



Code of practice for

Trees in relation to construction

Code de bonne pratique pour les arbres du point de vue de la construction

Richtlinien für Bäume vom Standpunkt des Bauwesens

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Foreword

This code of practice has been prepared at the request of the Landscape Institute, formerly the Institute of Landscape Architects, and other organizations concerned with trees, to provide authoritative guidance of the principles that should be observed in achieving the satisfactory juxtaposition of trees and construction.

Trees fulfil certain unique functions in improving the environment and they require reasonable conditions in which to thrive. Underground services and building foundations also make demands on the ground. Space in built-up areas is at a premium and this can contribute to the intimate quality of cities, towns and villages. Trees and buildings are not incompatible, but it is essential to create conditions that can enable buildings to be seen in a setting of trees and function satisfactorily. Time is important when considering matters relating to trees; a large tree lost through negligence or misunderstanding cannot be replaced

for decades. Employers should ensure that the contractor, who rarely sees a tree deteriorate seriously while he is on site, takes precautions from the planning stage onwards to ensure the safety of valuable mature trees. It is essential that those concerned with development are educated in the need to take the necessary precautions to protect trees from damage during construction, in order to retain the maximum number of suitable trees in development areas. It is also essential that they are educated in the need to plant to ensure continuation of the treescape. Hitherto there has been no authoritative recommendation that a planning authority can quote in assessing the proposals for reconciling services, foundations and trees on development sites where existing or new trees are involved.

Because of the factors mentioned above, this code is deliberately published in the building series.

British Standard Code of practice for

Trees in relation to construction

Section one. General

1. Scope

This code sets out the principles to be followed in order to achieve the satisfactory juxtaposition of trees and construction.

It recommends types of trees for planting near buildings, structures, plant and services and gives advice on planting trees in urban locations and paved areas and also on maintenance.

2. References

The titles of the standards publications referred to in this code are listed on the inside back cover.

Section two. Reduction of damage to existing trees

3. Protection of trees

3.1 Existing trees in the vicinity of buildings create a maturity of landscape, that would otherwise be expensive and take decades to attain. It is therefore essential that trees on sites suitable for or awaiting development are adequately protected. Damage is likely to occur by way of vandalism, indiscriminate or accidental felling, or ignorance of the requirements of trees for survival.

Legal protection may be afforded by the implementation of Tree Preservation Orders (TPOs), Conservation Area legislation, or planning conditions, but the effectiveness of these ultimately depends on goodwill between the potential developers, owners and local planning authority. Trees may also require physical protection with fencing. Warning notices may also be required.

In order to ascertain the extent of landscaping requirements it will often be helpful for the local planning authority to discuss the form of development with developers, many of whom realize the value of retaining existing trees. This discussion should take place prior to application for planning permission.

A tree and site survey of existing details is essential for all parties at any pre-planning discussions.

3.2 Damage frequently occurs when fires are made during demolition of old buildings on sites. It is therefore essential that:

- (a) protective fencing is ordered and erected as soon after acquisition of the site as possible (see clause 6);

- (b) demolition contractors are given strict instructions to light no fires until protection of trees has been carried out;

- (c) the location and control of fires is agreed in advance with the developer or his professional agent.

4. Tree Preservation Orders and tree survey

4.1 Tree Preservation Orders. At this stage it is important to be aware of any existing or proposed Tree Preservation Orders or Conservation Areas, and the necessity of increasing the protection of trees to be retained that are not so covered, by the implementation of an Order.

Work that is required to be undertaken immediately for the purpose of carrying out development does not require consent under the current TPO regulations. Where planning permission has only been given on an outline application, felling, etc., cannot properly be said to be required 'immediately' for development and the exemption under the prescribed form of order does not apply. (See DoE circular 36/78 — Trees and Forestry (Welsh Office Circular 64/78).)

4.2 Pre-planning survey

4.2.1 It is recommended that an up to date pre-planning survey be made and be available both to developers and to the local planning authority, before application for initial planning permission.

