting the shadow pattern through the main part of the day.

In reality trees may cause significant shading of daylight even on their south side and issues such as proximity shedding and overbearing may be as important as shade. As an alternative to the BS 5837 shade area a circular area with radius equivalent to two-thirds the mature height of the tree may be used to take account of daylight shading on the south side of the tree.

The shaded zones shown on the arboricultural constraints plan indicate the area within which the amenity interests of the future occupants - in terms of daylight, shading and physical presence - may be affected by retained trees. Daylight shading is, inevitably, more of an issue on the northern side of a tree. The constraints plan indicates two different areas associated with each significant retained tree: the shadow length area and the BS 5837 shade area. Collectively the two areas form the amenity clearance zone.

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Amenity clearance zones

Shading from daylight and sunlight is the main issue in a constraints plan. Within the indicated area the principal windows and living areas of adjacent buildings ought to receive a satisfactory level of sunlight.

The amenity clearance zones represent the area that will be affected by a structure obscuring the normal passage of the sun: in the case of a built structure this would represent a completely shaded area. However, tree canopies are not solid structures and varying amounts of light will pass through the crown creating differing levels of shade. The amount of light will depend on the species of tree, its condition and management.

To ensure a satisfactory relationship between a proposed habitable property and adjacent retained trees, a clearance zone roughly equal to two-thirds of the tree's expected mature height should be observed, in practice the exact distance will depend on factors such the species of tree and how it has been pruned, as well as the design of the building and the size and position of its windows.

Amenity clearance zones also serve to protect trees from pressure to be felled or undergo pruning after occupation of adjacent properties located too close to retained trees.

However, the amenity clearance zone is designed to protect amenity interests: it is not primarily aimed at protecting the trees. Any housing within the zone should be configured so that principal windows and living areas still receive the minimum level of daylight through internal property layout and window design.

Non-habitable structures such as garages and hard-surfaced areas can be placed inside the amenity clearance zones, provided they don't encroach into the root protection areas (RPAs).

One option for combining the need for daylight in buildings with the benefits provided by trees is to make greater use of upward facing windows with moderately dense tree cover between the houses. In cloudy conditions windows on the northern side of buildings can contribute as much to lighting as those on the southern side.

If it is necessary to build within the amenity clearance zones for design or planning reasons, the amount of daylight available to the windows can be calculated using the method set out in BRE 209 (see below). If the levels of light are found to be insufficient then often fairly minor changes to the windows or design of the internal room layout may provide a solution. Alternatively it may be possible to reduce the height, thin or lift the canopies of retained trees to allow more light to pass through them.

Calculating light levels

Daylight or natural light can be divided into the two components of sunlight and skylight and can be defined as follows:

- **sunlight** - the part of solar radiation that reaches the earth's surface as parallel rays after attenuation by the atmosphere
- **skylight or diffuse daylight** – the part of solar radiation that reaches the earth's surface as a result of scattering by the atmosphere. Diffuse daylight is the light received from the sun after diffusion from the sky.

The BRE daylight calculations measure the percentage of the sky visible from the centre of each main window (the reference point). This is known as the vertical sky component (VSC), the percentage of luminance at a point on a vertical plane compared with that on a horizontal plane.

Calculating the vertical sky component

The maximum value for a VSC is 40 per cent for a completely unobstructed vertical wall. For a room with non-continuous obstructions there is the potential for good daylighting provided that the VSC at a window 2m above ground is equal to 27 per cent or more (BRE 209).

Because VSC calculations apply to opaque obstructions, an adjustment must be made when dealing with tree canopies:

Adjusted VSC = V2 + [Tx(V1-V2)]

V1 = VSC without obstruction (the maximum VSC)
V2 = the calculated VSC assuming the tree is opaque
T = light transmission % (expressed as a decimal)

Use of the skylight indicator to obtain the unadjusted VSC

Skylight and sunlight indicators are marked transparent sheets that can be laid on top of plans.

