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EARTHQUAKE DAMAGE ANALYSIS

Building Damage Analysis from
April 2015 Nepal Earthquake

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Dataset Details



- In April 2015, a 7.8 magnitude earthquake struck in the Gorkha District of Nepal causing massive widespread damage to people, buildings, infrastructure and land.
- Data in this report are 10,000 building surveys collected by The Central Bureau of Statistics of Nepal post-earthquake.
- These datasets were the largest post-disaster ever collected and include information on earthquake impacts, household conditions and socio-economic-demographic statistics.
- Damage levels and building material types, age and sizes were assessed.

Key Questions



- How much damage did the earthquake cause?



- How did different building materials and combinations survive the earthquake?



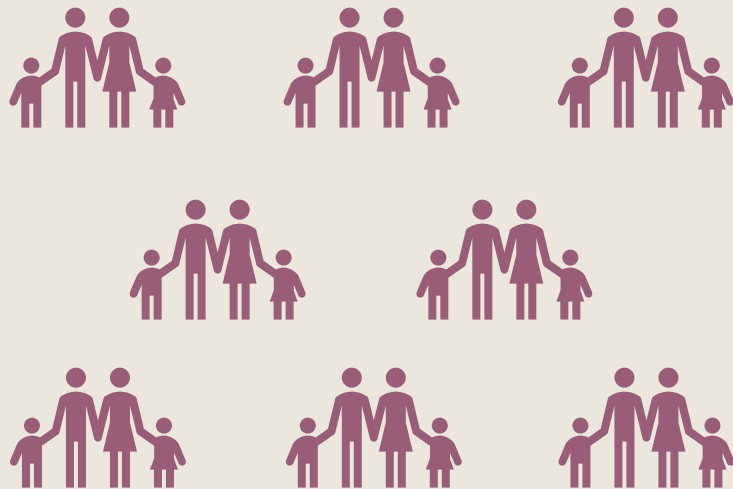
- How does building age relate to damage caused?



HOW MUCH
DAMAGE DID THE
EARTHQUAKE
CAUSE?

