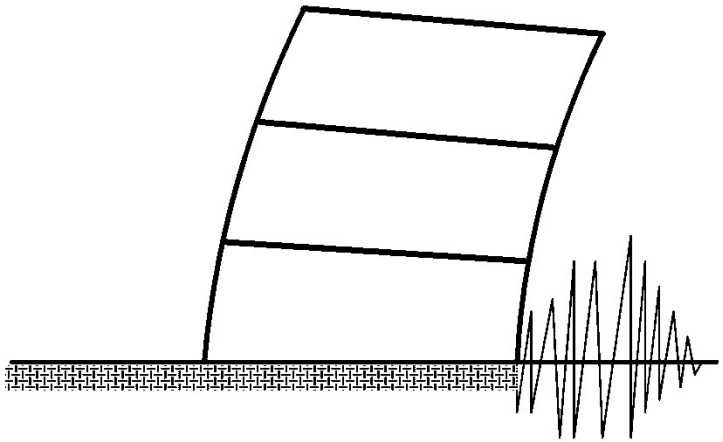
ASCE 7

SEISMIC DESIGN PARAMETERS

WITH 1997 UBC REFERENCE



WIRA TJONG, S.E.

ACKNOWLEDGEMENT
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ABBREVIATIONS

- ASCE : AMERICAN SOCIETY OF CIVIL ENGINEERS
- SEAOC : STRUCTURAL ENGINEER ASSOCIATION OF CALIFORNIA
- UBC : UNIFORM BUILDING CODES – OLD CODES
- IBC : INTERNATIONAL BUILDING CODES – CURRENT CODES WITH REFERENCE TO ASCE 7 : MINIMUM DESIGN LOADS FOR BUILDING
- CBC : CALIFORNIA BUILDING CODES – ADOPT IBC AS BASELINE

HISTORY OF UBC ⇒ IBC

FIRST UBC WAS PUBLISHED IN 1927

SEISMIC PROVISIONS IN APPENDIX & OPTIONAL TO LOCAL JURISDICTION

LONG BEACH EARTHQUAKE IN 1933

CA FIELD ACT : SEISMIC DESIGN MANDATORY FOR SCHOOLS AND, LATER, HOSPITALS

SEISMIC PROVISIONS IN THE MAIN TEXT 1940s

REQUIRED FOR ALL BUILDINGS;PROHIBIT NEW UNREINFORCED MASONRY BUILDINGS; LATE 1940s, MANDATORY BOLTING DOWN OF WOOD FRAME BUILDINGS,INCLUDING HOUSES.

SEISMIC DESIGN REGULATIONS WAS PUBLISHED 1950s

BY ASCE/SEAOC JOINT COMMITTE KNOWN AS "SEPARATE 66"
THE FIRST TIME DYNAMIC BEHAVIOR OF STRUCTURE DURING EQ IS CONSIDERED

HISTORY OF UBC ⇒ IBC

SEISMIC DESIGN REGULATIONS WAS FORMED IN 1959

BY SEAOC STATE LEVEL SEISMOLOGY COMMITTEE IN ONGOING

EFFORT FOR BETTER SEISMIC DESIGN CODES

SAN FERNANDO EARTHQUAKE IN 1971

MANY CHANGES IN SEISMIC DESIGN REFLECTED IN 1973 AND 1976 UBC CODES

NEW SEISMIC REQUIREMENTS IN 1973

WALL/ROOF CONNECTIONS FOR TILT UP WALL BUILDING; SOIL FACTOR; INCREASED FORCE LEVELS (1.5 TO 2.5 TIMES LARGER THAN PREVIOUS CODES); REQUIRES DUCTILE (SPECIAL) CONCRETE MOMENT RESISTING FRAMES

MEXICO CITY EARTHQUAKE IN 1985

AMPLIFICATION DUE TO SOFT SOIL

MID 1980s

CA SENATE BILL 547 : UNREINFORCED MASONRY BUILDING RETROFIT LAW

HISTORY OF UBC ⇨ IBC

NEW SEISMIC BASE SHEAR EQUATION IN 1988

CONSIDERATION OF IRREGULAR SHAPES, SIZES AND MASS; GYPSUM BOARD SHEAR CAPACITY WAS REDUCED

LOMA PRIETA EARTHQUAKE IN 1989

AMPLIFICATION IN SOFT SOILS LARGER THAN THE CODE'S EXPECTED

NEW SEISMIC REQUIREMENTS IN 1991

MORE STRINGENT REQUIREMENT FOR BUILDINGS IN SOFT SOILS; URM RETROFIT STANDARDS IN UCBC APPENDIX CHAPTER 1

NEW SEISMIC REQUIREMENTS IN 1994

USE OF WOOD FRAME CONSTRUCTION WAS DEFINED AND LIMITED; NEW CONCRETE SHEAR WALL DESIGN REQUIREMENT.