4.2.2 All trees of 75 mm stem diameter and above, measured at 1.4 m above ground level, should be noted together with their height, branch canopy shape and spread (measured as radii along the points of the compass) and trunk lean. The position of stumps should be noted so that provision may be made for their removal to prevent them acting as an infection source for such as the Bootlace fungus *Armillariella mellea* and so that areas of possible future soil heave may be identified. Trees should be numbered for identification on site with, wherever possible, a small durable metal or plastics tag. Such tags should be at least 2.5 m from the ground and attached in a manner that allows for the growth of the tree.

It is essential that at the time of this survey spot heights of ground levels are recorded throughout the proposed development site if the effects of subsequent ground level alterations on retained trees are to be considered.

4.2.3 In addition, particulars will be required of trees on land adjacent to the development site that might be affected by the development or might be useful as part of the overall landscape effect of the area.

Large groups of shrubs and important hedge material should be noted.

4.2.4 Trees should be divided on the survey plan into the following grades ((a) to (d)), differentiated by hatching or colour.

(a) Trees to be retained at all costs:

- (1) dominant trees of the area, perhaps of unusual form and visual merit;
- (2) trees of special merit in scale relationship with buildings;
- (3) trees of particular importance to the topography, e.g. trees as a skyline;
- (4) trees of a historic value and commemorative trees;
- (5) rare or unusual species;
- (6) trees for screening or softening the effect of existing development in the near vicinity.

NOTE. In all the above cases, the trees are presumed to be in good health and of a reasonable future life expectancy, expected to be measured in decades.

(b) Trees whose retention is very desirable:

- (1) trees that might be included in (a) but, because of their numbers or their slightly impaired health, should be downgraded in favour of retention of a tree from the first grading;
- (2) young vigorous trees that grow well in the area;
- (3) trees suitable for providing shelter near buildings or recreation areas to improve the microclimate.

(c) Trees whose retention is desirable but not essential:

- (1) trees in good health, but not included in (a) or (b);
- (2) trees that could be retained with minimal tree surgery.

(d) Trees for removal:

- (1) dead trees or structurally dangerous trees;
- (2) trees with insecure roothold;
- (3) trees with fungal rot at base or on main bole;
- (4) trees with significant cavities containing incipient decay;
- (5) trees that will be exposed to risk after the removal of other trees for any of the reasons given in (1) to (4).

In view of the high costs of transporting semi-mature trees to a site, it may be of economic value to include a further grade in the pre-planning survey. This would indicate any trees at risk from the development that are suitable for on-site transplanting.

4.2.5 With the details described in 4.2.1 to 4.2.4 readily available, the designer for the developer will be able to determine and also agree with the planning authority on the best form of layout of the development, that optimizes the retention of the existing treescape. It will also make it easier for the planning authority to specify their requirements and will subsequently make approval more readily obtainable, with saving in labour, time and cost.

5. Planning

5.1 General planning

5.1.1 Introduction. The developer and his professional team, jointly with the local planning authority, should

consider the inter-relationship between the trees and the proposed development in the early stages of such developments.

Expert information should be available from the planning decision stage onwards to avoid problems hard to remedy later.

5.1.2 Alteration of existing microclimate and environment.

It should be noted that after any group of trees is thinned those trees remaining will be more susceptible to wind throw or wind snap where 'wind tunnel' effects are created by new-buildings (see also 17.4(d)).

The appropriate consultants should give an opinion in these cases. It should also be noted that felling of trees on the perimeter of woodland can cause duress to trees thus exposed, by additional evaporation, sun scorch and wind blow.

5.1.3 Trees retained in enclosed developments. Care should be exercised over misplaced tree-conservation in which large old trees are 'trapped' in enclosed places. Such trees are likely to die long before the new buildings are obsolete and their extraction will be either virtually impossible or extremely costly. (See note at end of 4.2.4(a).)