Earthquake: People & Use Impacts

- 9,846 families were affected within single and multi-family dwellings

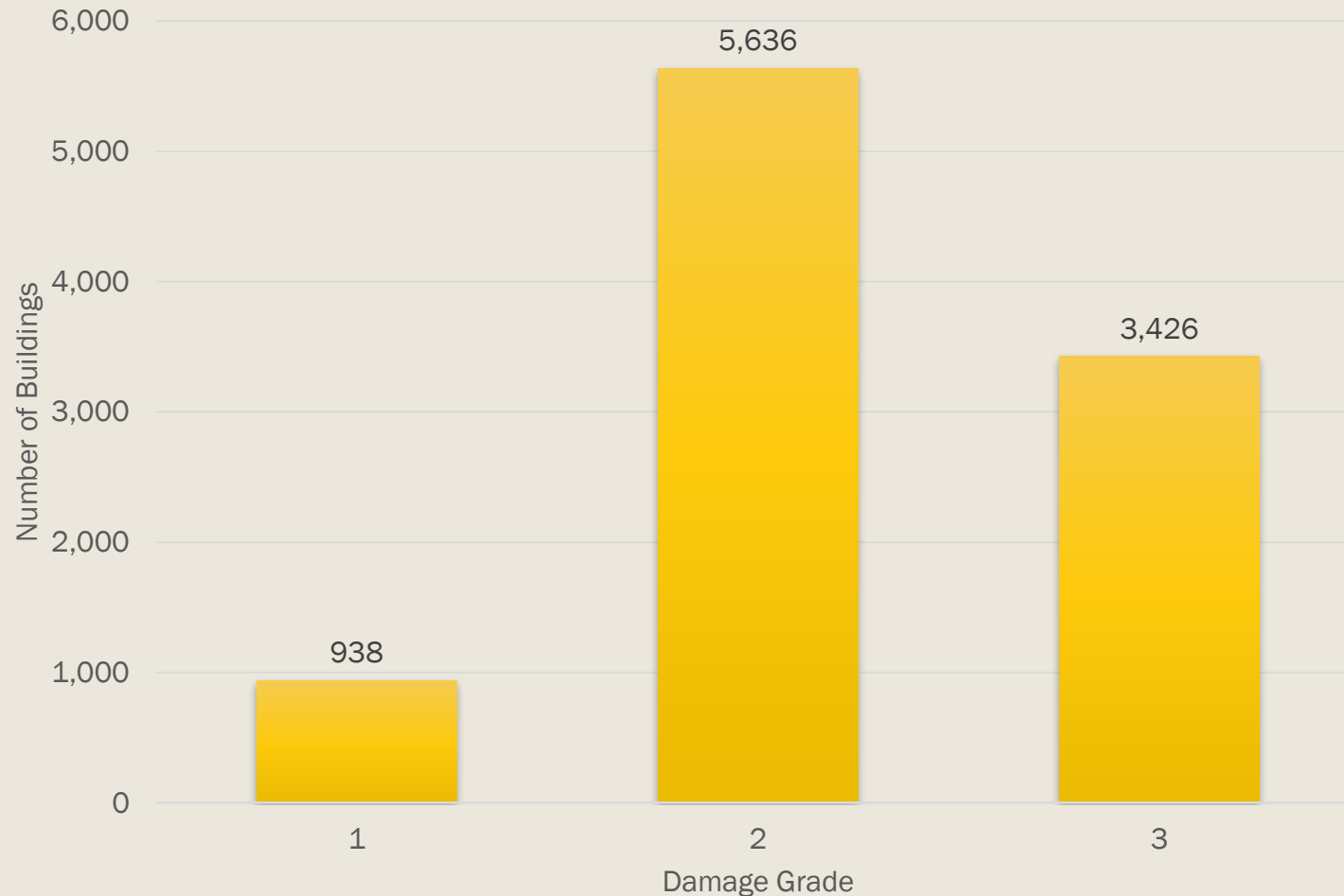


- 1,058 buildings of the 10,000 served secondary purposes other than residences

Secondary Usage	Number of properties affected
Agriculture	673
Hotel	294
Rental	64
Institution	7
School	7
Industry	8
Health Post	2
Government Office	2
Police	1

Earthquake Damage to Buildings

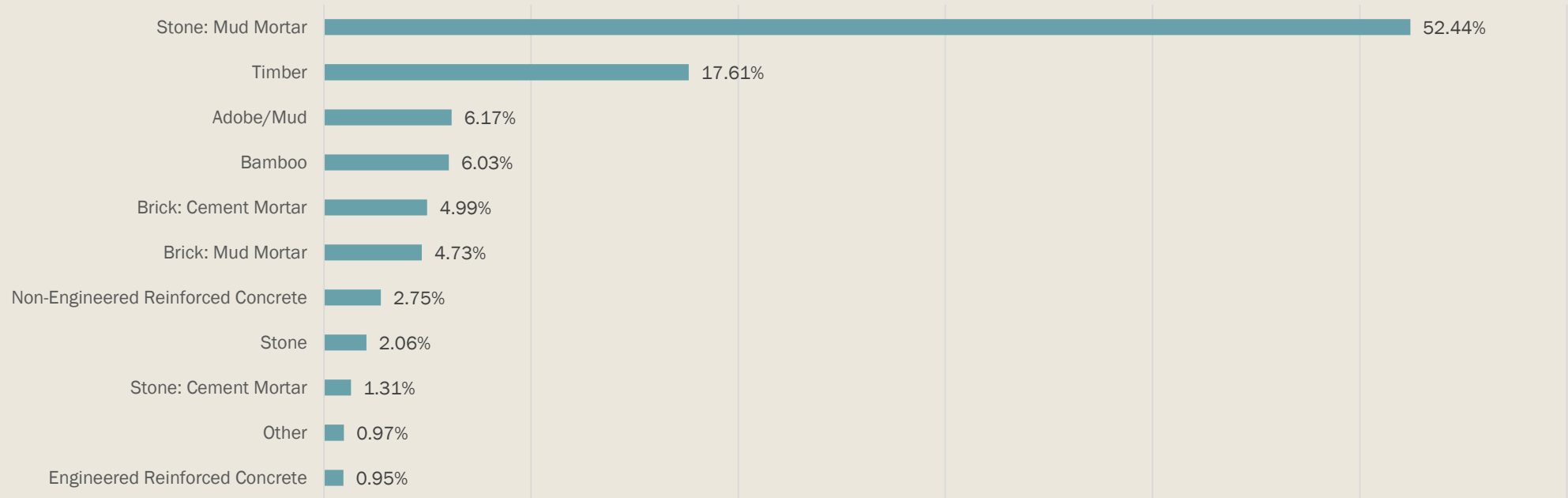
Damage Grades of 10,000 buildings



- 1 = Low damage
- 2 = Medium damage
- 3 = High damage, almost complete destruction
- 9,062 buildings received at least medium damage

