INFORMATION SHEET
STRUCTURAL MATERIALS

NZ WOOD
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ROUNDWOOD
APPLICATIONS

The information provided below has been taken from the New Zealand Timber Design Guide 2007, published by the Timber Industry Federation and edited by Professor A H Buchanan. To purchase a copy of the Timber Design Guide, visit www.nztif.co.nz

Roundwood poles have a wide range of uses in engineered applications, including pole foundations for buildings, pole frame houses, poles in industrial buildings and non-building uses such as retaining walls, fencing and wind shelter structures. Poles are also widely used for transmission lines, bridges and marine structures.

POLE AND PILE FOUNDATIONS FOR HOUSES

In typical timber framed house construction, pole or pile foundations are used to support the timber bearers and joists of the ground floor platform of the house. Pole foundation systems have become very popular for houses since the mid 1970's, especially on sloping sites.

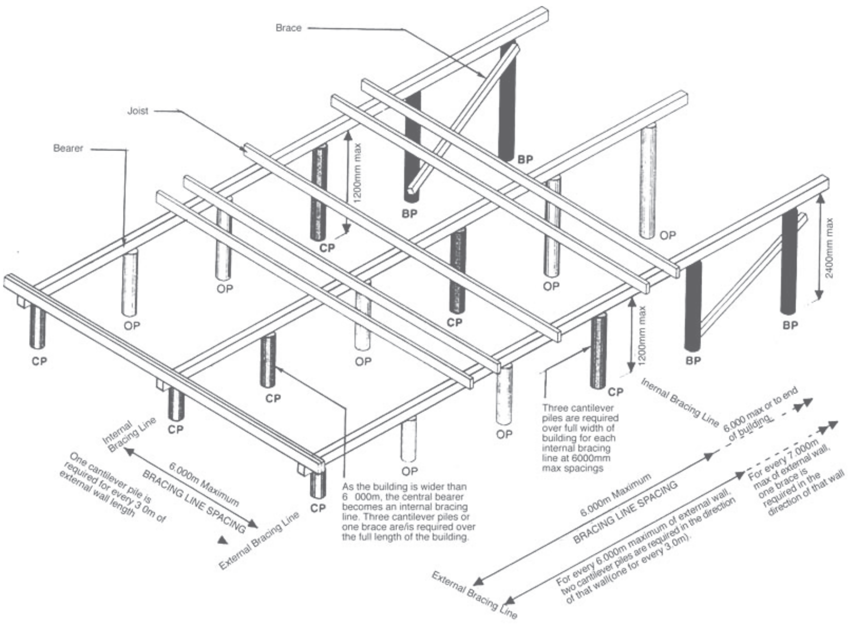
NZS 3604

Detailed requirements are specified in NZS 3604, the *Code of Practice for Timber Frame Buildings*. A step-by-step guide to this code, *Foundation Bracing Guideline* is available. When pole spacings are required to be larger than permitted in NZS 3604, or pole heights exceed 3.0 m, specific engineering design is required.

TYPES OF PILE

Most timber house foundations are either square timber piles embedded in concrete, or driven round timber poles. For both square and round piles, NZS 3604 specifies four types of piles; **Anchor Piles** and **Cantilever Piles** which resist lateral loads with no diagonal bracing, **Braced Piles** which are restrained with diagonal braces, and **Ordinary Piles** which carry gravity loads only. Diagram 1 shows the different types of house piles.

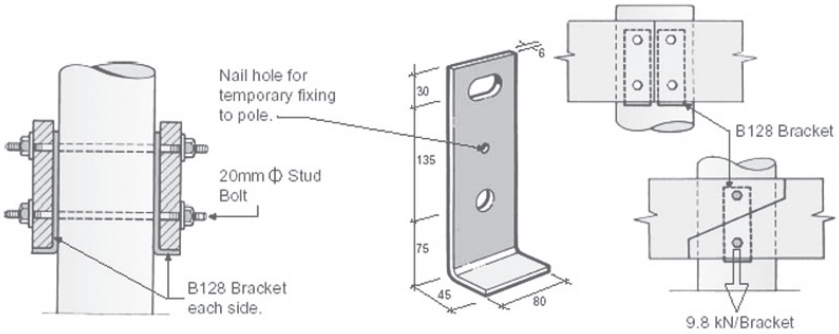
Diagram 1: Different types of house piles



CONNECTIONS TO HOUSE

A critical part of a pole or pile foundation system is the connection between the foundations and the house. NZS 3604 is a performance-based code which specifies 6 kN connections at the top of cantilever piles and 12 kN connections at the top of anchor piles or braced piles. To meet the performance requirements, connections must have been tested by an approved laboratory. A range of proprietary connections are available for such connections. A double bearer typical connection is shown in diagram 2.