5.1.4 Damage to buildings by trees. Particular attention should be paid to the distance from buildings on shrinkable clays where structural precautions are not taken (see clause 8). Damage may be caused to buildings sited too close to trees. The extent of any damage depends on the type of tree and its age, condition, and mature height and spread, and on the building foundations, the type of structure and the type of soil.

5.1.5 Damage to trees by building and construction works. Damage to tree roots may be caused by excavating trenches for surface water and foul sewers, underground electricity cables, gas pipes, telephone ducts, water pipes, foundations, driveways, kerbs or highways. Local planning authorities should request that plans are submitted indicating the agreed lines and depths of all services on the site, with the aim of avoiding damage to the root systems of trees to be retained and averting future problems with new plantings in the vicinity of service runs.

Stripping of topsoil beyond the area to be occupied by the buildings, roads, paved surfaces or working areas should not be permitted.

Root deterioration and decay leading to the premature death of a tree (usually three or four years after a site has been developed) may be caused by changes in ground levels or grade. Similar problems are experienced from excessive compaction, resulting from the passage of construction vehicles; or as a result of ground works; or from the storage of materials within the branch spread of the tree.

All amended ground levels should be compared with those obtained at the pre-planning survey stage (see 4.2) and the opinion of a suitably qualified expert sought on the effect of such changes on the safe survival of the trees. (See also clauses 14 and 16.)

Branches may be damaged by tall cranes and tipping lorries. Indiscriminate branch reduction during installation of overhead services can also cause serious damage to the tree.

Plans indicating the agreed lines of protective fencing around trees to be retained should be prepared and issued to the contractor and the local planning authority prior to the commencement of work on the site. Protective fencing should conform with the recommendations given in 6.2.

5.2 Maintenance planning

5.2.1 Landscape maintenance schedule. Planning for maintenance is essential and requires suitably qualified and experienced personnel. This involves the preparation of a landscape maintenance schedule to include physical maintenance, pruning, spraying, weed control and associated tasks and, in exceptional cases, such provisions as lighting systems for the landscape scheme, e.g. floodlighting for trees.

5.2.2 Role of landscape architect. The landscape architect or designer should be responsible for seeing that there is adequate:

- (a) drainage of tree pits and shrub areas;
- (b) watering facilities;
- (c) space for well maintained planting;
- (d) access for maintenance;
- (e) room and protection where there is public circulation.

In consultation with the maintenance specialist he should advise on the maintenance regime, the type of maintenance equipment, and the materials required and their storage.

The landscape architect with the arboriculturist should make adequate provision in the landscape maintenance schedule for the supply of plant material, soil mix, fertilizers, manures and mulches, and for planting, staking, tying, protection and maintenance. They should be responsible for ensuring that the landscape maintenance schedule is properly implemented and supervised.

6. Protection of trees against damage on site

6.1 General. A tree fatally damaged while construction work progresses may not necessarily die within a year. Its life will depend upon the type and extent of damage from, for example, compaction of the soil, raising or lowering the water table, removal of roots and stripping of bark. A large tree may linger on for over five years or merely exist with little growth, prone to disease and insect attack.

6.2 Fencing around trees. Trees that are to be retained on site should be fenced to prevent damage to the boles and the root systems. Before any materials are brought on the site or any demolition or development commenced, it is essential that stout fencing such as post and rail fencing be erected around trees or shrubs that are to be retained, as indicated on the contract plan. This fencing should comply with the requirements of BS 1722:Part 7 or be strong and suitable for local conditions.

Protective fencing should be erected as nearly as possible to enclose the perimeter of the branch spread of each tree or shrub to be retained. In the case of fastigate trees, it will be beneficial to increase the area of protective fencing to a distance of up to the maximum of two-thirds of the height of the tree. Such fences should be satisfactorily maintained until all development has been completed. No work should be carried out within the fenced areas without prior consultation with the architect, the landscape architect and the arboriculturist.