Impacted Building Materials

Percentage of Buildings by Construction Material*



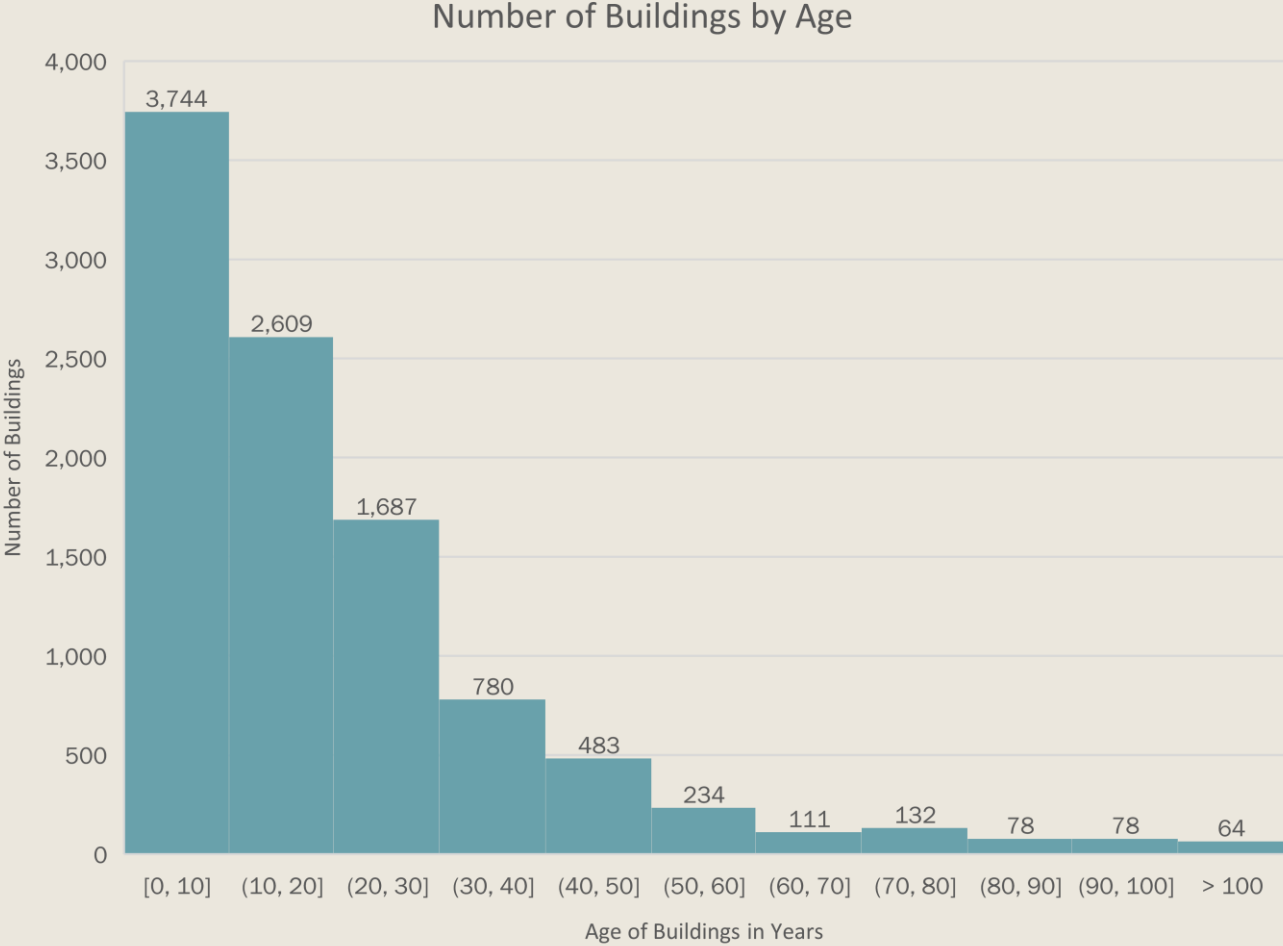
*The dataset is unclear on how superstructure construction material was determined.

Per numbers below, majority of the 10,000 surveyed buildings had multiple materials in their superstructure.

Multiple Materials in Super Structure	Single Material in Super Structure
6,816	3,184

Age of Impacted Buildings

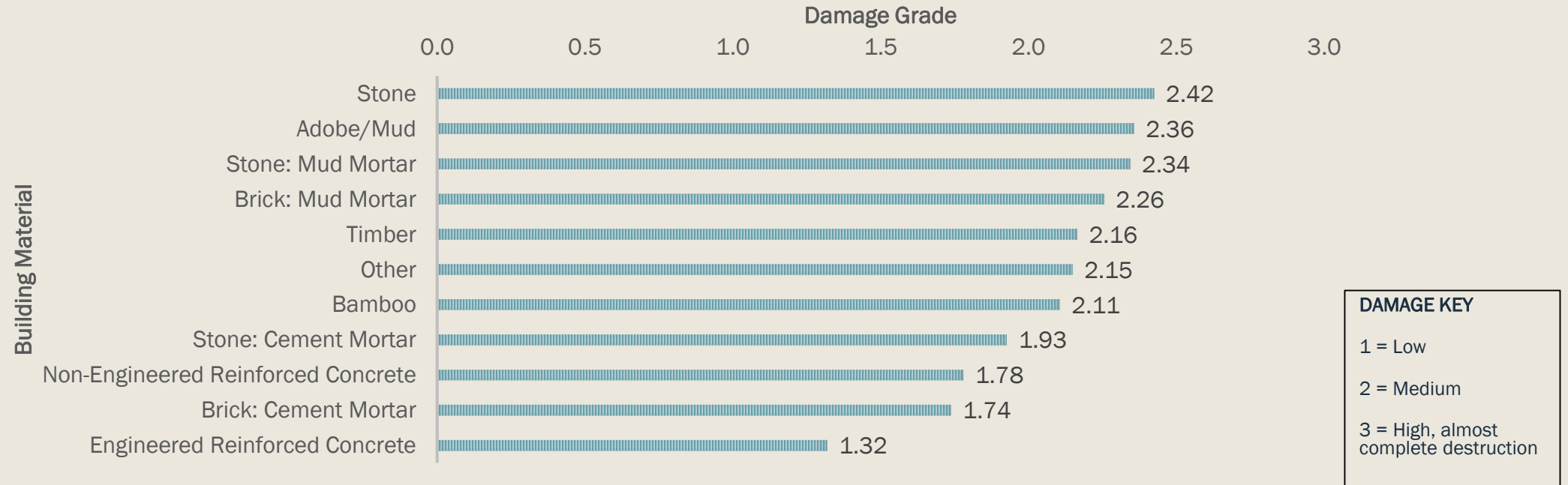
- The majority of buildings surveyed were built less than 30 years ago.
 - 80% or 8,040 buildings
- The mean age of buildings surveyed is 25 years old.