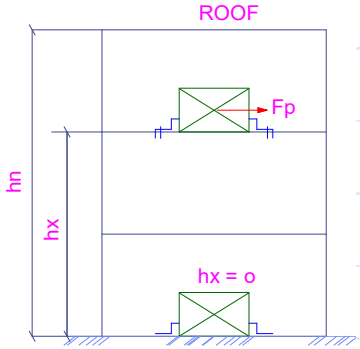
NORTHRIDGE EARTHQUAKE IN 1994

REFLECTED IN 1997 UBC; MORE STRINGENT WALL TO ROOF CONNECTION

MAJOR CHANGES DUE TO RECENT EARTHQUAKE

THE LAST UBC - 1997

- INFLUENCED BY 1994 LOS ANGELES,NORTHRIDGE EQ
- REDUNDANCY & NEAR FAULT FACTORS
- Rw WAS REPLACED BY R = Rw/1.4 - STRENGTH DESIGN FORMAT
- VERTICAL SEISMIC FORCE TO BE INCLUDED IN THE DESIGN
- EQUIPMENT ANCHORAGE BASED ON THE LOCATION ABOVE THE GROUND



ASCE 7

- **EARTHQUAKE FORCES PER ASCE 7 –2005 OR 2010**
- **DESIGN EQ/ BASIS GROUND MOTION**
- **SEISMIC ZONES ARE REPLACED BY RESPONSES CONTOUR**
- **SEISMIC DESIGN CATEGORY (SDC) & SITE SPECIFIC LONG PERIOD**
- **EQUIPMENT ANCHORAGE FORCE REFINEMENT**

OBJECTIVES & EQ LEVEL DEFINITIONS

1997 UBC

A. TO PROVIDE BUILDING WHICH IS EXPECTED TO MEET LIFE SAFETY OBJECTIVE AND NOT TO LIMIT DAMAGE OR MAINTAINING FUNCTION

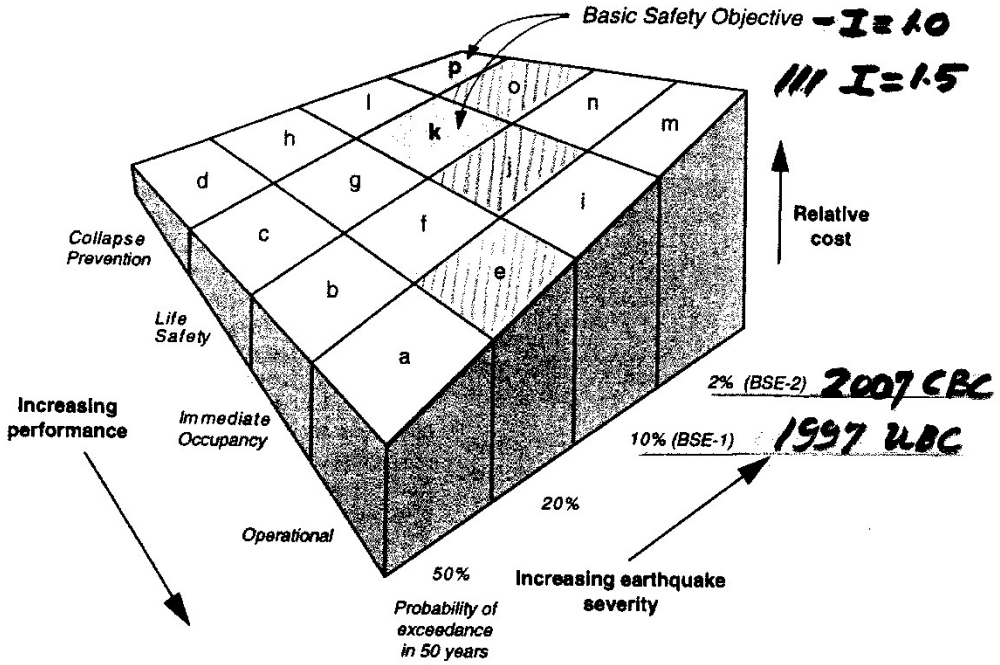
B. STRUCTURES HAVE TO BE ABLE TO RESIST

1. A MINOR EARTHQUAKE WITHOUT DAMAGE
2. A MODERATE EARTHQUAKE WITHOUT STRUCTURAL DAMAGE BUT POSSIBLY EXPERIENCE SOME NON-STRUCTURAL DAMAGE

