

Advance knowledge of an 'impending' disaster

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Earthquakes can shake the earth, cause harbour wave (Tsunami in Japanese), kill and maim people, level cities and towns, render inhabitants homeless, set off fire, destroy service lines, and above all, be a traumatic experience even if it does none of the above.

Dhaka and some other cities in Bangladesh, having been warned by experts and observers for the past several years, are presently bracing itself for a major earthquake. The concern for Dhaka is intensified by rapid urbanisation, a consequence of need, greed and haphazard construction. Violation of the minimal building construction rules has played a villain's role in the massive development works taking place in the major cities of the country. More so, many of our buildings are of brick and several decades old, and the wetness of air has primed the structure for vulnerability in a jolt of perhaps any magnitude.

History is also not on our side. A 100-year cycle brightens the ill prospects of a major earthquake striking some part of Bangladesh sometime now or in the near future. Volcanic activities of severe consequences in Bhuj (Gujarat, January 2001) and more recently in the northern Pakistan and nearby parts of India have only increased the fears.

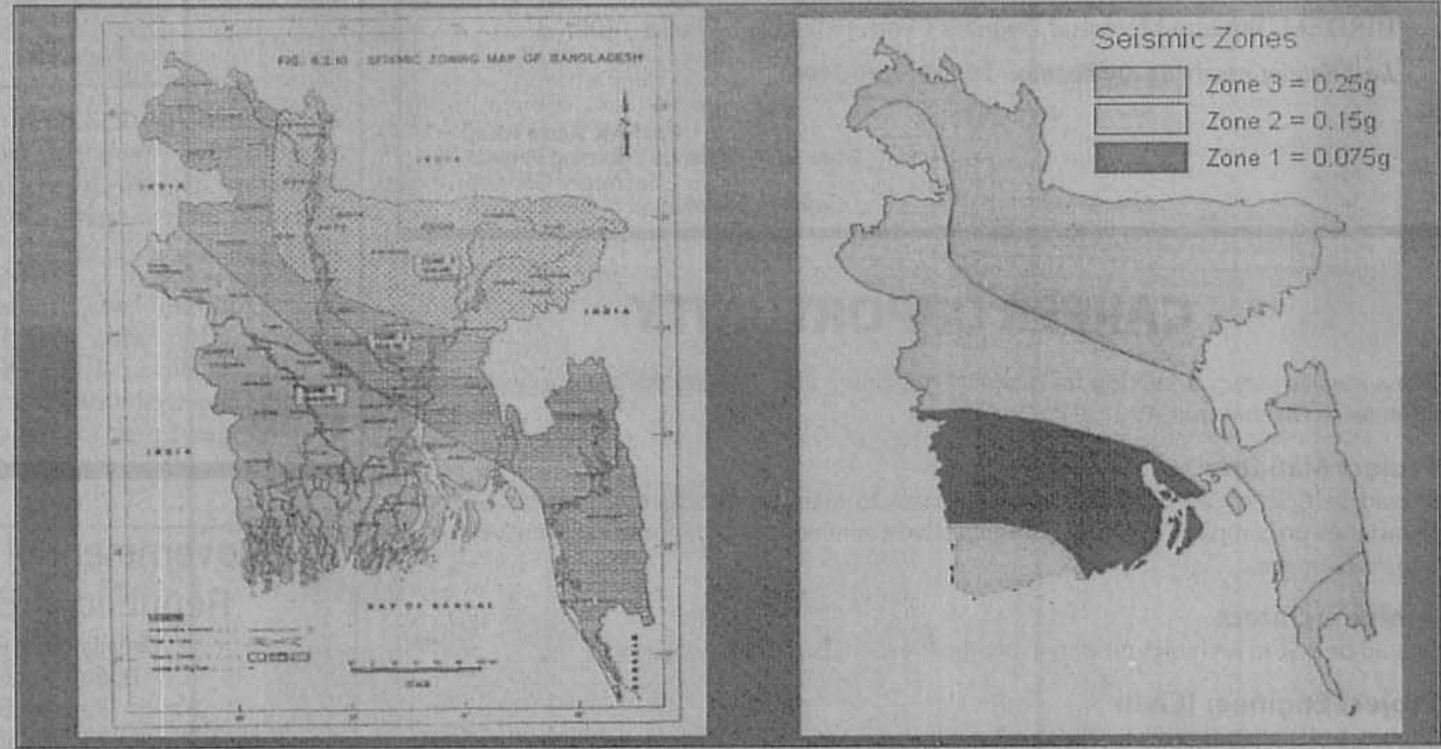
Our piece today could not have been better timed, as our expert tries to explain in advance about an 'impending' disaster that we hope and pray will never happen.

One may easily confuse Dr. Mehedi Ahmed Ansary as a seismologist, so deep is his concern for earthquake. In fact his civil engineering background only allows him to analyse the impact of earthquake on our buildings that much better. To me he is a social worker. We might need thousands like him should we indeed be hit.