HOW DID
DIFFERENT
BUILDING
MATERIALS AND
COMBINATIONS
SURVIVE THE
EARTHQUAKE?

Average Damage by Building Material



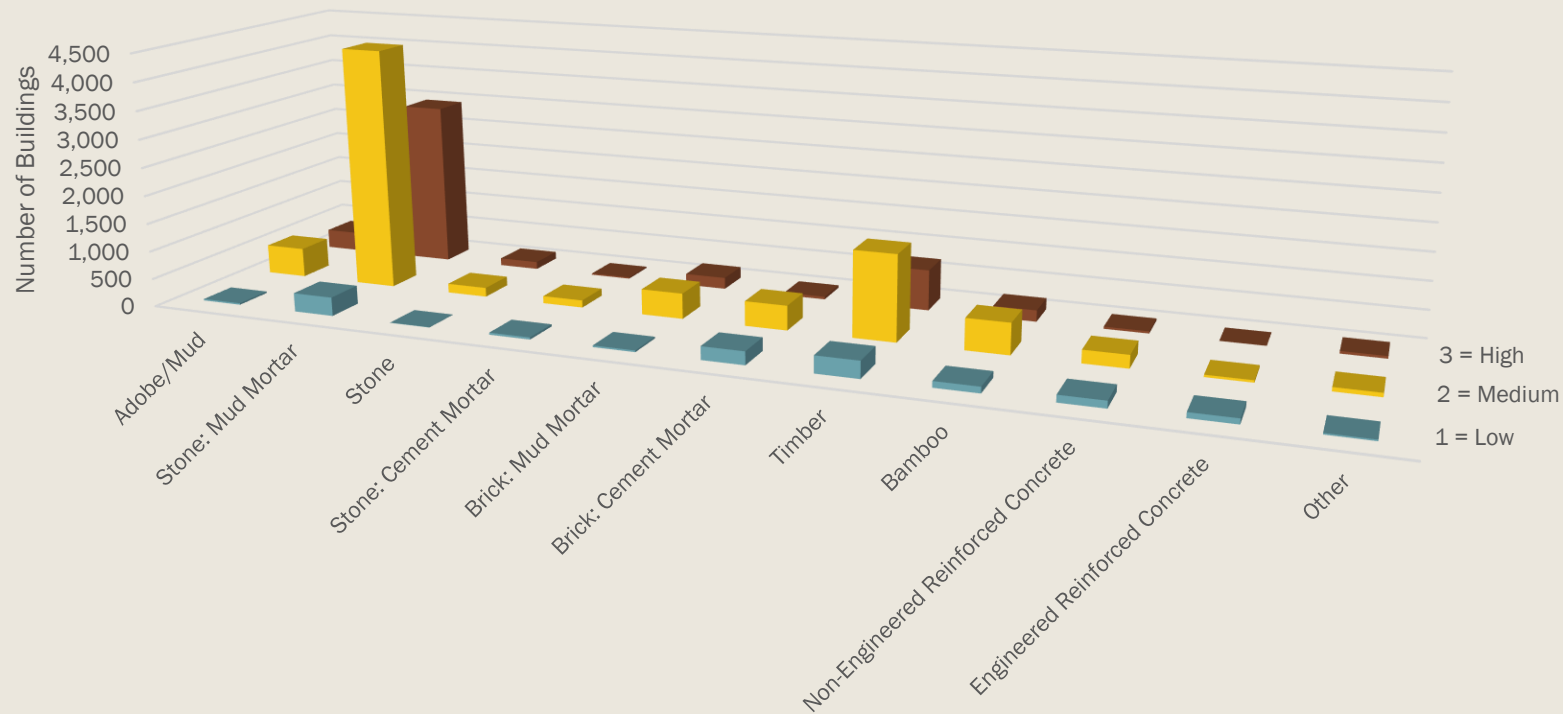
- Buildings constructed with any mud component experienced some of the highest average damages.
- Buildings constructed with stone were also heavily affected, though type of mortar shows a difference in average damage grades.
- Buildings with industrial materials (cement mortar and concrete) or wood materials (timber, bamboo) sustained lower average damage grades.