ASCE 7

A. **LIFE SAFETY FOR STANDARD BUILDING UNDER DESIGN EARTHQUAKE**

B. **DEFINE EQ LEVEL BASED ON PROBABILITY OF OCCURRENCE**



OBJECTIVES & DESIGN CATEGORY

1997 UBC

3. A MAJOR EARTHQUAKE HAVING AN INTENSITY EQUAL TO THE STRONGEST EITHER EXPERIENCED OR FORECAST FOR THE BUILDING WITHOUT COLLAPSE, BUT POSSIBLY WITH SOME STRUCTURAL & NON-STRUCTURAL DAMAGE.

IT IS EXPECTED THAT IN MAJOR EARTHQUAKE, DAMAGE WILL BE LIMITED TO A REPAIRABLE LEVEL.

ASCE 7

BY CORRELATING THE EXPECTED PERFORMANCE LEVEL UNDER DIFFERENT EQ LEVELS, EACH BUILDING IS ASSIGNED SEISMIC DESIGN CATEGORY (SDC) "A" TO "F" BASED ON

- **OCCUPANCY CATEGORY OF THE BUILDING**
- **LOCAL GROUND MOTION INTENSITY AND SITE CLASS/SOIL TYPE**

EACH DESIGN CATEGORY HAS SPECIFIC DETAILING & CONFIGURATION REQUIREMENT WITH CATEGORY "F" AS THE MOST STRINGENT AND DUCTILE.

11.1.2 SCOPE

1997 UBC

- APPLIES TO BUILDING AND NON- BUILDING STRUCTURES.
- ONE OR TWO STORY FAMILY DWELLING IN ZONE 1 NEED NOT CONFORM TO THIS PROVISION.

ASCE 7

EVERY STRUCTURE INCL NON-STRUCTURAL COMPONENTS EXCEPT

- **DETACHED ONE OR TWO FAMILY DWELLINGS**
  - **UNDER SEISMIC DESIGN CATEGORY (SDC) A, B, or C or LOCATED AT THE AREA WITH Ss < 0.4 G**

OR

  - **ASCE 7: 2 STORIES or LESS USING WOOD FRAME SATISFYING IRC**
  - **CBC: SEISMIC RESISTING SYSTEM OF WOOD FRAME CONFORMING TO SECTION 2308**

11.1.2 SCOPE

ASCE 7

- AGRICULTURAL STORAGE WITH INCIDENTAL HUMAN OCCUPANCY
- NOT IN SCOPE
  SPECIAL STRUCTURES: BRIDGES, ELEC TRANSMISSION TOWERS, BURIED UTILITIES LINES, NUCLEAR REACTORS

SEISMIC DESIGN REQUIREMENT

- SEISMIC DESIGN IS NOT ONLY FOR HIGHRISE BUILDING
- CASUALTY FROM INDUSTRIAL BUILDING FAILURE CAN BE CATASTROPHIC AND ENORMOUS TO THE PUBLIC
- EQUIPMENT ANCHORAGE NEEDS TO BE ENGINEERED AND DESIGNED
- PROPER DETAILING IS MORE IMPORTANT THAN DESIGN FORCES IN SURVIVING SEISMIC EVENT

OCCUPANCY CATEGORY & IMPORTANCE FACTORS

OCCUPANCY CATEGORY

CBC TABLE 1604.5/ASCE TABLE 1.5 -1

I : OTHER BLDGS/STRUCTURES WITH LOW HAZARD

II : ALL BUILDINGS NOT UNDER I, III, OR IV

III : BUILDINGS WITH SUBSTANTIAL HAZARD AND ECONOMIC IMPACT, MASS DISRUPTION

IV: ESSENTIAL BUILDINGS AND BUILDINGS CONTAINING CERTAIN QUANTITY OF HIGHLY TOXIC SUBSTANCES

BUILDING IMPORTANCE FACTOR

ASCE 7 TABLE 1.5 -2

OC	I	II	III	IV
I	1.0	1.0	1.25	1.50

20.3 SOILS TYPE/SITE CLASS

1997 UBC

SOIL PROFILE TYPE PER TABLE 16-J (6 TYPES)

