Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 81 (1999)

Artikel: Code calibration and optimisation through Asian model code
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DOI: https://doi.org/10.5169/seals-61414

Code Calibration and Optimisation through Asian Model Code

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Summary

Asian Model Code (AMC) would be addressing the needs of a majority of world's population – a body in a great hurry to make up the lost time but beset with meagre resources matched only with its high ambitions. This explosive blend places a heavy responsibility on the Code formulation. Some of the major issues that need to be addressed, problems to be resolved and pitfalls avoided are brought out in this paper.

1. Introduction (Opportunity and threat)

The Asian Model Code (AMC), when drawn and put into effect would enjoy an audience of over 60% of the world's population. One can well imagine the onerous responsibility that is placed on the Code Committee.

AMC starts with an advantage that the entire region enjoys certain conformity in basic values, aspiration, climatic conditions and importantly, the cost functions. The region is also characterized by a paucity of resources as well as the existence of an abundant semi-skilled work force, trained in traditional construction practices. Hence AMC stands the best chance of universal acceptability in the region.

However, there does not exist sufficient interaction amongst the Nations of this region as there does amongst those of the European Union. Also there has not been any concerted

effort at sustained regional research. These conditions make it difficult for the adoption and formulation of AMC.

This paper, seeks to address the question of code calibration and therefore, through this, Optimization. Further, possible problems and pitfalls in formulating the AMC are briefly covered.

A Code is basically is an exercise in number crunching. A set of numbers need to be laid down to define an acceptable design domain eg. allowable stresses, load factors, sampling, testing procedure and frequency, acceptance criteria, allowable tolerances, minimum requirements such as cement content, span to depth ratios, age factor, serviceability requirements, to cite a few.

These numbers are fixed by the Code Committee, keeping in view, the latest research, International Codes, Industry Practice duly tempered by their respective National past practices, status and projected progress of available technology and know-how and know-why available to the profession [1]

Many questions are often debated during code formulation such [2] as :

- Should money be spent on research and evolution of design parameters and limitations, or for the extra materials that go into the structure as a penalty for such ignorance?

- Should money be spent on obtaining quality control of material through rigid acceptance criteria and allowing higher stresses, or

on compromising with a poorer control and paying the penalty for the lack of quality through additional materials?

Fixing these values is the first level of optimization on a National scale. One can easily appreciate the even a slight change in the number eg. the depth to span ratio of slabs or minimum cement content or maximum steel percentage will have a far reaching cost impact, in view of the large volumes involved.

These numbers are arrived at, through an interplay of conflicting/supplementing technologies.

Having arrived at a National level numbers, designers through their individually inspired excellence optimize their specific designs to get the best value for the end users. This is the second level of optimization.

More enlightened designers go a step further into the basic philosophy of arriving at these numbers, to use the benefits available in using alternative methods, rigorous analysis (say of crack width, deflection, creep calculation, stricter QA methods[3] and this leads further into a third level of optimization [4]

In specifying the numbers, codes have a further responsibility: - viz. structures built in the yester years are not rendered prematurely obsolete causing a heavy insurance, legal, retooling and replacement cost.

As a corollary, unless backed by solid evidence, drastic liberalization from levels or from current National codes is not to be resorted to. [5]

These are the upper and lower bound limits against which the design and detailing parameters are to be calibrated.

In a society where certain serviceability requirements (eg. noise level, vibration level) are non existent, a question often asked is whether, the building can be treated as yet another consumer product [6]. A building with an appropriately less stringent serviceability requirement (say deflection) can be built at a lower cost. (Indian Standard / Loading standard [7] for example, specifies a lesser imposed load for low cost housing).

While all this number game may appear all "Science and Technology", the pulse of users (the designers and through them the consumer viz public) is what finally makes or mars the Code.

Taking a few examples from Indian Code Drafting Scheme:

a) At one stage of revision, I.S Loading Standards (IS : 875), some years back, increased the live load on sloping roofs as also wind loads under a severe revolt by the Indian Engineering Association which had under its fold, steel structural manufacturers, these values where scaled down to a none too scientific intermediate value.

b) More recently, an amendment to impose a limiting deflection on purlins was decided to be put on hold, as new cloaking materials are being introduced into the Indian market.