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Seismic Zoning Map of Bangladesh based on 200 years Return Period



BNBC (1993)

Ansary (2001)

Seismicity and seismic design

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THE NATURE OF GROUND MOTION

THE "P" WAVE

dilation
compression

a "slinky toy" produces a similar motion

Magnitude and Intensity

Magnitude is directly related to energy release due to plate movement. It has a unique value for an earthquake. It varies from 1 to 10.

Intensity is related to human feelings, behavior of secondary structures and structural behavior. It has different values at different locations for a particular earthquake. It varies from I to XII.

DAVAGE ONE FOUR SIVANA S. E. EARTHQUAKE

Intensity: VII
Vulnerability: II
Grade: 3

Intensity: VI
Vulnerability: I
Grade: 3

MODES OF VIBRATION

Tall buildings will undergo several modes of vibration, but for seismic purposes (except for very tall buildings) the fundamental period, or first mode is usually the most significant.

first mode second mode third mode

DRIFT and DEFORMATION

story drift ratio

PRINCIPLES OF SEISMICITY AND SEISMIC DESIGN

THE ORIGIN OF EARTHQUAKES

THE "S" WAVE

horizontal axis
vertical

cracking a whip produces the same motion

WAVES will be generated at any angle from the axis but arrive at the earth's surface primarily as HORIZONTAL WAVES

Magnitude and Intensity of Some Historical Earthquakes in Bangladesh

Event Name	M	Depth	Distance
1889 Cachar	7.5	V	250 km
1885 Bengal	7.0	VII	170 km
1897 Great Indian	8.7	VIII+	230 km
8.0 Ambraseys, 2000			
1918 Srimangal	7.6	VI	150 km
1930 Dhubri	7.1	V+	250 km

FUNDAMENTAL PERIOD and RESONANCE

each object has its own fundamental period at which it will vibrate

TYPICAL RESPONSE SPECTRUM of a building site

CONFIGURATION regular and irregular

PRINCIPLES OF SEISMICITY AND SEISMIC DESIGN

FAULT SLIPPAGE

Loma Prieta 1989

rupture area located 5 km below earth surface

no surface fault traces

plane of fault

fault rupture 30 km long x 7 km deep

MOTION AT A SITE

scratch left on the floor by a kitchen range in the 1933 Long Beach, California earthquake.

SEMI VII

- Many people find it difficult to stand, even outdoors.
- Furniture may be overturned. Waves may be seen on very soft ground.
- Many buildings of class B (Unreinforced brick) and a few of class C (Unreinforced with RC floors/frams with no antisismic design) suffer damage of grade 3.

Many buildings of class A (Mud houses) and a few of class B suffer damage of grade 3. A few buildings of class A suffer damage of grade 5.

FUNDAMENTAL PERIOD in seconds

height is the main determinant

DUCTILITY

Ductility is the characteristic of materials such as steel that fall only after considerable deformation has occurred.

ductile
brittle

CONFIGURATION — SIZE and SHAPE

the more the building configuration deviates from a simple rectangle form, the more likely it is to suffer damage.

configuration irregularity results in two main effects: stress concentrations and torsional effects.

TYPES OF FAULT SLIPPAGE

normal fault reverse fault dip/slip faults

FORCES and GRAVITY

... NEWTON'S SECOND LAW OF MOTION ...

$$F = MA$$

force mass acceleration

VULNERABILITY TABLE

Type of Structure	Vulnerability Class
	A B C D E F
MASONRY	
solid masonry	O
solid (arch) brick	O-H
single masonry	H-O
massive masonry	H-O-H
unreinforced brick / concrete blocks	H-O
unreinforced brick with RC floors	H-O
reinforced brick (confined masonry)	H-O-H
REINFORCED CONCRETE (RC)	
RC without antisismic design (ASD)	H-O
RC with minimum level of ASD	H-O
RC with moderate level of ASD	H-O
RC with high level of ASD	H-O
WOOD	
wooden structure	H-O

DAMAGE GRADE

Table 2: Classification of damage to masonry buildings

OVERTURNING

buildings seldom overturn—they fall apart or pancake

TORSIONAL FORCES and STRESS CONCENTRATION

THE SUBDUCTION ZONE

ACCELERATION

Newton's Apple acceleration is measured in "gs". one g is the acceleration due to gravity

1.0 g = 32 feet/second/second

Intensity Distribution of 1897 Great Indian Earthquake

M_s = 8.7
I₀ = X
Dhaka = VIII
Chittagong = IX

PANCAKING

buildings seldom overturn they fall apart or pancake

STRESS CONCENTRATIONS

The most serious condition of vertical irregularity is the soft or weak story, in which one story, usually the first with taller, fewer columns, is significantly weaker or more flexible than the stories above.

TYPES OF SEISMIC WAVES

Rayleigh wave Love wave surface waves

P-wave S-wave deep waves

DURATION, VELOCITY and DISPLACEMENT

Duration x seconds

Velocity z mph

Displacement y feet

STRENGTH and STIFFNESS

members are equally strong but their stiffness is different: lateral forces are distributed in proportion to stiffness of resisting members

PRINCIPLES OF SEISMICITY AND SEISMIC DESIGN

STRESS CONCENTRATIONS

the soft story collapse mechanism

normal drift overstress