- USE TYPE Sd IF UNKNOWN
- SPECIAL SITE EVALUATION FOR SOIL TYPE Sf

ASCE 7

SITE CLASSIFICATION PER TABLE 20.3-1 (6 CLASSES)

- **USE SITE CLASS "D" IF UNKNOWN**
- **SPECIAL SITE EVALUATION FOR SITE CLASS "F"**

Site Class		Shear Wave Velocity
A	Hard rock	> 5000 ft/sec
B	Rock	2,500 to 5,000 ft/sec
C	Very dense soil and soft rock	1,200 to 2,500 ft/sec
D	Stiff soil	600 to 1,200 ft/sec
E	Soft clay soil	< 600 ft/sec
F	Soils vulnerable to failure or collapse under seismic loading, such as liquefiable soils, highly sensitive clays, and weakly cemented soils; require site response analysis in accordance with ASCE 7 Chapter 21.	

SOILS TYPE/SITE CLASS

1997 UBC

SOIL TYPE

Sa Sb Sc Sd Se Sf

HARD ROCK → SOFT SOIL

ASCE 7

SITE CLASSIFICATION

A B C D E F

HARD ROCK → SOFT SOIL

TYPE Sf

- LIQUEFIABLE SOILS, QUICK AND HIGHLY SENSITIVE CLAYS, WEAK CEMENTED SOILS
- > 10 ft [3 m] THICK PEATS OR HIGHLY ORGANIC CLAY
- > 25 ft [7.6 m] THICK VERY HIGH PLASTICITY CLAY WITH PI>75
- > 120 ft [36.5 m] THICK SOFT/MEDIUM STIFF CLAY

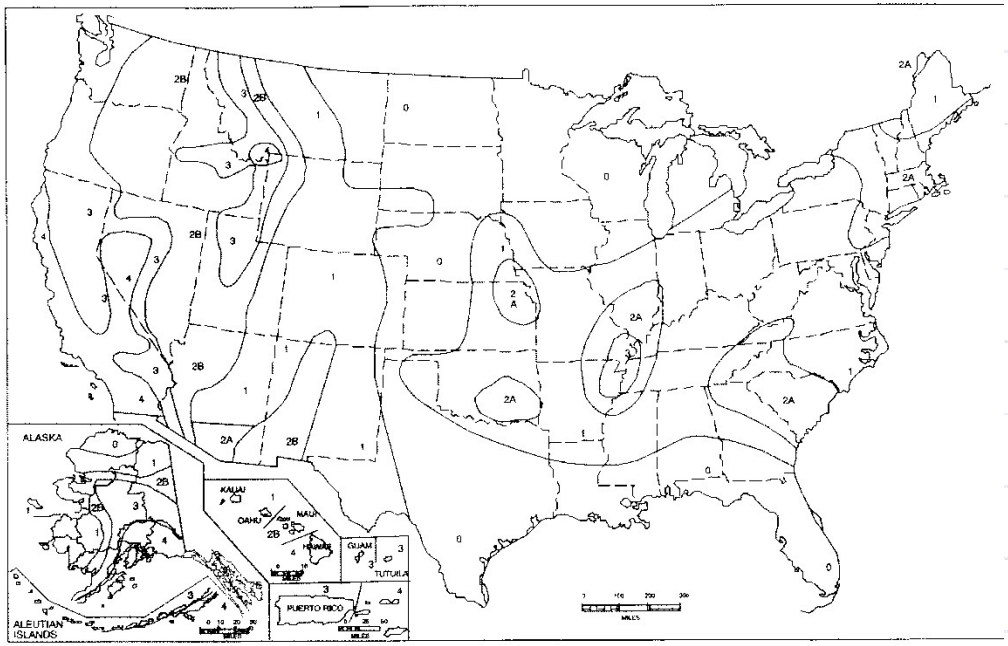
CLASS "F"