Diagram 2: Proprietary connection of a double bearer (with splice) to the sides of a round pile



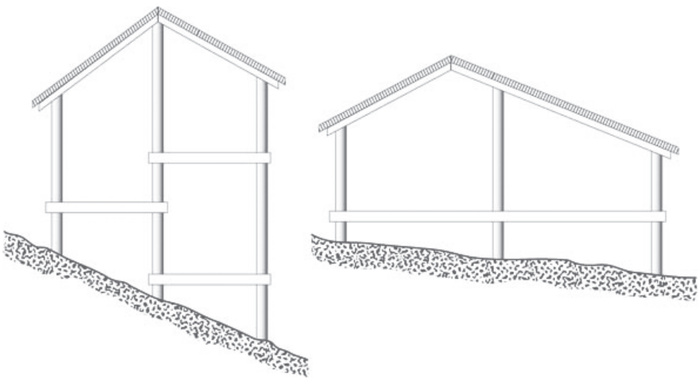
BRACING

Sub floor bracing has to be carefully designed. The connections of the bracing are most important, with different details depending on whether the brace is parallel to the joists or to the bearers, and which members the brace is actually connected to. Common problems are lack of connections providing resistance to "roll-over" of the joists or beams, and excessive scarfing of pile tops at connections to bearers. Consult the manufacturers' literature for a wide range of details.

POLE FRAME OR POLE PLATFORM HOUSES

Pole frame houses use round poles for the load-bearing structure at both the foundation level and continuing through to higher levels. The poles can be either inside or outside the walls, depending on the design. Construction of pole frame houses is fast and simple, because a multi-storey framework of poles and double bearers can be erected quickly, with floors, roof and walls following. Two possible arrangements are shown in diagram 3. More common is the pole platform house where the dwelling is a standard form of construction on a platform constructed with a substructure of braced poles.

Diagram 3: Pole frame houses



BRACING

Lateral bracing is required in pole houses, to maintain strength and prevent excessive movement under usage, wind or earthquake loading. Bracing can be steel or timber diagonal bracing. Knee braces are less effective. Bracing should carry forces from the floor diaphragm to a pile close to ground level (or to the next floor in a multi-storey building).

Braces should not be more than 6 metres apart, and the horizontal component of the design load in each brace should not exceed 20 kN. When a heavy brace is attached to a pole, the pole size should be checked for local bending and shear stresses. A few examples of bracing details are illustrated in diagrams 4 and 5. Steel rods with turnbuckles are also often used for bracing of pole structures.

Diagram 4: Proprietary Bracing connection to braced piles (from MiTek New Zealand Ltd)

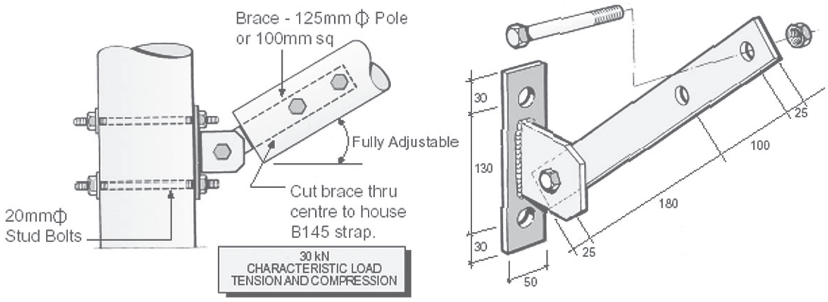
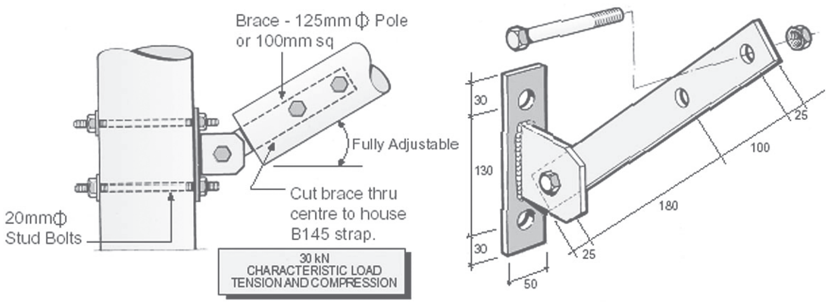