Building Material	Average Damage Grade WITH this Building Material	Average Damage Grade WITHOUT this Building Material	t	p	Significant?
Stone	2.42	2.24	5.053805097	< .001	TRUE
Adobe / Mud	2.36	2.24	5.544784211	< .001	TRUE
Stone: Mud Mortar	2.34	1.94	28.88006147	< .001	TRUE
Brick: Mud Mortar	2.26	2.25	0.311520223	0.755411667	FALSE
Timber	2.16	2.28	-8.080985717	< .001	TRUE
Other	2.15	2.25	-1.951444717	0.051032053	FALSE
Bamboo	2.11	2.26	-7.250976104	< .001	TRUE
Stone: Cement Mortar	1.93	2.26	-7.353549162	< .001	TRUE
Reinforced Concrete NE	1.78	2.27	-15.83029994	< .001	TRUE
Brick: Cement Mortar	1.74	2.29	-23.99448225	< .001	TRUE
Reinforced Concrete Engineered	1.32	2.26	-18.27032794	< .001	TRUE

Average Damage Grade Compared by Building Material

- Buildings constructed with mud and mud mortar experienced some of the highest damage with grades above 2.25.
- Buildings constructed with stone were also heavily affected. However, stone with cement mortar (1.926) fared better than stone structures with mud mortar (2.344) or no mortar (2.425).
- Statistical significance was assessed using t tests and p -values.

Damage Grades by Building Material



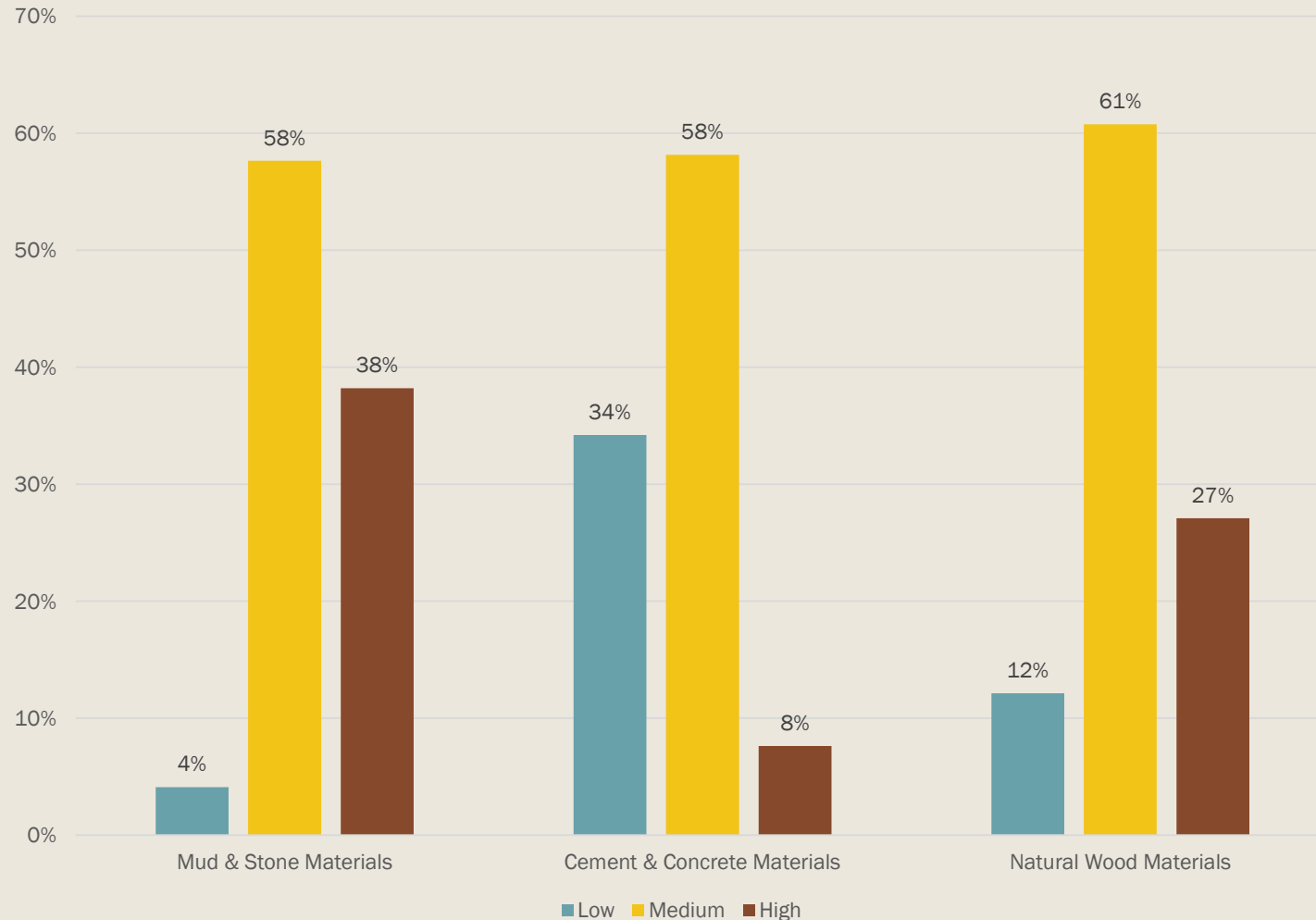
- Majority of buildings surveyed were built of stone with mud mortar = 7,626
- Mode value for damage grade for all building materials = 2 Medium
 - Exception of Engineered Reinforced Concrete where Mode = 1 Low

