POLICY RECOMMENDATION 2013-2

SEISMIC PROVISIONS FOR DESIGNING SCHOOLS AND PUBLIC BUILDINGS
(ADOPTED 14 NOVEMBER 2013; UNANIMOUS)[1]

The Alaska Department of Education and Early Development, Department of Public Safety (Division of Fire Safety), and Department of Transportation and Public Facilities should temporarily adopt the seismic provisions in the 2012 International Building Code (IBC) for designing future new schools and public buildings, or structural retrofits thereof, versus using the seismic provisions in the 2009 IBC currently in effect. The seismic provisions in the 2012 IBC reflect a number of significant technical changes from the 2009 IBC, all very relevant for Alaska, which would improve the resiliency and safety of future schools and public buildings until such time as the full 2012 IBC is adopted by the State.

BACKGROUND

Alaska statute requires that building structures be designed following the triennial International Building Code (IBC). The State adopted the 2009 IBC effective November 2012. The 2012 IBC was published in February 2012, but will likely not be adopted by Alaska until possibly 2015.

The seismic provisions in the 2012 IBC reflect a number of significant technical changes from the 2009 IBC, all specifically intended to improve the structural resiliency of buildings to resist earthquake loads. The technical changes in the 2012 IBC seismic provisions most relevant to building designs in Alaska include:

- Design ground motions in the 2012 IBC are based on the most recent USGS probabilistic seismic hazards maps for Alaska, published in 2007, which reflect much improved characterizations of the principal known earthquake sources across the state. The 2009 IBC uses the USGS maps for Alaska published in 1998.
- The 2012 IBC design ground motions provide a uniform one-percent in 50-years risk target of building collapse. The design ground motions in the 2009 IBC, and proceeding editions, are derived from a uniform hazard maximum considered earthquake with a probabilistic return period of 2,500 years. This represents a significant change in basis of determining seismic ground motions and loads, and is intended to improve the consistency of structural designs across the United States to prevent building collapse; which is the over-riding principal safety objective of the code.
- Design ground motions in the 2012 IBC reflect the maximum directional component of the ground motion, which is approximately 10 to 30 percent greater (depending on the period of the motion) than the geometric mean of the two principal horizontal motion directions used in the 2009 IBC. However, the 2012 IBC also set a ‘deterministic’ upper

[1] This conforms to the Western States Seismic Policy Council (WSSPC) Policy Recommendation 13-4, *Seismic Provisions in the 2012 International Building Codes*, which was adopted in November 2012.

limit for the design ground motions at sites near large, active sources; which control the design ground motions over much of southcoastal Alaska.

- To evaluate the potential for earthquake-induced ground failure (e.g. liquefaction, settlement, lateral spreading, slope instability, etc.), the 2012 IBC uses an index peak ground acceleration (PGA) with a slightly lower probability of occurring versus the building design ground motions. The 2009 IBC uses an index PGA that has the same probability of occurring as the building design ground motions. This change reflects the current reasoning of code officials and seismic engineers that more conservancy is warranted in the geotechnical evaluations to improve confidence that the ground does not fail before the structure; a fundamental condition of all model building codes.
- Details are improved for seismic design of critical nonstructural components such as stairways, doors, suspended ceilings, etc.

The consequence of these changes in Alaska will be most dramatic to the structural design of taller or more flexible buildings, and the geotechnical investigations for all buildings. For example, the 2012 IBC design ground motions in regions of Alaska characterized with moderate to high seismic activity will generally be within plus or minus five to 15 percent of the 2009 IBC values for short period (e.g. short and stiff) structures, but over 15 to plus-30 percent greater than the 2009 IBC values for longer period (e.g. tall and flexible) structures. Further, the index PGAs used in Alaska to evaluate the potential for earthquake-induced ground failure are roughly 25 to plus-50 percent greater than the values used in the 2009 IBC.