- **LIQUEFIABLE SOILS, QUICK AND HIGHLY SENSITIVE CLAYS, WEAK CEMENTED SOILS**
- **> 10 ft [3 m] THICK PEATS OR HIGHLY ORGANIC CLAY**
- **> 25 ft [7.6 m] THICK VERY HIGH PLASTICITY CLAY WITH PI>75**
- **> 120 ft [36.5 m] THICK SOFT/MEDIUM STIFF CLAY**

DESIGN EQ GROUND MOTION

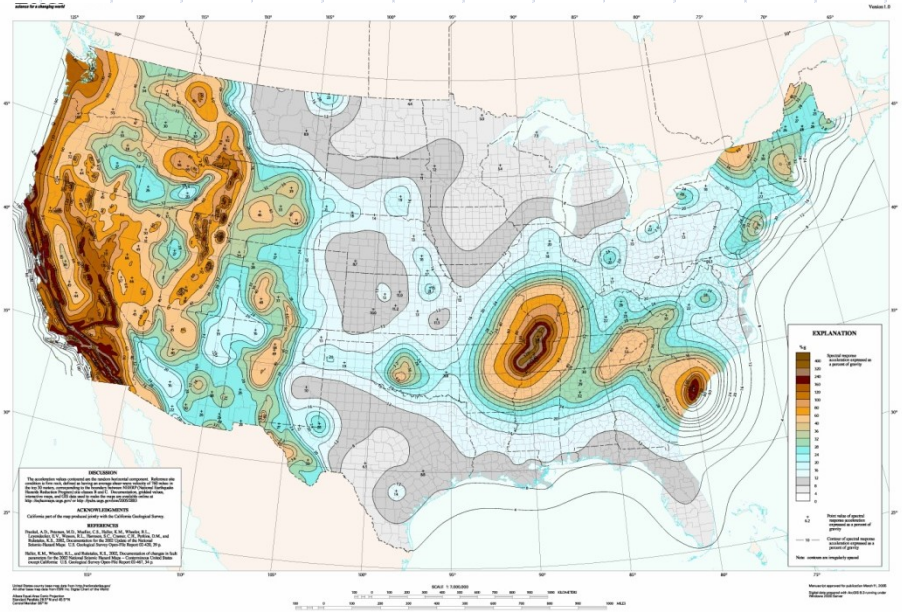
1997 UBC

1. BASIS GROUND MOTION WITH 10% PROBABILITY OF EXCEEDANCE IN 50 YEARS (ONCE IN 475 YEARS)



ASCE 7

1. **MAPPED MAX CONSIDERED EQ GEOMETRIC MEAN (MCE_G) PEAK GROUND ACCELERATION WITH 2 % PROBABILITY OF EXCEEDANCE IN 50 YEARS (ONCE IN 2500 +- YEARS)**