	Adobe/Mud	Stone: Mud Mortar	Stone	Stone: Cement Mortar	Brick: Mud Mortar	Brick: Cement Mortar	Timber	Bamboo	Non-Engineered Reinforced Concrete	Engineered Reinforced Concrete	Other
1 = Low	26	332	5	37	29	237	306	111	127	96	24
2 = Medium	525	4,342	162	130	454	441	1,527	562	234	40	72
3 = High	346	2,952	132	23	205	47	728	204	39	2	45

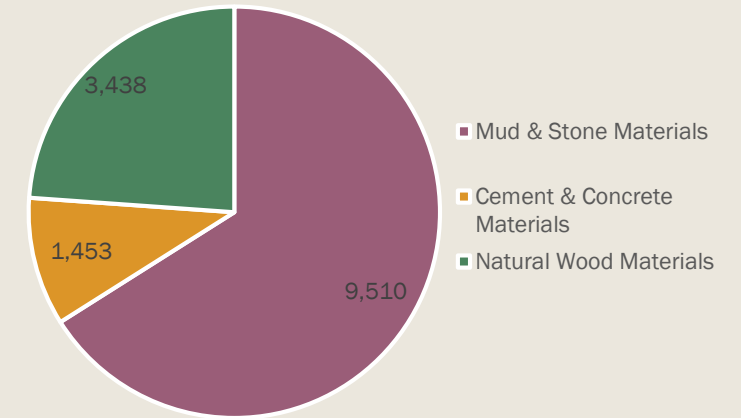
Building Material

Damage Grades by Building Material

Percent Damage Grades by Building Material Type



Number of Buildings by Material Type



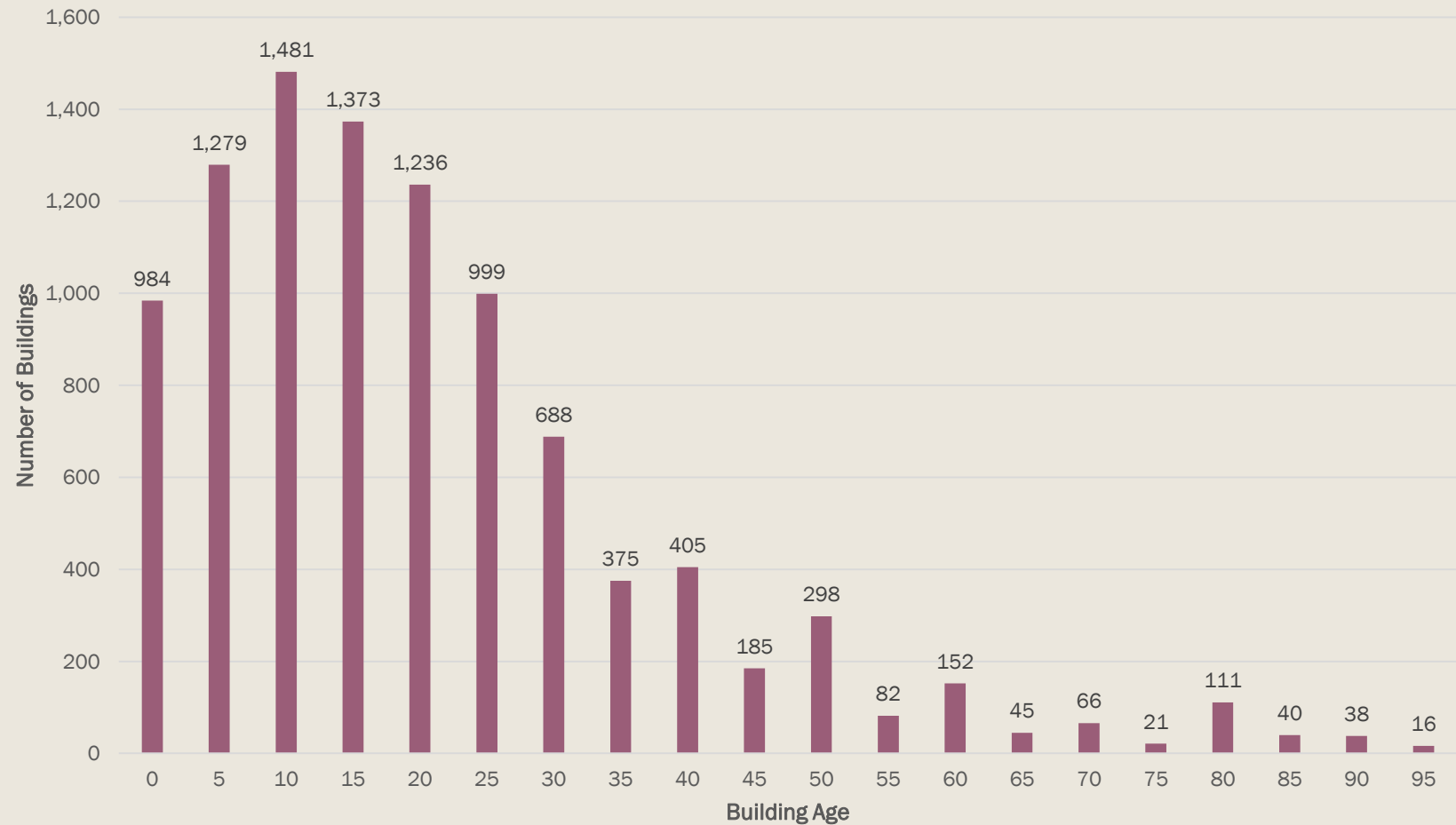
- All categories of building materials experienced primarily medium damage
- Most low-rated damage occurred in buildings with cement and concrete materials = 34%
- Where natural materials of mud, stone and wood were present, high destruction was much more apparent