In conclusion, the Commission believes that the seismic provisions in the 2012 IBC are more up-to-date and appropriate for use in Alaska versus the seismic provisions in the 2009 IBC, the building code presently enforced by Alaska. Therefore, the Commission believes that applying the seismic provisions of the 2012 IBC would improve the resiliency and safety of future schools and public buildings until such time as the full body of the 2012 IBC is adopted by the State.

Implementation & Assessment

The Commission will prepare a position paper providing more complete background and discussion to support the policy recommendation. The position paper will then be submitted directly to the Commissioners of the Alaska Department of Education and Early Development, Department of Public Safety, and Department of Transportation and Public Facilities.

Measure of this policy recommendation will be gauged by its acceptance and adoption by the targeted departments.

The Commission's Schools, and Education, Outreach and Partnering Committees will be responsible for the implementation and assessment of this policy recommendation.

POSITION PAPER (*APPROVED 21 APRIL 2014*)

SEISMIC PROVISIONS FOR DESIGNING SCHOOLS AND PUBLIC BUILDINGS

In compliance with its statutory powers and duties, the Alaska Seismic Hazards Safety Commission unanimously approved *Policy Recommendation* 2013-2[1], which states:

> *THE ALASKA DEPARTMENT OF EDUCATION AND EARLY DEVELOPMENT, DEPARTMENT OF PUBLIC SAFETY (DIVISION OF FIRE SAFETY), AND DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES SHOULD TEMPORARILY ADOPT THE SEISMIC PROVISIONS IN THE 2012 INTERNATIONAL BUILDING CODE (IBC) FOR DESIGNING FUTURE NEW SCHOOLS AND PUBLIC BUILDINGS, OR STRUCTURAL RETROFITS THEREOF, VERSUS USING THE SEISMIC PROVISIONS IN THE 2009 IBC CURRENTLY IN EFFECT.*

This *position paper* summarizes the differences between the 2009 and 2012 building codes, and explains why the seismic provisions in the 2012 IBC are more appropriate for designs of new schools and other public buildings in Alaska.

BACKGROUND

Alaska statute requires that publically funded buildings be designed and constructed following the International Building Code (IBC), which is updated and reissued every three years. The 2009 IBC [4] was adopted and amended to Title 13 of the Alaska Administrative Code (*Chapters 50 through 55*) effective November 2012.

The 2012 IBC [5] was published in February 2012, but will likely not be adopted by Alaska until possibly 2015. The seismic provisions in the 2012 IBC include a number of fundamental changes from the 2009 IBC, specifically intended to improve the structural design and resiliency of buildings to resist earthquake loads and effects of earthquake-induced ground failure. The changes most relevant to building designs in Alaska are related to the ground motions specified for structural design and geotechnical investigations, as discussed in the following sections.

STRUCTURAL DESIGN GROUND MOTIONS

The 2009 IBC and 2012 IBC both follow the same procedure to establish the seismic ground motions, which are in turn used to determine the building importance factor, seismic design category, and structural design loads. However, there are several fundamental changes in the 2012 IBC which directly affect the design seismic ground motions in Alaska.

- ***Alaska Seismic Hazard Maps***: The seismic forces for structural design are determined using an acceleration response spectra developed from two index coefficients. These coefficients are derived from probabilistic seismic hazard models developed by the USGS. The 2009 IBC uses the USGS's seismic hazard model for Alaska completed in the late 1990s [8]. However, the USGS updated their seismic hazard model for Alaska in 2007 [7], based on improved characterizations of the principal known earthquake sources across the state (i.e. the Aleutian Subduction Zone along southcoastal and southwestern Alaska, the Castle Mountain fault in southcoastal Alaska, the Denali fault across central Alaska, the

[1] Conforming to the Western States Seismic Policy Council (WSSPC) Policy Recommendation 13-4, *Seismic Provisions in the 2012 International Building Codes*, adopted in November 2012.

Fairweather-Queen Charlotte fault in southeastern Alaska, and several active crustal fault zones on Kodiak Island); as well as improved models for random local earthquakes not associated with a known source (based on historic earthquakes). The seismic ground motion maps in the 2012 IBC are based on the more recent and improved 2007 USGS seismic hazard model for Alaska. Note that since 2007, the design specifications for highway bridges in the United States [1], and currently used by the Alaska Department of Transportation and Public Facilities, have used the 2007 USGS seismic hazard model for Alaska.