Each mark represents a percentage of skylight or sunlight. The calculation process for unadjusted VSC is as follows:

- check tree survey data to make sure canopy spreads on plan are accurate
- lay the transparent skylight indicator on the plan with base parallel to wall and its centre on the reference point on the plan
- the reference point is 2m above ground level, so subtract 2m from the tree heights
- the edges of the tree canopies should be represented by radial lines drawn to the actual edge of the canopy
- the distance of the obstruction is the distance from the reference point to the tree
- the height above reference point is the height of the tree minus 2m

The following can then be calculated:

distance of obstruction ÷
height above reference point

The resultant figure is marked as a line between the two radial lines that represent the sides of the canopy.

There are 80 crosses marked on the indicator, each representing 0.5 per cent of skylight (the maximum VSC obtainable is 40 per cent). All the crosses that fall outside the plotted obstruction(s) are counted. If a cross lies on the edge of an obstruction, half a cross can be counted. The total number of crosses is divided by two to give the unadjusted VSC.

Use of the sunlight indicator

- the sunlight indicator is laid over the plan with south parallel to the south point marked on the plan
- the obstruction is marked on the indicator as for the skylight indicator
- each dot on the indicator represents one per cent of available sunlight (100 dots in total)
- the dots outside the marked obstruction are counted, not including those that fall beyond the base line of the indicator which are beyond the wall and therefore do not enter the calculation

It is recommended that 25 per cent of annual probable sunlight hours should be available, with five per cent available between 21 September and 21 March. To achieve this there should be 25 unobstructed dots, at least five of them below the line marked equinox.

BRE 209 – further recommendations

Sunlight should be measured in terms of how many hours of sun a window will receive over the course of a year.
The BRE sunlight tests are applicable only to windows that face within 90 degrees of due south. BRE guidance recommends that main windows should receive at least 25 per cent of the total annual probable sunlight hours, including at least five per cent of the annual probable sunlight hours in the winter months between 21 September and 21 March. Sunlight availability will be adversely affected if the total number of sunlight hours falls below these targets and is less than 0.8 times the amount prior to the development.

It is suggested that for a garden to be adequately sunlit throughout the year, no more than two-fifths and preferably no more than a quarter of the garden or amenity space should be prevented by buildings from receiving sun on 21 March.

Example of VSC calculation

A beech tree has an unadjusted VSC calculated as 25 per cent. This does not fulfil the 27 per cent criterion for skylight. The VSC is adjusted to take into account that the tree is not opaque. From table 6 of BRE 209 we know that a beech has a transparency of 10 per cent when in leaf and 80 per cent when bare. The 10 per cent figure is used as this represents the worst case scenario.

Adjusted VSC = 25 + [0.1x(40-25)]
= 25+ [0.1x15]
= 25+1.5
= adjusted VSC of 26.5%

To calculate the adjusted VSC for the beech with bare branches:

Adjusted VSC = 25 + [0.8x(40-25)]
= 25+ [0.8x15]
= 25+12
= adjusted VSC of 37%

In this case the tree/building relationship does not allow for reasonable levels of skylight in accordance with BRE 209 when the beech is in leaf (less than 27 per cent) but does achieve it when the tree is bare. However alterations to the layout/design would probably not be considered necessary to improve the summer VSC by 0.5 per cent.

About JP Associates

JP Associates provides impartial, quality-assured consultancy to clients involved in development projects, or the management of woodland, open land or urban spaces across the south of the UK. Founded in 2000, the company is known for its friendly, responsive service and for delivering pragmatic solutions. Its three units are:

JPA Arboriculture
Independent consultants helping clients assess, plan, develop and manage sites with trees and hedgerows

JPA Trees & Development
Expert arboricultural partners for residential or commercial development projects

JPA Land & Habitat
Trusted advisors helping clients balance commercial, aesthetic and regulatory requirements, and manage invasive species such as Japanese knotweed.

JP Associates

46 St Peter Street
Tiverton , EX16 6NR
T: 01884 258430

Certificate Number 9587
ISO 9001, ISO 14001

To learn more about
JP Associates, please visit

www.jp-associates.co.uk