If reduction or raising of levels in an area up to one-and-a-half times the diameter of the canopy of the tree cannot be avoided, an arboriculturist and landscape architect should be consulted for specifications. Fences should be re-erected immediately on completion of such works.

6.3 Identification of trees for removal. Trees that are to be removed should be marked with a timber scribe or paint, but it is important that those who are responsible for felling first check that the marked trees correspond to the ones indicated for felling on the survey plan.

6.4 Prevention of damage. It is essential that the contractor takes measures to ensure that trees intended to be conserved are not damaged by the works. The following measures are particularly important.

- (a) No oil, tar, bitumen, cement or other material likely to be injurious to a tree should be stacked within 10 m of a bole, and no materials whatsoever within 5 m of a bole.
- (b) It is essential that no fires be lit beneath or in close proximity to the canopy of a tree.
- (c) Trees to be conserved should not be used as anchorages for equipment used for removing stumps, roots or other trees or for other purposes except on the advice of an arboriculturist.
- (d) No notice boards, telephone cables or other services should be attached to any part of a tree.
- (e) Care should be exercised when using cranes or similar equipment near the spread of a canopy of a tree.
- (f) Trees to be felled that are adjacent to or that lie within a continuous canopy of trees to be retained should be carefully removed. In some cases a tree may have to be removed in sections to avoid damage.
- (g) Cement mixing should not be carried out within a distance of 10 m of a tree. It is essential that allowance be made for the slope of the ground so that caustic or other materials cannot be washed towards trees.

7. Amelioration of damage to trees on site

Where damage has already occurred expert advice should be sought. It may be possible to ameliorate the effect of damage by feeding, surgery or ground work as specified in BS 3998 and BS 4428 (see also clause 16).

Section three. Relation of trees to buildings, structures, plant or services

8. Influence of trees on building fabric

8.1 Introduction. As the natural condition of lowland Britain is tree cover, most buildings are likely to come into close proximity with trees during their useful life, owing to self-sown trees or to planting.

Trees enhance the surroundings of buildings visually and by improving the microclimate. In most situations they coexist happily with each other. However, trees may adversely affect the building fabric by direct action or, occasionally, indirect action. The latter predominates on shrinkable clay soils, which occur mainly in South East England (see figure 1).

This clause is intended to identify those particular situations when it may be necessary to consider precautions to ensure harmony between trees and buildings.

Knowledge of the interaction between trees and buildings is very limited owing to its complexity. Little is generally known about the pattern of water extraction from the ground by plants. Research programmes are continuing on

this subject and it is expected that comprehensive recommendations will be incorporated in this code at a later date. In the meantime this code of practice bases its recommendations on current good practice and such records of field observations as are available.

Users are recommended to seek expert advice, particularly that based on local knowledge.

8.2 Direct action of trees on building fabric. If trees are planted very close to buildings or buildings are erected very close to existing trees, contact between trees and buildings, trees and paving or trees and services may cause damage. The possible ways in which damage may be caused and recommended methods of preventing it are as follows.

(a) By the forces exerted due to the expansion of the trunk and near-surface roots. The effect of these forces may be obviated by root bridging (see figures 2 and 3) and by allowing sufficient clearance.

(b) By storm and wind causing the branches to move and strike the structure. Such branches should be pruned back to the branching point (see BS 3998). Where a tree and a building are in close proximity, such pruning should be repeated whenever necessary.

(c) By root systems disrupting underground services, particularly sewers, water mains and drains. Defective culverts or underground drainage may attract the roots of several species, notably poplar and willow, in their search for water. Such disruption may be overcome by the following:

- (1) re-routing the services;
- (2) adoption of a services specification that is sufficiently strong or flexible to accommodate the presence of roots;
- (3) attempting periodic root control. This requires current specialist advice on the health and stability of the tree.