HOW DOES
BUILDING AGE
RELATE TO
DAMAGE CAUSED?

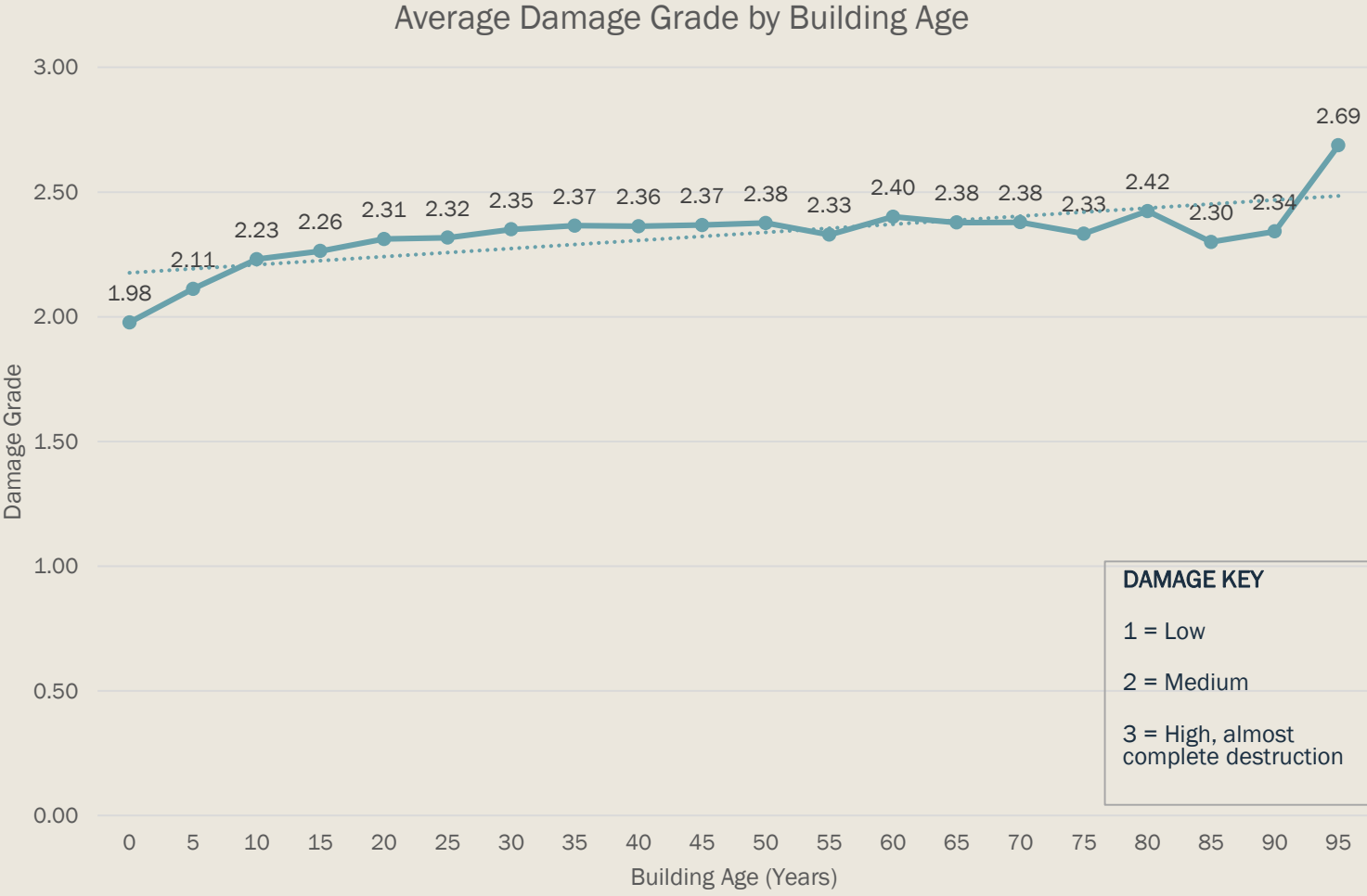
Number of Buildings by Age

- Average Building Age: 20.7 years
- Building Age Mode: 10 years



*126 buildings over 100 years old were excluded from these calculations.
Complete dataset includes 10,000 buildings.

