**plans plus**
**architectural and structural design**
**konstantin ashkinadze, p.eng.**
**consulting engineer**

**#202, 8704 - 51 avenue**
**edmonton, alberta**
**t6e 5e8**

**phone: (780) 719-4188**
**fax: (780) 468-0059**
**web: www.planspls.com**

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Safety Services Branch
Alberta Municipal Affairs
16th Floor, Commerce Place
10155-102 Street
Edmonton, AB T5J 4L4

Dear Sirs,

**Re: Request for Review of Current Practice of Construction of Concrete Foundations in Houses**

As the revised Building Codes are currently under public review, I would like to make a submission and possibly initiate an examination of the practice of construction of concrete basements of residential and commercial buildings in Alberta, falling into the scope of "housing and small buildings" as defined in Clause 2.1.3.1 of the current Alberta Building Code.

It is my firm belief that the present day practice of construction of such basements is inadequate. The firm I represent – Plans Plus and Konstantin Ashkinadze, P.Eng., Consulting Engineer – and its direct business predecessor, Brown Engineering, for several decades were involved in assessment and expertise of concrete construction for housing and small buildings in the province. Being an inspector for buildings retained by the City of Edmonton, I have personally inspected dozens of concrete basements, ranging from brand new to 90 and more years old. My inspection findings, as well as an analysis of current design practices and codes, form the basis of the present submission.

In Alberta, concrete basements are built by custom and tradition, not by engineered design. Clause 9.15.4.1 of the Alberta Building Code is interpreted in such a way that structural reinforcement (in the form of tied together, regularly spaced vertical and horizontal bars) is not required in the walls meeting certain criteria of height and thickness. In keeping with it, the Illustrated Guide for the National Housing Code 1998 (para. 2.3) does not show or mention any rebar in the concrete walls. While the minimum thickness limitation is indeed necessary (to reduce bulging of the wall under the soil pressure in the uncracked state), it should not, in my opinion, negate the need for proper reinforcing in the walls. The concrete design code (CSA A23.3-94) allows the use of

unreinforced plain concrete (the “two rebars at top and bottom” don’t count, this is too small an amount to be considered) only for members in uniform compression or continuously supported by the soil (Clause 22.1). The concrete basement walls are neither. Then, why are they allowed to be unreinforced?

Heavy waterbearing clays of glacial and lacustrine origin covering most of the Province of Alberta, can exert a significant and variable pressure on the basement walls. Swelling of these soils under frost and wetting cycle further increases it. Finally, in many areas the soils are chemically aggressive and tend to physically dissolve the concrete, especially if it is not made with sulphate resistant cement. Ravines, valleys, slopes, underground creeks, or other discontinuities which are abundant in Alberta, cause the soil to move sideways, forming cracks and tearing apart the foundations.

At present, there are hundreds of houses in Edmonton alone (mostly in the city centre and the east, but also in other areas of the city) whose foundations are in a structural distress, sometimes, to the point of an imminent danger of collapse. We have on file dozens of photographs and other materials to support this claim. Plans Plus has worked in close collaboration with the City of Edmonton building authorities to identify such houses and repair them. However, there is no easy way to save these houses. When they are worth salvaging, then at least they need a new foundation (which could cost $30K-50K in each particular case, which adds up to millions of dollars). This becomes a major technical and economical issue which directly affects quality of life and safety of the public.

My greatest concern, however, is about new houses, being built nowadays with repetition of the same mistake over again. Designs prepared “en masse” by home building organizations, are detailed in every aspect except the construction of the foundations. At best, they specify the wall thickness, the footing width, and the traditional “two rebars at top and bottom”. All the rest is left to the discretion of the contractor. Given the volume of residential construction today, we are creating tomorrow’s million-dollar problems simply by refusing to put the rebar where it logically belongs.

Oddly enough, the practice of construction of concrete walls with no reinforcing, or with less than the minimum amount of reinforcing, which was largely instituted by do-it-yourselfers in the wake of the 20$^{th}$ century with very limited understanding of how foundations work, is now finding “theoretical substantiation” from professional engineers. In 1992-1996, the University of Alberta researchers published a series of articles in the Canadian Journal of Civil Engineering (see References) trying to justify construction of thin unreinforced wall foundations from an engineering standpoint. The theory presented relied wholly on tensile resistance of the concrete. In keeping with this, the Alberta Home Builders’ Association has on file a report prepared by Bearden Engineering, titled “Guideline for Lateral Bracing of Residential Concrete Foundation Walls” (November 1999). This report forms a basis of the Table 9.15.4.1.A and B of the Alberta Building Code 1997, which stipulate maximum heights of unreinforced walls

with or without restraint at the top. The report states clearly that the calculations are based on an uncracked concrete wall section.