(Based on Institute of Geological Sciences maps)

Figure 1. General location of clay soils in the British Isles

Where the firm, shrinkable clays occur
In South East England the firm, shrinkable clays occur in the shaded areas in the map below. Within these areas, some clays are more shrinkable than others. The following are examples of the more important clays.

Amphill clay
Gault
Kimmeridge clay
Lias
London clay
Oxford clay
Reading Beds clay
Wadhurst clay
Weald clay
Glacial clays derived wholly or in part from the above

Outside South East England
Carboniferous shales and glacial deposits are locally important, e.g. river beds, valley bottoms, flood plains. They are likely to shrink and swell in a similar manner to the firm, shrinkable clays of the South East.

8.3 Indirect action of trees on building fabric

8.3.1 The nature of indirect action. Indirect action by trees results from the removal of soil moisture by tree roots. When the soil is shrinkable clay the changes in soil moisture are accompanied by volume changes that can cause movement of building foundations. Such action is very complex because it involves the tree, the local climate, the soil and groundwater conditions, the building, and the interaction between them. While it is seldom possible to make precise predictions of the influence of trees on building performance, some understanding of the above factors is required when making a reasonable judgement. The factors are set out in 8.3.2 to 8.3.5.

8.3.2 Type of subsoil. The only types of subsoil that can be affected by the indirect action of trees are shrinkable clays; those subsoils that are predominantly granular are unaffected. Therefore, precautions are needed only when buildings and trees are near to one another on clay, and local conditions are such as to give rise to shrinkage. These conditions are mainly confined to the South East of England.

8.3.3 Ground conditions and shrinkable clays. To establish ground conditions clearly, a site reconnaissance and subsoil investigation by specialists are essential. Clay may be identified by its smooth greasy feel and by its plastic and cohesive properties. Clay soils are sticky in wet weather and have hard, cracked surfaces in dry weather.

Clays can contain relatively large quantities of water and its removal causes them to shrink. Such extraction of water can take place by evaporation and transpiration. Large trees that transpire large quantities of water in dry weather may cause extra-deep zones of desiccation, depending on the extent of their root systems, and the availability of ground moisture; as a result, significant ground surface subsidence may occur. Clays usually have low permeability so that replenishment by rainfall is slow except near the surface.

When trees are removed, replenishment of the desiccated zone produces swelling of the clay and a heaving of the ground surface. The process can take many years to complete. Local experience is valuable in assessing the likelihood of shrinkage or swelling of clays.

8.3.4 Root spread and moisture requirements. The spatial distribution of tree roots, extracting moisture from beneath foundations, is influenced by several factors, including the following:

- (a) soil type, density and permeability;
- (b) ground water conditions and the variable position of water-table;
- (c) nutrients in the soil;
- (d) local climatic conditions;
- (e) tree type;
- (f) local topography;
- (g) the presence of relatively impermeable surfaces such as roads and pavements.

Prediction of root spread is, therefore, extremely difficult. However, some species, namely poplar, elm and willow, generally have a higher moisture demand than other species, and case studies of poplar and elm have suggested that these species are more likely to cause damage. Site investigations should aim to determine root spread by identification of roots in excavations. Care should be taken to avoid damage to roots and the recommendations of 14.5 and 14.6 should be applied.

8.3.5 Building performance. Ground movements exacerbated through indirect action by trees on shrinkable clays may give rise to damage to buildings. The amount of foundation movement that buildings can withstand before structural distortion causes significant damage varies from one type and design of structure to another; for example, evidence shows that single-storey buildings, extensions, added porches and bay windows are most vulnerable. Materials used and construction techniques can also influence the vulnerability of a building to distortion performance. It is important to consider the degree of damage sustained; at low levels of damage it may not be possible clearly to attribute the cause to foundation movement brought about by clay shrinkage and tree roots. Many other causes of minor damage exist. Local knowledge is valuable in determining whether indirect action by tree roots has aggravated damage to structures in the past. As damage due to shrinkage of clays is often slight, care should be taken not to remove existing trees or limit new planting except in cases where such actions is indicated to be necessary (see 8.4.3).