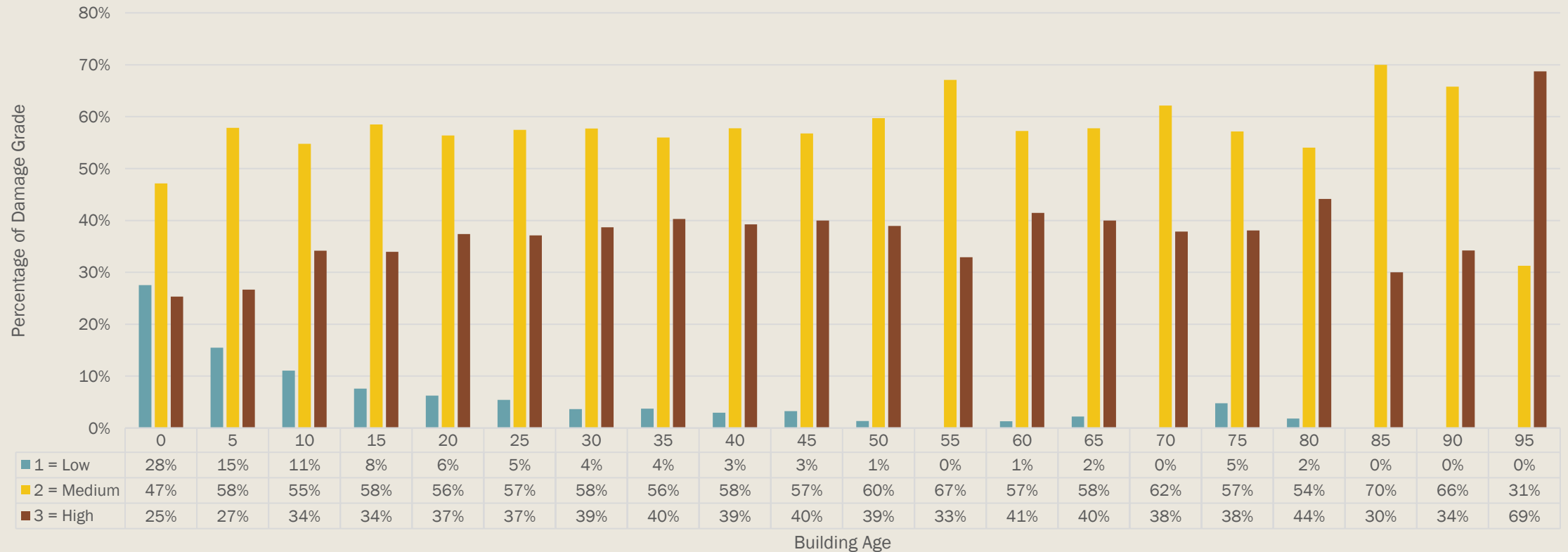
Average Damage by Building Age



- Buildings under 5 years had lowest damage rate at 1.98.
- As age increases, so does average damage, although some older buildings between 75-90 years fared better.
- Buildings between 30 and 50 years have very close average damage scores.

*126 buildings over 100 years old were excluded from this chart.

Damage Grades by Building Age



- Lowest damage grades occurred in buildings younger than 5 years and trends down as buildings age.
- All ages were mostly impacted by medium damage with the exception of 95 year-old buildings.
- High damage is fairly consistent between 10 and 75 year-old buildings.

*126 buildings over 100 years old were excluded from this chart.

Executive Summary

- How much damage did the earthquake cause?
 - The earthquake caused widespread, major and extreme damage to buildings with **90% of buildings receiving at least medium damage** and 34% being almost completely destroyed.
- How did different building materials and combinations survive the earthquake?
 - Buildings constructed with **any mud component** experienced the highest average damages.
 - Stone buildings were also heavily affected, though **type of mortar** (none vs. mud vs. cement) **shows a difference in average damage grade**.
 - Buildings with wood materials (timber, bamboo) sustained lower average damage grades than mud materials while **industrial materials (cement mortar and concrete)** maintained lowest damage grades.
- How does building age relate to damage caused?
 - Lowest damage grades occurred in buildings younger than 5 years and tapered as buildings aged higher.
 - **All ages were mainly impacted by medium damage**, with the exception of 95 year-old buildings.