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Foundation Developments for Arctic and Poor Soils Conditions

Nouveau type de fondations pour des conditions de sol difficiles

Neuartige Fundationen für arktische und wenig tragfähige Böden

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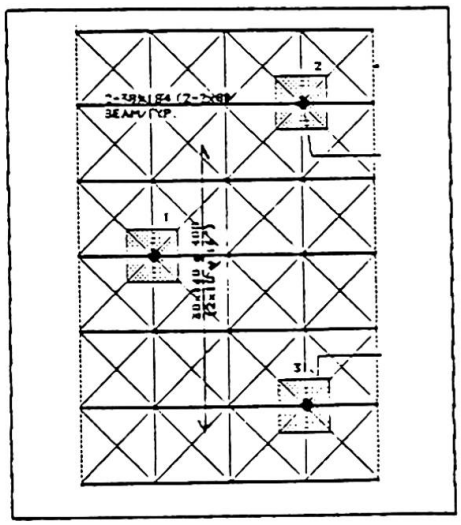
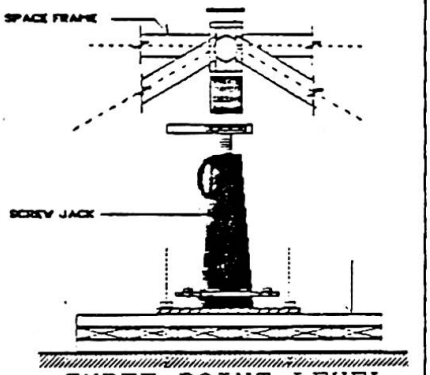
It is expensive to repair or replace residential buildings in remote Arctic locations damaged by differential foundation movement and frame racking. This paper highlights a Canadian Arctic residential foundation research program directed toward the development of practical and cost effective structural systems that will eliminate this problem. A tubular metal space frame chassis and plywood monocoque superstructure on three point or multiple point bearing conditions are two systems that are presently undergoing both theoretical computer modelling as well as field demonstration and testing.

Various combinations of geotechnical and structural foundation systems are traditionally used in Arctic residental construction including piles, surface pads/wedges and buried pad and pier. The performance of these systems are dependent on the construction process, geology, and level of maintenance. A purely structural solution reduces the number and complexity of the variables and increases the probability of providing long term stable support for the residential structure. A three dimensional metal space frame under the house or a stress skin shell structure encorporated into the wood frame superstructure are the two structural systems being developed. Either structural system could be simply supported on three determinant bearing points which has the advantage of eliminating torsional racking forces but increasing bending and bearing stresses.