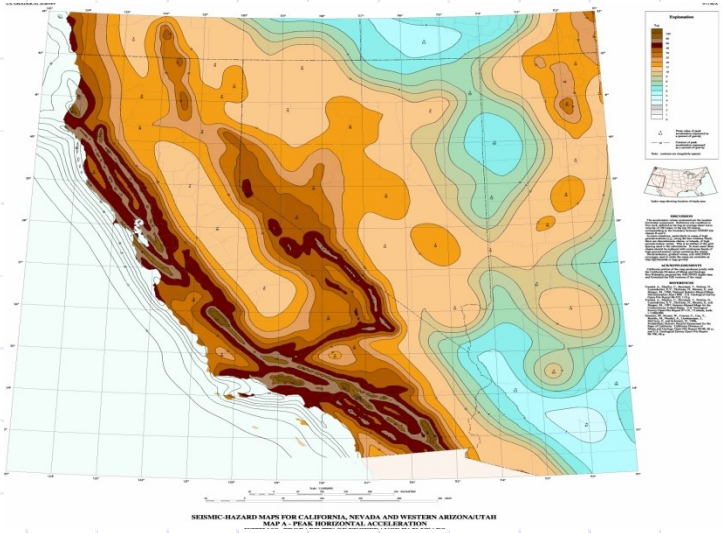
DESIGN EQ GROUND MOTION

1997 UBC

2. SEISMIC ZONE IN ACCORDANCE WITH FIG. 16-2 WITH A ZONE FACTOR Z PER TABLE 16-I (5 ZONES)

ZONE	1	2A	2B	3	4
Z	0.075	0.15	0.20	0.30	0.40

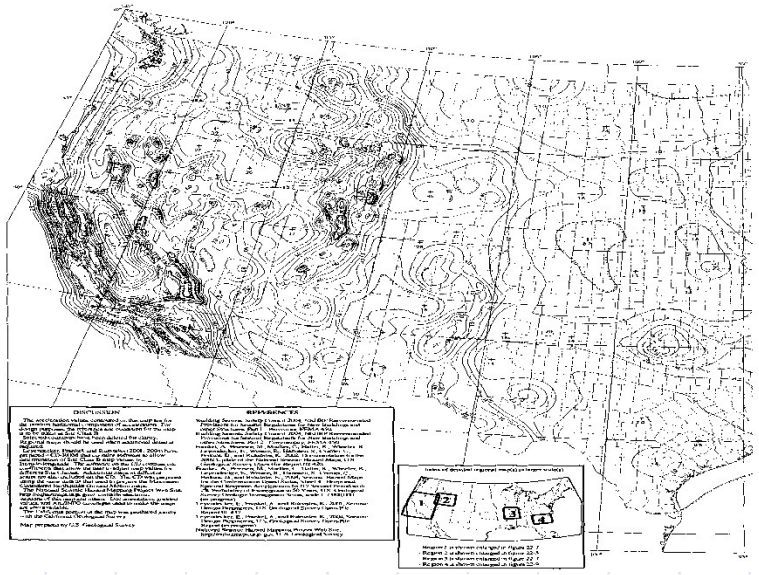
EFFECTIVE PEAK GROUND ACCELERATION IN g



PGA FOR 475 YEARS EQ

ASCE 7

2. SPECTRAL RESPONSE ACCELERATIONS AT SHORT PERIOD (Ss) AND AT 1 SECOND PERIOD (S1) BASED ON LOCAL MCE_R WITH 5 % DAMPING



Ss FOR 2500 YEARS EQ

SITE COEFFICIENTS

1997 UBC

3. NEAR FAULT FACTORS Na & Nv

ASCE 7

3. DETERMINE SITE COEFFICIENTS Fa & Fv PER TABLE 11.4-1 & 2 FUNCTION OF SITE CLASS & MCE_R SPECTRAL RESP ACCLELARATION Ss AND S1 ON CHAPTER 22

SITE COEFFICIENTS

SITE COEFFICIENT Fa

Linear interpolation for intermediate values of Ss and S1

SITE COEFFICIENT Fv

SITE CLASS	Ss <=0.25	Ss 0.50	Ss 0.75	Ss 1.0	Ss >= 1.25	S1 <= 0.10	S1 0.2	S1 0.3	S1 0.4	S1 >= 0.5
A	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
B	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C	1.20	1.20	1.10	1.00	1.00	1.70	1.60	1.50	1.40	1.30
D	1.60	1.40	1.20	1.10	1.00	2.40	2.00	1.80	1.60	1.50
E	2.50	1.70	1.20	0.90	0.90	3.50	3.20	2.80	2.40	2.40

DESIGN SPECTRAL RESPONSES

1997 UBC

4. BASED ON ZONE AND SOIL PROFILE, DETERMINE SEISMIC RESPONSE COEFFICIENTS Ca PER TABLE 16 - Q AND Cv PER TABLE 16 – R
5. FOR ZONE 4, DETERMINE THE NEAR FAULT FACTORS Na AND Nv BASED ON DISTANCE FROM AND THE TYPE OF THE NEARBY FAULT.

ASCE 7

4. DETERMINE RISK TARGETED MAX CONSIDERED EQ (MCE_R) SPECTRAL RESPONSE ACCELERATION PARAMETERS

Sms = Fa Ss
Sm1 = Fv S1

5. DETERMINE DESIGN SPECTRAL RESPONSE ACCELERATION PARAMETERS

SDs = 2/3 Sms
SD1 = 2/3 Sm1

SDs=2.5Ca & SD1=Cv

11.6 SEISMIC DESIGN CATEGORY(SDC)

SDC IS USED TO DETERMINE THE REQUIRED LEVEL OF DUCTILE DETAILING & PERMITTED STRUCTURE CONFIGURATION

1. DETERMINE SEISMIC DESIGN CATEGORY (SDC "A" TO "F") PER CBC SECTION 1613.5.6 OR ASCE 7 11.6. USE THE MOST SEVERE SDC FROM THE TABLES REGARDLESS OF T