- ***Uniform Risk Target versus Uniform Hazard***: Prior to and including the 2009 IBC, the design seismic ground motions reflected a uniform, two-percent in 50 years hazard level (i.e. the ground motions corresponded with a 2,500-year return period maximum considered earthquake) [3]. However, the 2012 IBC now uses design ground motions that provide a uniform one-percent in 50-years collapse risk target [3, 6]. This represents a significant change intended to improve the basis and consistency of designing for seismic loads across the United States by achieving a more uniform margin against structural collapse (as that is the over-riding principal safety objective of the code).
- ***Maximum versus Geometric Mean***: The USGS seismic hazards model, as well as the ground motion parameter maps in the 2009 IBC represent the geometric mean of the two orthogonal components of horizontal motion. However, the index ground motion parameter maps in the 2012 IBC reflect the maximum directional component of the ground motion, which are slightly greater than the geometric mean values [3].
- ***Dominant Active Source Limits***: In areas of very high seismicity the seismic hazard is dominated by large magnitude earthquakes on well-defined fault systems. In such areas, probabilistic ground motions are often overly conservative where these major active faults produce large characteristic earthquakes every few hundred years. Therefore, to provide a more balanced level of conservatism the maps in the 2012 IBC set limits on ground motion parameters where the hazard is controlled by very active major faults; such as near the Aleutian Subduction Zone under southcoastal Alaska, Kodiak Island, and the Aleutian Islands.

Table 1 illustrates the effects of these general changes on the ground motion index coefficients used for structural designs in Alaska. From inspection of Table1, the 2009 and 2012 IBC design short period ground motion values (S_{DS}), which have more bearing on short stiff structures, are more or less the same. However, the 2012 IBC design long period values (S_{D1}), which have more bearing on taller and flexible structures, are notably greater (by about 15 to plus-30 percent) relative to the 2009 IBC values.

GEOTECHNICAL INVESTIGATIONS

The scope of geotechnical investigations required in the 2009 IBC and 2012 IBC are the same. However, the 2012 IBC requires a different hazard level (i.e. ground motion probability) for evaluating the potential for liquefaction, soil strength loss, and associated earthquake-induced ground failure (e.g. settlement, lateral spreading, slope instability, etc.).

The structural provisions in the model building codes have always been based on a fundamental condition that the ground does not fail before the building. Prior to and including the 2009 IBC, the potential for earthquake-induced ground failures were evaluated using an index ground motion (i.e. peak ground acceleration, *PGA*) that had roughly the same hazard level as the ground motions used to design the building structure. However, the current reasoning of the code officials and seismic engineers is that more conservatism is warranted in the geotechnical evaluations to improve confidence that the ground does not fail before the structure [2, 3]. Accordingly, the 2012 IBC uses an index *PGA* to evaluate earthquake-induced ground failure potential that has a lower hazard level (i.e. less likely to occur) relative to the ground motions used to design the building structure.

Table 2 compares the 2012 versus 2009 IBC peak ground accelerations that would be used to evaluate earthquake-induced ground failure potential at a number of Alaska cities. From inspection of Table 2, the 2012 IBC index *PGA* values are notably greater (by about 30 to 60 percent) relative to the 2009 IBC values.

CONCLUSIONS

In conclusion, the Commission believes that the seismic provisions in the 2012 IBC are more up-to-date and appropriate for use in Alaska versus the seismic provisions in the 2009 IBC (the building code presently enforced by Alaska). Therefore, the Commission believes that the Alaska Department of Education and Early Development, the Department of Public Safety (*Division of Fire Safety*), and the Department of Transportation and Public Facilities can improve the resiliency and safety of future schools and public buildings by requiring that the seismic provisions of the 2012 IBC be used for designing these structures (new and retrofitted) until such time as the full body of the 2012 IBC is adopted by the State.