THREE POINT SPACE FRAME MODULE PLAN

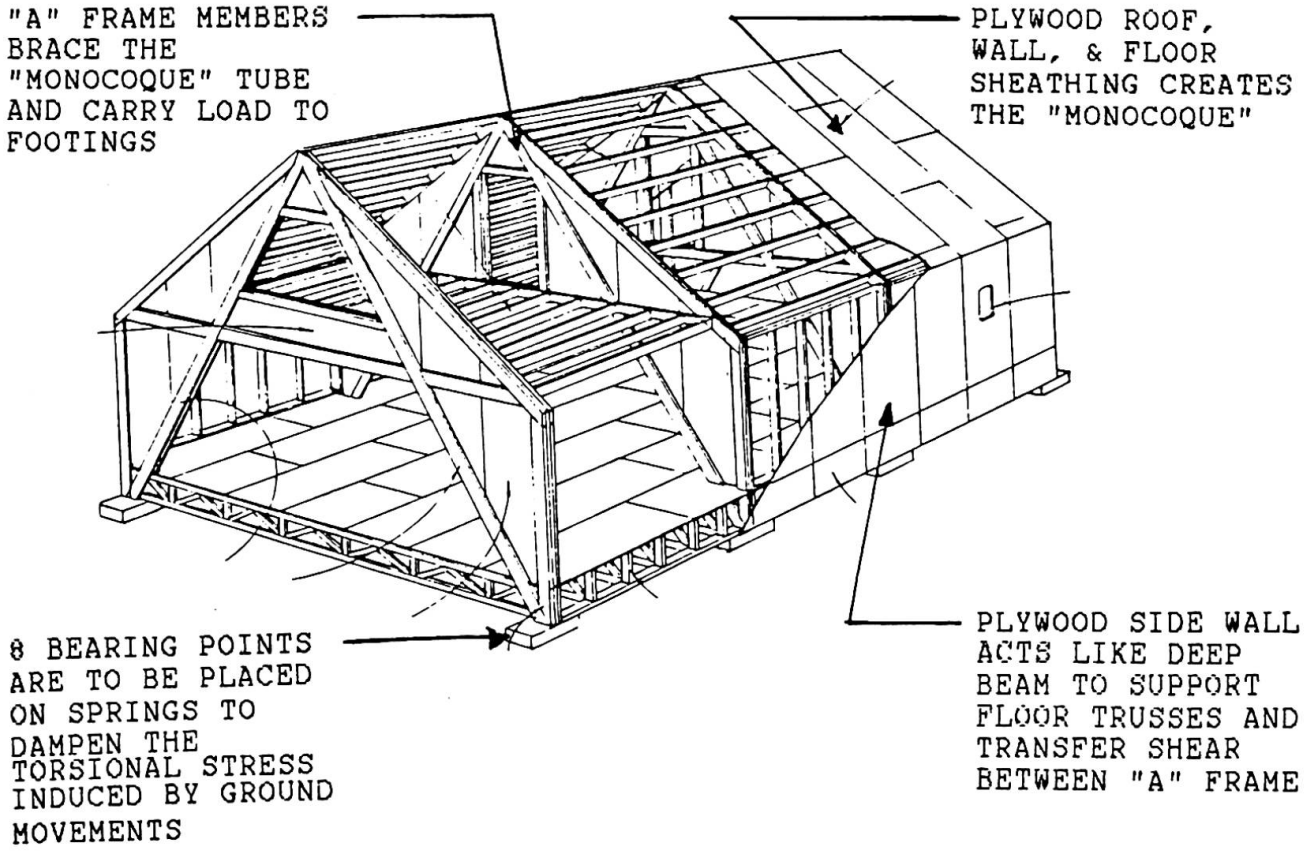
A space frame on three bearing points was designed and manufactured by Triodetic Building Products Ltd. and constructed under a house in Rankin Inlet, NWT in 1985, whose steel pile foundations had failed. Maximum deflections were calculated to be 44 mm but measured to be 7 mm with no damage to the plaster board finishes. Double tubing was required at each of the three bearing points to reduce the stresses caused by the focus of loads. Other disadvantages of the three bearing point concept are that the structural system limits the floor plan and specialized engineering design and construction are required.



THREE POINT LEVEL SCREW JACK DEVICE

A modular multiple bearing point concept would overcome the three point limitations but would also introduce torsional racking forces. Both the space-frame and monocoque systems can be designed to resist torsional racking forces caused by differential ground displacement however, to reduce the structural framing requirements, it is advantageous to dampen footing displacements. Proto-type development and testing of dampening devices such as metal springs, air bags, and foam gasket materials are underway. The top of the soil layer may provide a dampening effect and reduce over-stressing forces by slighlty undersizing the footing plates so that any overloaded footing will fail the soil on a local basis and redistribute the load. A frame was installed in Hay River, NWT, in 1987 that is designed according to this philosophy.

A multiple bearing point and rack resistant monocoque structure is in the design stage and will be constructed and lab tested in Vancouver, B.C. in 1988. This full scale testing under controlled loading and displacement conditions will produce optimum designs for production purposes. Although these foundation systems are being developed in Arctic soils conditions such as discontinuous permafrost, the concepts could find application in conditions where soils are generally unstable such as expanding clays and unstable silts.



MONOCOQUE CONCEPT

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