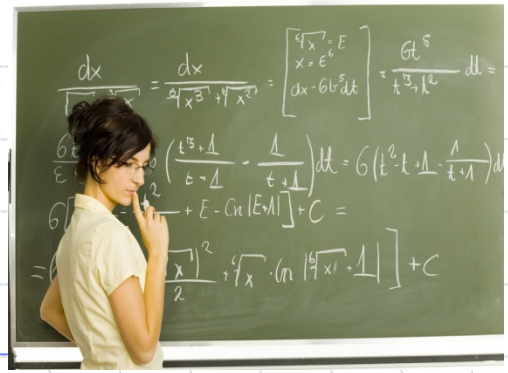
2. SDC E FOR OC I TO III AT S1 >=0.75 g
3. SDC F FOR OC IV AT S1 >= 0.75 g

TABLES 1613.5.6(1) / ASCE 7 – 11.6.1

	OCCUPANCY CATEGORY		
VALUE OF SDs	I or II	III	IV
SDs < 0.167 g	A	A	A
0.167 g<= SDs<0.33 g	B	B	C
0.33 g <= SDs < 0.50 g	C	C	D
SDs >= 0.50 g	D	D	D

TABLES 1613.5.6(2) / ASCE 7 - 11.6-2

VALUE OF SD1	I or II	III	IV
SD1 < 0.067 g	A	A	A
0.067 g<= SD1 < 0.133 g	B	B	C
0.133 g <= SD1 < 0.20 g	C	C	D
SD1 >= 0.20 g	D	D	D
S1 > = 0.75 g	E	E	F



SDC EXAMPLE

SEVEN STORY CONCRETE FRAME FOR OFFICE BUILDING IN KATHMANDU

Acceleration Responses :

Ss = 1.15 g & S1 = 0.45 g - US STATE DEPT.

OFFICE BUILDING

Occupancy Category II - I = 1.0

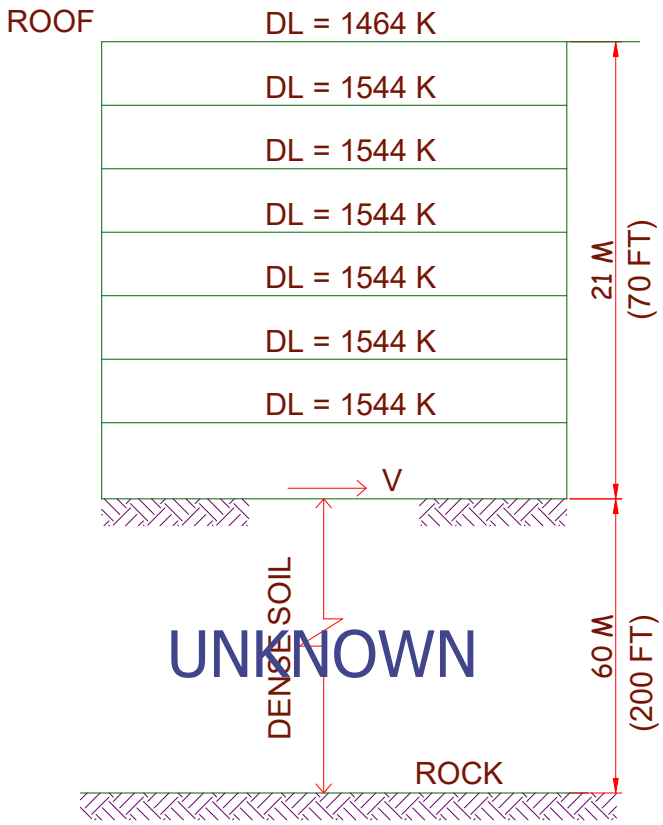
PER TABLE 20.3-1 , UNKNOWN SOILS CONDITION

SITE CLASS "D"

SITE COEFFICIENTS:

Fa = 1.01 FROM TABLE 11.4-1

Fv = 1.55 FROM TABLE 11.4-2



SDC EXAMPLE

SPECTRAL ACCELERATION RESPONSE:

Sms = Fa Ss = 1.10 ; Sm1 = Fv S1 = 0.70

DESIGN ACCELERATION RESPONSE:

SDs = 2/3 Sms = 0.80 ; SD1 = 2/3 Sm1 = 0.47 in g

SEISMIC DESIGN CATEGORY:

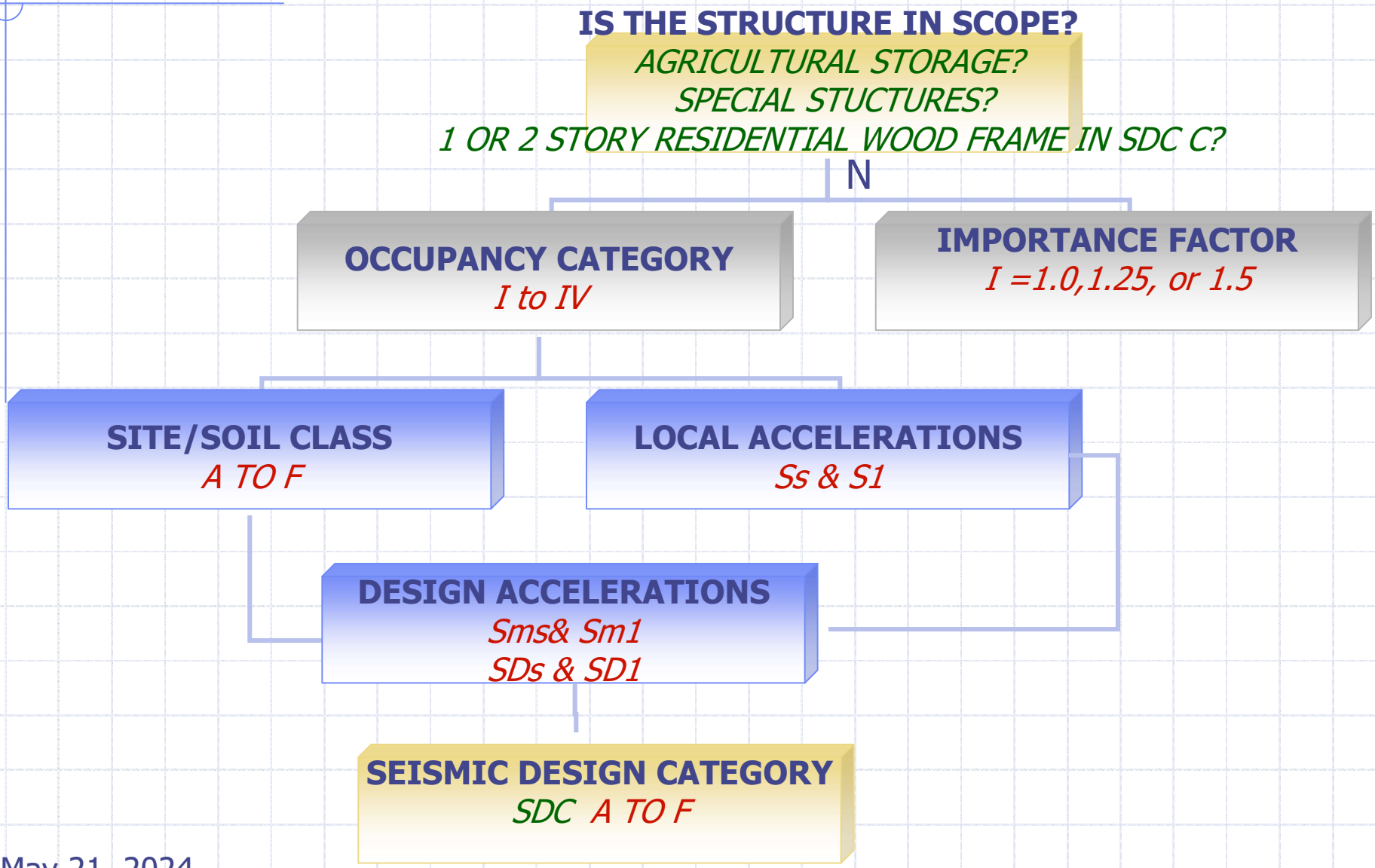
BASED ON THE DESIGN ACCELERATION RESPONSE, TAKE THE WORST WORST CASE FROM TABLES 11.6-1& 11.6-2 TO GET THE SEISMIC DESIGN CATEGORY:

SDC "D"

CHECK PROVISION FOR S1 > 0.75 g … NOT APPLICABLE

IBCPRO SOFTWARE

SEISMIC DESIGN CATEGORY STEPS SUMMARY



END OF SEMINAR

THANKS …
QUESTIONS AND ANSWERS