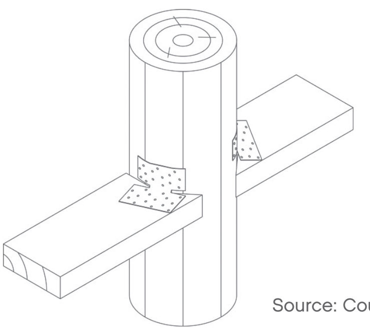
Diagram 5: Proprietary diagonal bracing connections (from MiTek New Zealand Ltd)



POLE-TRUSS INDUSTRIAL AND AGRICULTURAL BUILDINGS

Pole truss buildings, are fast and economical for single storey industrial or agricultural buildings. The cantilever poles are usually grouted with concrete in drilled holes in the ground. They serve a dual function, carrying gravity loads from the roof and resisting lateral loads from wind or earthquake in simple cantilever action. In small span buildings, the truss may be replaced by simple rafters of sawn timber, glulam or LVL. If the truss has some depth at the knee, then some frame action can be relied on to resist lateral loads. With a pinned connection, all lateral loads must be resisted by cantilever action. Simple metal plates can be used to connect wall girts to the poles. An example is shown in Diagram 6.

Diagram 6: Girt to pole connection



Source: Courtesy MiTek.

UNIFORM DIAMETER POLE STRUCTURES

Uniform diameter pole structures can be used for buildings. Proprietary joint systems and sculptured ends of poles, engineered frame structures and cantilever structures are provided for residential, commercial, recreational, agricultural and industrial buildings by specialist manufacturers. The buildings are specifically designed to the customers' needs and supplied as kitsets. Uniform diameter treated poles can be used for purlins and girts, also for cantilever columns set in concrete in the ground and for portal frames using proprietary steel connectors at the knee and apex joints. Further information can be obtained from the manufacturers (see Further Reading)

Fencing, gates and windshelter structures can also be built with uniform diameter poles. Where aesthetics or the need for uniformity of line is important, uniform diameter poles provide attractive and practical options for fencing, gates, bridges, jetties, playground equipment and wind shelter structures. Further information can be obtained from manufacturers.

RETAINING WALLS

Cantilever pole retaining walls

The most common retaining wall system has nearly vertical cantilever poles driven into sound foundation material or grouted in concrete, supporting H4 or H5 treated horizontal rails which are rounds, half rounds, or sawn planks. Cantilever retaining wall heights in sound founding material up to 3.0 metres are achievable with normal density poles. Higher walls (to 4.0m or 4.5m) are possible if stronger poles can be sourced (density over 450kg/m3) and, if needed, a tieback system incorporated in the design.

Assessments by the engineer of the properties of the backfill material, the slope of the backfill, surcharge pressures behind the wall and the proximity of the wall to boundaries are all issues needing careful consideration and selection. Some proprietary literature provide design charts for walls with many exceptions. These should only be used (and with care) for preliminary design. The final design should be carried out by engineers experienced in the design of these structures.

Tied retaining walls

For walls higher than about three metres, simple cantilever poles may become uneconomic. Much higher walls can be built with tension members which tie the poles back to the slope at regular intervals. The ties can be galvanised steel rods anchored to suitable supports such as treated timber planks, vertical or horizontal buried poles, or precast concrete, or anchored in the fill material itself. Corrosion protection of the steel rods or any tie back system must be considered carefully. Specialist specific engineering design is necessary for tied retaining walls.

Horizontal rails

The retaining structure between the vertical poles usually consists of horizontal rails, made from sawn timber, small diameter poles or half-round poles. Design is based on strength and serviceability from the design actions of the earth pressures and surcharge at the various levels behind the wall. Engineers make judgements on the allowable deformation of the rails and whether or not to connect the rails to each other with steel dowels to ensure uniform movement (where appearance is important). Consideration may be given to providing a nominal horizontal gap between all the rails, to allow easy dispersal of any water which may build up behind the wall (eg a burst water main or a blocked drain).

Typical construction details for cantilever pole retaining