REFERENCES

[1] American Association of State Highway Transportation Officials (AASHTO). 2009. LRFD Bridge Design Specifications, Customary U.S. Units.

[2] American Society of Civil Engineers (ASCE) 2010. Minimum Design Loads for Buildings and Other Structures. *ASCE Standard ASCE/SEI 7-10.*

[3] Building Seismic Safety Council. 2009. NEHRP Recommended Seismic Provisions for New Buildings and Other Structures. *FEMA P-750/2009 Edition*.

[4] International Code Council. 2009. 2009 International Building Code.

[5] International Code Council. 2012. 2012 International Building Code.

[6] Luco, N., et al. 2007. Risk-targeted versus current seismic design maps for the conterminous United States. *Proc. SEAOC 76th Annual Convention,* Structural Engineers Association of California.

[7] Wesson, R.L., O.S. Boyd, C.S. Mueller, C.G. Bufe, A.D. Frankel, and M.D. Peterson. 2007. Revision of time-independent probabilistic seismic hazard maps of Alaska. U.S. Geological Survey *Open-File Report 2007-1043*.

[8] Wesson, R.L., A.D. Frankel, C.S. Mueller, and S.C. Harmsen. 1999. Probabilistic seismic hazard maps of Alaska. U.S. Geological Survey *Open-File Report 99-36*.

TABLE 1: ALASKA DESIGN SEISMIC GROUND MOTIONS[a]

CITY[b]	2009 IBC		2012 IBC (*% Change from 2009 IBC*)	
	S_S / S_{DS}, g	S_1 / S_{D1}, g	S_S / S_{DS}, g	S_1 / S_{D1}, g
Anchorage	*1.49/0.99*	*0.55/0.55*	*1.50/1.00 (1)*	*0.68/0.68 (23)*
Bethel	*0.30/0.31*	*0.09/0.15*	*0.30/0.31 (2)*	*0.13/0.19 (27)*
Fairbanks	*1.11/0.78*	*0.31/0.36*	*0.99/0.73 (-6)*	*0.38/0.41 (14)*
Juneau	*0.60/0.53*	*0.28/0.35*	*0.57/0.51 (-3)*	*0.37/0.41 (18)*
Kodiak	*1.50/1.19*	*0.88/0.66*	*1.50/1.00 (-16)*	*0.88/0.88 (33)*
Nome	*0.51/0.47*	*0.14/0.21*	*0.54/0.49 (4)*	*0.19/0.26 (23)*

S_S and S_{DS} are the mapped and design short period (0.2 seconds) spectral acceleration coefficients, respectively; S_1 and S_{D1} are the mapped and design long period (1.0 seconds) spectral acceleration coefficients, respectively.

a. Determined using the USGS online *Seismic Design Maps* program[2], assuming the buildings have an *Occupancy Category [in 2009 IBC] or Risk Category [in 2012 IBC]* of III. The design coefficients S_{DS} and S_{D1} reflect *Site Class* 'D' geotechnical conditions.

b. Assuming a location roughly at the center of the city; actual values will vary across the respective city limits.

TABLE 2: PEAK GROUND ACCELERATION FOR GEOTECHNICAL STABILITY ANALYSIS[a]

CITY[b]	PGA_{SSA}, g[a]	
	2009 IBC[c]	2012 IBC (% Change)
Anchorage	*0.40*	*0.50 (26)*
Bethel	*0.12*	*0.20 (60)*
Fairbanks	*0.31*	*0.44 (42)*
Juneau	*0.21*	*0.31 (44)*
Kodiak	*0.48*	*0.62 (30)*
Nome	*0.19*	*0.31 (62)*

a. Peak ground acceleration for evaluating site stability (e.g. liquefaction, soil strength loss, earthquake-induced ground failure, etc.); for *Site Class* D and *Seismic Design Categories* D through F.

b. Assuming a location roughly at the center of the city; actual values will vary across the respective city limits.

c. S_{DS}/2.5 (per Section 1803.5.12, 2.)

2 http://geohazards.usgs.gov/designmanps/us/application.php