The bottom line is to provide a level playing field for competing technologies.

If for example, limiting deflection value is different between say, insitu and precast system on one hand (say L/325) and metal building (say L/60), then the dice is loaded against one system.

A level playing field then cannot be said to be existing in evaluating the competing systems in arriving at a most cost-effective structure, falling inside the accepted design domain.

2. Objective function

The AMC would have to start with the following ground realities :

i) Level of Technology, material availability, design and construction capabilities, cost indices of component materials and competing technologies available in the member Nations.

i) Construction practices and levels of quality assurance (QA).

ii) General conformity with the respective National codes currently in vogue.

iii) Values of various National Codes are to be reconciled. For example, maximum percentage of steel reinforcement in column in the Indian Code is 4% while in the Japan Code it is 2%. While sound reasoning has preceded before these values have been pegged, similar and identical design requirement (eg. seismic load) would call for identical values.

Based on the above data, a set of most acceptable design parameters will have to be laid down.

In this process, the AMC will have to adopt certain Lowest Common Multiples (LCM) or Highest Common Factors (HCF) as values for the code parameters from amongst the National codes consistent with sampling testing and acceptance criteria of the respective National Codes. The AMC cannot said to have achieved its objective, if it does not recognize progressive technology up-gradation, such that fruits of technology (eg. Ready mix concrete, pre-cast construction, higher QA requirements) are immediately translated to effectively reduce cost, time, and enhance durability, saving precious raw materials or energy.

While this in itself is a formidable task the AMC must note the following points:

One – the need to maintain certain uniformity with the other existing structural codes of the member Nations (eg. effective length factors of steel and concrete codes, need to be the same).

Two – the smooth transition between AMC and existing structural codes especially in cased of mixed construction (concrete encased or in filled steel construction).
I therefore make bold to suggest that as an achievable first step, the AMC should confine itself to following a "Life – Limb" policy of code formulation [7].

That is to say, the AMC may deliberately choose to stop with specifying values and laying down procedures, that will include a common minimum programme pertaining to 'Limit State', involving safety (to Life and limb of the user) and leave the serviceability criteria to the user Nation. This will also help formulating and implementing the AMC within a reasonable time frame.

A dilemma often faced by the code formulative body is whether the code should precede introduction of technology or technology ingress should precede code clauses. The chicken and egg syndrome.

As upgrading and wide dissemination of technology is an important function of code, the AMC may also address itself, to obtaining concrete of quality.[8] Concentrating on quality of ingredient materials, making, placing and compacting of concrete, curing and form work, detailing of reinforcement for durability etc. and also lay down more rigorous methods of analysis of structures, doing away with empirical methods (eg. empirical methods of flat slabs design, experimental investigation method of design).

Wide spread and voluntary acceptance of AMC, is only possible through certain levels of official recognition. Placing AMC on an equal footing with National Codes, for domestic use, and giving it an edge – albeit marginal – in case of international operation in the works in the Asian Continent, is one way of making it popular.

Thus, so far, the author has sought to expose and highlight the possible areas of conflict resolution and lay down common minimum programme in drawing up AMC. While it is recognised that there is no easy solution, the basic cultural values, and commonality of the problems that individual constituent countries face, give the AMC a head start in effective implementation of AMC.

3. Future work

Having successfully implemented AMC, the next step could be to integrate the loading standards (eg. imposed load, load combination, reduction in loads, in upper floor of multi-storey buildings), other structural codes (particularly structural steel with AMC) and laying down common serviceability requirements.

Conclusion

While the underlying philosophy of each of the questions raised may by itself need tremendous patience and skill in resolving them, one can imagine the complexity of the exercise, when finally one has to reduce these philosophical journeys into a set of consistent numbers. But the very thought that AMC will address a population far vaster than anything, so far even attempted, is sufficient to fuel the imagination and motivate the AMC formulating body.

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