INTRODUCTION

Recent research [Enermodal 1996, Kosny and Desjarlais 1994, Christian and Kosny 1995, Tuluca et al. 1997] has shown that thermal bridging through framing and at corners and junctions can significantly reduce the thermal resistance of wall and roof assemblies. Many transient calculation programs ignore this effect. Even for those that do account for the reduced thermal resistance, the transient or dynamic behavior of the thermal bridging is almost never taken into account in transient building energy simulation programs. These whole-building programs were calibrated using field data for lightweight wood-framed walls and assuming one-dimensional heat flow through walls. However, the material variations introduced by thermal bridging elements can affect the dynamic performance of the building envelope, by altering the temperature distribution and dynamic characteristics. These multi-dimensional effects raise concern over the ability of simulation programs to model the thermal performance of steel-framed walls and masonry walls with significant thermal bridging.

It has been known for some time that massive walls (concrete-block, monolithic concrete or brick walls) have a strongly time-dependent behavior, and cannot be accurately represented in transient building energy programs by a simple R-value, yet this is what is most commonly done. The result can be an inaccurate computer model, higher than expected energy use and improperly sized heating and cooling equipment. Also, many building codes and performance-based building design standards such as ASHRAE 90.1 rely on accurate computer simulation models to deliver a level of energy performance that may not be accurate without including transient and multi-dimensional effects.

It is possible to account for these effects in transient simulation programs, however, as long as the model is developed correctly. What is required is a method of allowing programmers to accurately represent the transient and multi-dimensional aspects of common thermal bridges in transient simulation programs. The development of a simplified model, referred to as “the equivalent wall model”, as described in this report, is intended to provide such a method. Specifically, the objectives of this research project are fourfold:

- to identify common building assemblies with significant thermal bridging
- to develop a library of simple response factors and transfer function coefficients or equivalent wall properties representative of these common details, which include transient and multi-dimensional effects;
- to validate the simplified model and compare it to the detailed three-dimensional model; and

- to develop clear guidelines on how to use the response factors and transfer function coefficients or equivalent wall properties.