8.4 Recommendations to minimize damage due to indirect action on shrinkable clays

8.4.1 Planting new trees near to new or existing buildings on shrinkable clay soils. If the soil is shrinkable clay and the foundations or superstructure of the existing building have not been designed for the effects of shrinkage and heave, there is a possibility of future damage if trees are planted too close to the building. The likelihood of damage, and its degree, are difficult to predict and will depend on all the factors mentioned in 8.3. Acknowledged local experience provides the best guide for safe planting distances from buildings.

8.4.2 Building near existing trees on shrinkable clay soils

8.4.2.1 Subsoil investigation. A subsoil investigation should be carried out in accordance with 8.3.2 to establish whether the soil is shrinkable clay. Such soil investigations should also establish the possible effects of roots and in clay soils probes should be inserted to the greatest depth that shows root traces or 5 m, whichever is the deeper. If consistent beds of non-cohesive soils under a clay soil, the soil investigation can be confined to the depth of the clay bed. Such limitations on depth clearly apply only to root effects, and investigations to establish a bearing pressure or other criteria may have other requirements. It is also important to determine the age of nearby trees in order to estimate likely future growth of root systems. Where possible, specialized advice relevant to the particular local conditions should be obtained.

8.4.2.2 Precautionary measures. Where the presence of shrinkable clay has been established and where roots have been found, or are anticipated in the future, it is advisable to take precautionary measures in the design of the building's foundation (in accordance with CP 2004 and CP 101). Alternatively, consideration should be given to designing the superstructure to accommodate any foundation movement that might be induced by clay shrinkage.

Where a subsoil investigation has not been carried out an approximate 'rule of thumb' guide is that on shrinkable clay, if risk of damage is to be minimized, special precautionary measures with foundations or superstructure should be considered where the height or anticipated height of the tree exceeds its distance from the building. It is hoped that the results of current research will enable more specific guidance to be given in the future.

The precautionary measures mentioned in the previous paragraph may take several forms.

- (a) Conventional foundations may be taken down to a depth not affected by tree roots.
- (b) Bored piles or deep intermittent bases may be installed which transmit loads down to more stable levels of subsoil.
- (c) The foundations may be designed to incorporate sufficient stiffness to resist the natural localized effect of roots; the effects of tilting also need to be considered.
- (d) The building may be designed and its materials may be so chosen that movement may be absorbed without physical distress.

CP 2004 gives further guidance and expert advice may be necessary.

If considering felling trees near planned construction, the risks associated with heave as described in 8.4.3 should be borne in mind, and foundations designed accordingly. The effect of soil swelling on buildings and their foundations through subsequent removal or the death of trees also needs to be considered.

8.4.3 Building on sites newly cleared of trees and shrubs on shrinkable clays. When trees and shrubs are removed from a shrinkable clay site the deep zones of desiccated clay will tend to absorb moisture that would have been taken up by the roots, and this will result in swelling of the clay and heaving of the ground surface. The rate at which soil heave takes place depends on the extent of the root system, the mass permeability of the ground and the groundwater conditions. In some circumstances the process of swelling, following tree removal, will continue for many years. Soil heave often takes place more rapidly than soil shrinkage, and can continue at a decreasing rate over some years and may in total be as much as 150 mm. It may also present a more serious problem than soil shrinkage. Soil heave also creates horizontal pressures.

It is important that site investigations determine the presence and extent of root systems. Unless sufficient time has elapsed for there to be no doubt that ground conditions have normalized, buildings should be constructed on foundations suitable to accommodate or resist ground heave. Choice of such foundations follows the same criteria as those for settlement (see 8.4.2). Certain additional precautions may therefore be necessary and specialist advice may be advisable. The following should be noted:

- (a) where piles are used, these should be sleeved for their top 3 m;
- (b) beams and slabs supported on piles or other deep foundations should be built with a space or a highly compressible material left beneath them to accommodate soil expansion;
- (c) piles should be designed to resist tensile forces created by soil heave, and supporting structures should be designed to resist the distortion in ground slabs created by heave and the localized tying action of piles or other deep foundations;
- (d) the horizontal thrust due to added earth pressure behind walls should be accommodated.