Obviously, resistance of concrete walls to lateral soil pressures cannot be substantiated without recourse to concrete tensile strength. But such a recourse is a direct violation of the very basic principles of concrete design (see CSA A23.3-94, Chapter 10). It should be understood that endorsement of a professional has a tremendous weight for designers and builders. It is not enough to simply say "that's the way it's always been built, and it stands up". The mentioned authors (Dozzi et al., 1992) state in their paper that "conventionally built unreinforced concrete foundations have historically performed well under field conditions". Yes, new foundations, on average, perform adequately (if properly built); but as they age, problems with their structural strength start to compound. Note that only a small percentage of foundation failures becomes known to the engineering community.

Reliance on concrete strength in flexural tension is wrong not only theoretically but also practically. The quality of concrete used in basement construction in Alberta has historically been less than perfect. In the first decades of the 20$^{th}$ century, river-borne gravel and sand with high silt content were widely used in concrete construction. These materials, besides being weak, have near zero adhesion to cement paste and could not produce a solid concrete. But even now, it's a struggle to get anything over 20 MPa on a residential construction site. The concrete is routinely diluted with water on site to improve workability (at the expense of structural strength). The formwork is often not properly coated with release agent and tears chunks of concrete off when removed. It is not uncommon to see interruptions in concreting operation which lead to formation of "cold joints". Winter concreting often causes "thermal shock" to the structure when heat is turned on, in addition to the "normal" temperature and shrinkage deformation and cracking of fresh concrete. In general, as the construction practice shows, solidity of residential concrete cannot be relied upon. In the last year alone, I had several calls to inspect basements that were either brand new (still under construction), and cracked when heat was turned on, or middle-aged but solidly built and had the history of adequate performance for decades, and now suddenly ruptured because of long-term soil consolidation and subsidence, or construction activities in the area. In both cases, the structural damage was extensive and hard to repair.

It should be understood that an unreinforced wall, once a crack from whatever reason has formed, has irrevocably lost its integrity. Now, if the wall is subjected to lateral soil pressure and soil-imposed deformations, the crack is free to expand and widen without limitation, till pieces start falling out. Wide opened cracks, besides structural problems, can give rise to leaks and black mould development, which is unhealthy and can cause severe allergic reactions in the inhabitants.

It is difficult, if not impossible, to prevent formation of cracks in concrete basement walls (and in concrete structures in general). However, their uncontrolled and dangerous

opening can be prevented if the walls are properly reinforced. Because of this, CSA A23.3-94 calls for the minimum amount of reinforcing in the walls 0.15-0.20% (Clause 14.3.2 and 14.3.3), which is also endorsed by ABC 1997 Clause 9.15.4.1(3). For the common 8″ thick walls, it amounts roughly to 10M bars at 12″ on centre vertically and horizontally. I can't see this being a critical cost item in the construction budget of a modern house. A professionally done cost analysis for an actual size basement included in the cited paper by Dozzi et al., suggests that the cost of reinforcing to the extent required by the concrete design code would be 4-4.5% of the cost of the basement alone, and a negligible percent of the cost of the entire house.

The purpose of the present submission is not to "outlaw" dozens of thousands of houses that have been built to date without proper reinforcing in the concrete walls. The purpose is to stop replicating the problems, by changing the way the present-day houses are built. It is better to correct the impropriety sooner than later, and later than never. I hereby suggest that a review by a board of involved professionals be undertaken to make a decision whether the evidence available is sufficient to change the Alberta Building Code in Part 9, Chapter 9.15.4, and abolish the practice of construction of concrete basement walls of houses and small buildings without reinforcement to the extent stipulated by CSA A23.3 Clause 14.3 as a minimum amount.

Respectfully submitted by:

Konstantin Ashkinadze, P.Eng., D.Sc.(Eng.)
Plans Plus
#202, 8704-51 Avenue
Edmonton, AB T6E 5E8
Phone (780) 719-4188
Fax (780) 468-0059
E-mail email@planspls.com

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