8.4.4 Existing trees near existing buildings. When building damage could be attributable to the indirect action of trees,

remedial action is unwise until the cause and degree of damage has been established.

It is important to bear in mind that most buildings develop minor cracks owing to causes other than foundation movement*. Even when minor cracks are attributable to the action of shrinkable clays it is usually unwise to take drastic remedial action immediately. Frequently, the soil will largely recover its original form during the winter rains, and as a consequence of this the cracks will partially close.

In order to determine whether clay shrinkage is likely to be the principal cause of damage a close examination should be made and the following information obtained.

- (a) The position and size of cracks both on the outside and on the inside of the building should be noted. If possible, levels of the damp-proof course should be taken at appropriate positions to establish the approximate magnitude and location of differential vertical movement. The form of damage should be consistent with foundation movement*.
- (b) The history of the site (including details of previous vegetation) and the building, and dates of observed movement and damage.
- (c) A subsoil investigation should have revealed the depth of the foundations, the presence of shrinkable clay and the presence of fine roots below the foundations (it is recommended that identification of roots and their activity be carried out).
- (d) The position, species and approximate age of all nearby trees and shrubs.
- (e) Location and condition of nearby drains.

Where the indirect action of existing trees has been identified as the principal cause of damage, considerable care and experience is required in planning remedial action and specialized advice should be obtained.

When the damage is slight and unlikely to become progressively worse, only minor cosmetic treatment to the building is usually required. The following factors should be borne in mind.

- (1) Where trees have reached maturity or are close to it, seasonal shrinkage and swelling movements can be anticipated, but large movements are only likely to occur in exceptional spells of dry weather. Felling can lead to worse damage due to swelling of the clay (see 8.4.3).
- (2) If trees that have been established as a substantial cause of damage are still far from mature there is a possibility that the damage will become progressively worse and specialized advice on remedial action should be obtained.
- (3) Small alterations in the environmental conditions such as the repair of a leaking drain or an increase in the area of paved surface between a building and trees, can lead to further root extension and the possible effects should be considered.

9. Damage to trees by buildings

9.1 Natural spread. When siting a building near to a tree the natural spread of branches of the tree should be taken into account. Tree branches can otherwise be damaged by continuously whipping against the structure, and branch

*Further information on this is available in BRE Digest 75 'Cracking in buildings'.

ends may have to be cut back, possibly spoiling the shape of the tree.

9.2 Effect of microclimate

9.2.1 Reflected heat. In some cases the shelter afforded by a building complex may be beneficial to trees. Heat, however, can damage trees, especially that reflected from building surfaces. As much ground cover planting or pervious surface as possible should be left around the tree.

9.2.2 Drought. Within a group of buildings it is possible that only limited areas can be left unpaved for trees. In the absence of a natural catchment area for rainfall, it is essential that the soil moisture is very carefully maintained and preferably only trees that are naturally tolerant of hot or dry situations should be chosen for these sites (see appendix A). It is necessary to water the trees on such sites regularly; misting with very fine water sprays can be very beneficial, these being turned on early in the morning by hand or remote control. Surface water drainage can sometimes be arranged to provide a regulated flow of water to trees. This water should be clean and should not be taken from, for example, roads. In all such arrangements attention should be paid to the need to avoid the collection of excess water near a tree.

9.2.3 Frost pocket. Adequate air circulation should be allowed where frost pockets would otherwise form. See also 17.4(d).

10. Atmospheric pollution

Most polluted atmospheres contain mixtures of pollutants. Until now sulphur dioxide and smoke have been considered as the most restricting in urban localities, but recent research suggests that ozone and oxides of nitrogen may be important. Other substances may be locally important, e.g. fluorides near brickworks and aluminium smelters.

Because detailed observations have not been made it is impossible to prepare definitive series of tolerance rankings. Nevertheless, experience suggests that some tree species are notably tolerant whereas others are sensitive to urban pollutants.

The following trees tend to be tolerant to urban pollutants:

Chamaecyparis lawsoniana (Lawson Cypress)
Taxus baccata (Common yew)
Thuja plicata (Western Red Cedar)
Acer campestre (Field maple)
Acer pseudoplatanus (Sycamore)
Fagus sylvatica (Common or European beech)
Platanus x hispanica (London plane)
Quercus spp. (Oak)
Robinia pseudoacacia (False Acacia)

NOTE. Whereas *Acer pseudoplatanus* (Sycamore) and *Platanus x hispanica* (London plane) tolerate most urban pollutant mixtures, they are sensitive to fluoride pollution.

The following trees tend to be sensitive to urban pollutants:

Cedrus atlantica (Atlantic Cedar)
Larix spp. (Larch)
Picea abies (Norway spruce)
Pinus strobus (Weymouth pine)
Pinus sylvestris (Scots pine)
Alnus incana (Grey alder)
Betula pendula (Silver birch)
Fraxinus excelsior (Ash)
Juglans regia (Common walnut)

11. Suitable trees

Appendix A gives a short guide to trees for consideration when planting in relation to construction.

12. Planning considerations

12.1 Environment. In a rural environment trees have the advantage of air that is little polluted and that has a higher humidity and lower temperature than town air. With the more adverse conditions found in towns it is necessary to choose trees that are better able to withstand such conditions. Also, in natural conditions, in the absence of hard surfaces to prevent water penetration, the water catchment area of the tree extends to at least the spread of the branches, the only problem remaining being competition from other plants. In towns, where such hard surfaces are prevalent, limited water catchment should also be a factor in the selection of a tree.

There are many ways of modifying the microclimate of built-up areas; for example, enough moisture will evaporate from pools and fountains, if sufficiently large, to contribute significantly to the humidity of the surrounding areas. Trees and shrubs should, where possible, be planted in a soft surface that enables penetration of water. These surfaces can be planted with groundcover plants which will increase the water vapour around the trees by their own transpiration and evaporation. It is, however, essential to maintain soil moisture.

There are some advantages to planting in towns. The microclimate formed by the buildings often allows plant material to be grown that would otherwise be unsuitable and difficult to cultivate in a countryside setting where, owing to lower ground temperatures, the aerial parts of plants lose more moisture than they take in through their inactive root systems. Buildings and pavings keep the ground warmer, therefore there is less chance of desiccation in the spring.

12.2 Choice of plants. Plants should be in harmony with their surroundings. In rural situations plants that will appear natural should be selected. It should be recognized that many other plants are suitable besides those included in the limited range usually described as indigenous or native. Such planting should sometimes be used on the perimeter of towns to provide an easy transition from rural to urban surroundings.

The British climate permits selection from one of the widest range of plant material in the world and advantage should be taken of this in the selection of plants for urban situations. The plants listed in appendix A are only a limited selection of the many available.

12.3 Highway considerations. When planting trees in streets, care should be taken that traffic hazards are not caused by the obstruction of visibility at street intersections or on the inside of curves, and the highway authority should be consulted at the planning stage. Similarly the lighting authority should be consulted to ensure that the planting does not reduce the adequacy of street lighting. The location of existing public utility services, drains and sewers should also be ascertained so that they can be avoided or adequate precautions taken. If new streets with trees are envisaged, space should be sufficient to allow for the above factors, and the schemes for street lighting and tree planting should be designed in conjunction with each other. Whether in relation to visibility or lighting, a plan should be made for the mature size of the trees to be planted.