edX

Microsoft: DAT290x

Microsoft Professional Capstone: Data Analysis

Analytic Report by:
Ricardo José Garcia da Costa Lobato [04/2019]
(RLobato – ricardo.c.lobato@gmail.com)

April 2015 Nepal Earthquake **Building Damage**

Key findings from a dataset collected by

The Central Bureau of Statistics of Nepal

U.S. Marine Corps photo by Staff Sgt. Jeffrey D. Anderson [Public domain]
Wikimedia Commons. Retrieved 11:33 GMT, April 15, 2019 from this permanent URL

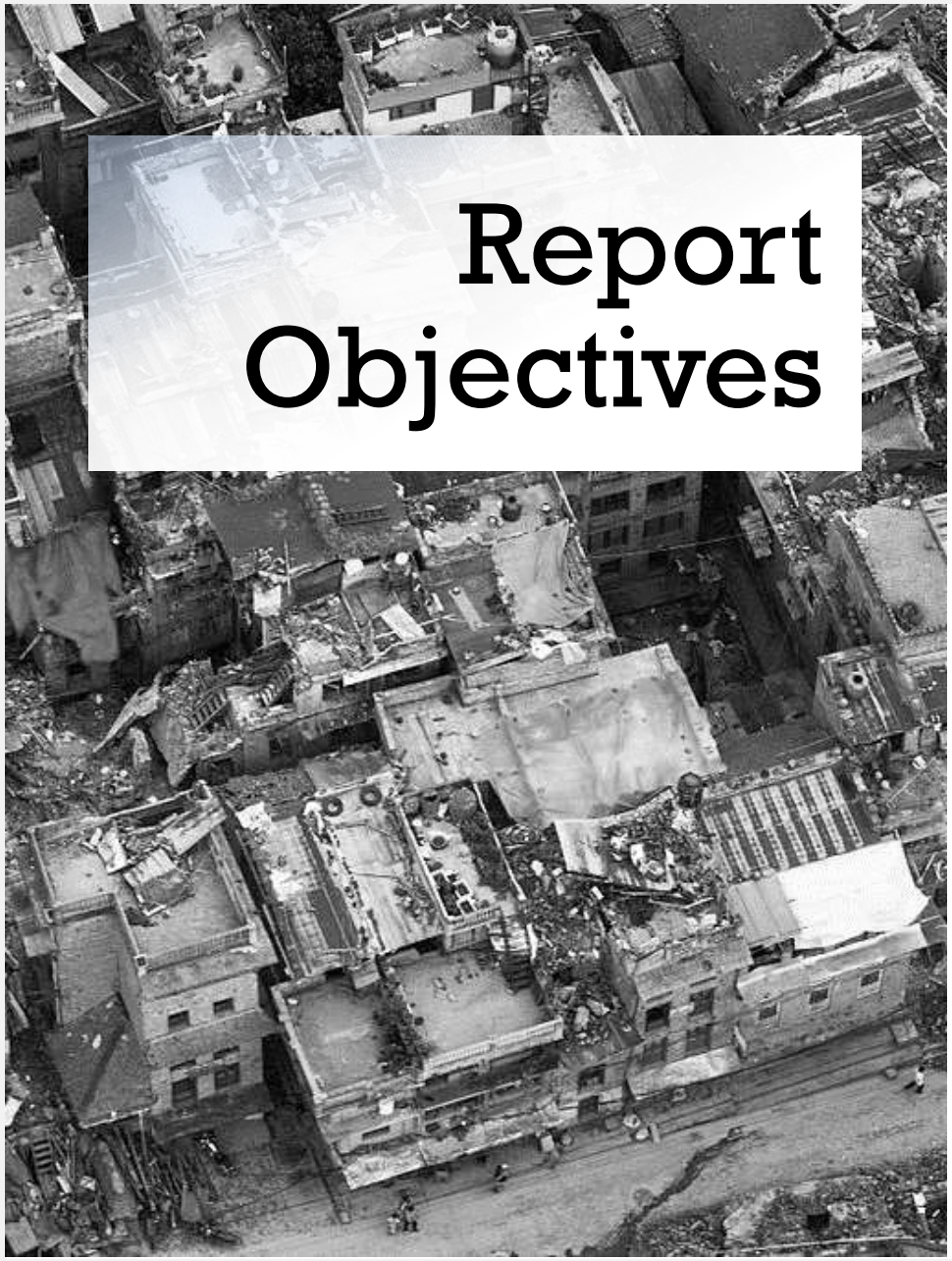
Earthquake Key Facts:

- Date & Time: 25 April 2015, 11:56 NST
- Epicentre: Barpak, Gorkha
- Hypocentre: 8.2km deep approx.
- Magnitude: 7.8M (Richter Scale)
- Mercalli Intensity of VIII (severe)
- Triggered avalanches and landslides
- Nepal's Worst Natural Disaster since 1934
- Deaths: 9,000 approx..
- Injured: 22,000 approx..
- Homeless: 100k+
- Entire villages flattened
- Several UNESCO buildings destroyed

Source: Wikipedia permanent link (accessed 13:26 GMT, 09 April 2019)

Dataset:

- Collected by *The Central Bureau of Statistics of Nepal*
- Outcome of extensive building surveys carried out after the earthquake
- Contains 10.000 records
- Each record is related to one building, compiling several information about it. Of particular interest for this report:
  - **Damage Level** awarded (on a scale 1 to 3)
  - Superstructure **Material Types** (based on 11 categories)
  - Building's **Age** (5 year groups)



Report Objectives

A. How much damage was caused overall?

B. How did different building materials and combinations survived?

C. How building age related to damage caused?

A

Building Distribution by: Damage Levels, Material Types & Age

Building Count by Damage Level

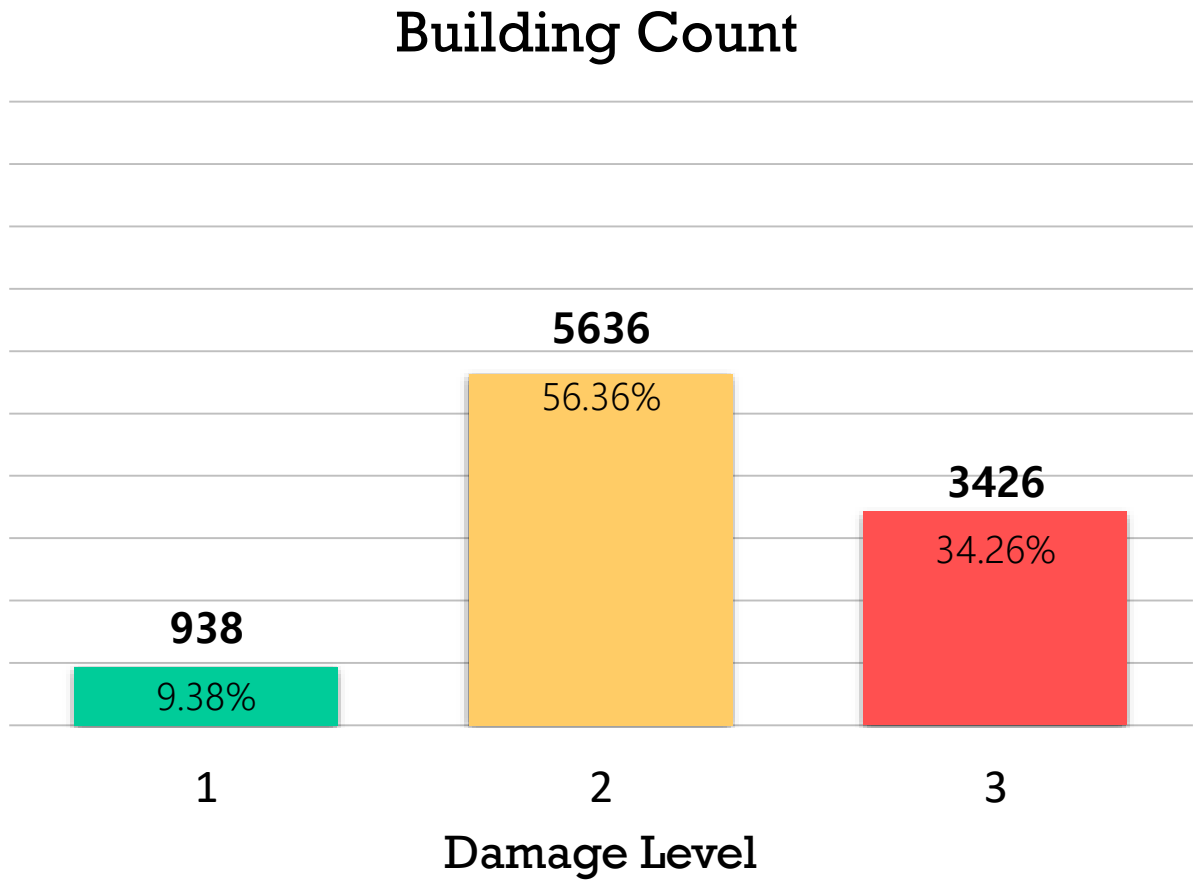
Damage Levels:

1 - low or no damage

2 - medium amount of damage

3 - almost complete destruction

- Nearly **91%** of surveyed buildings suffered considerable damages (levels 2 + 3)
- Overall Average Damage Level **2.25**



Building Count by Superstructure Material Types

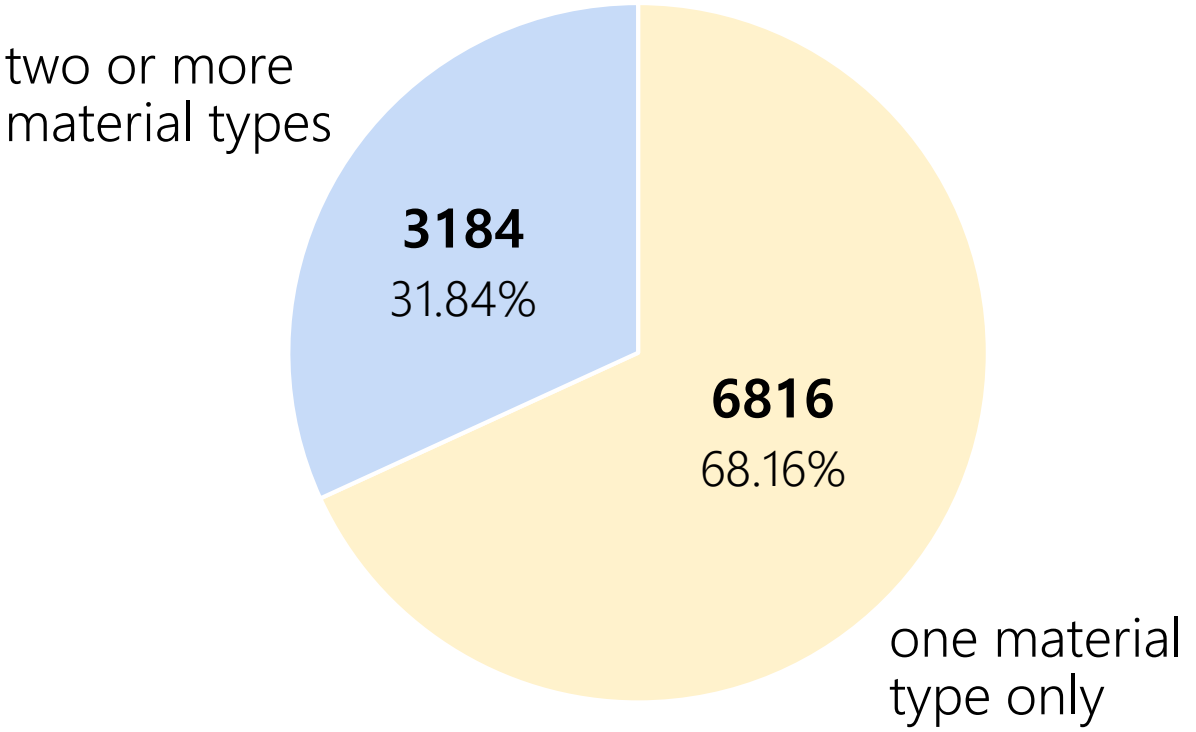
Material Type Major Split

Material Type wise, buildings can be split into 2 major categories:

A. Buildings logged with **one material type only**

B. Buildings logged with **two or more material types**

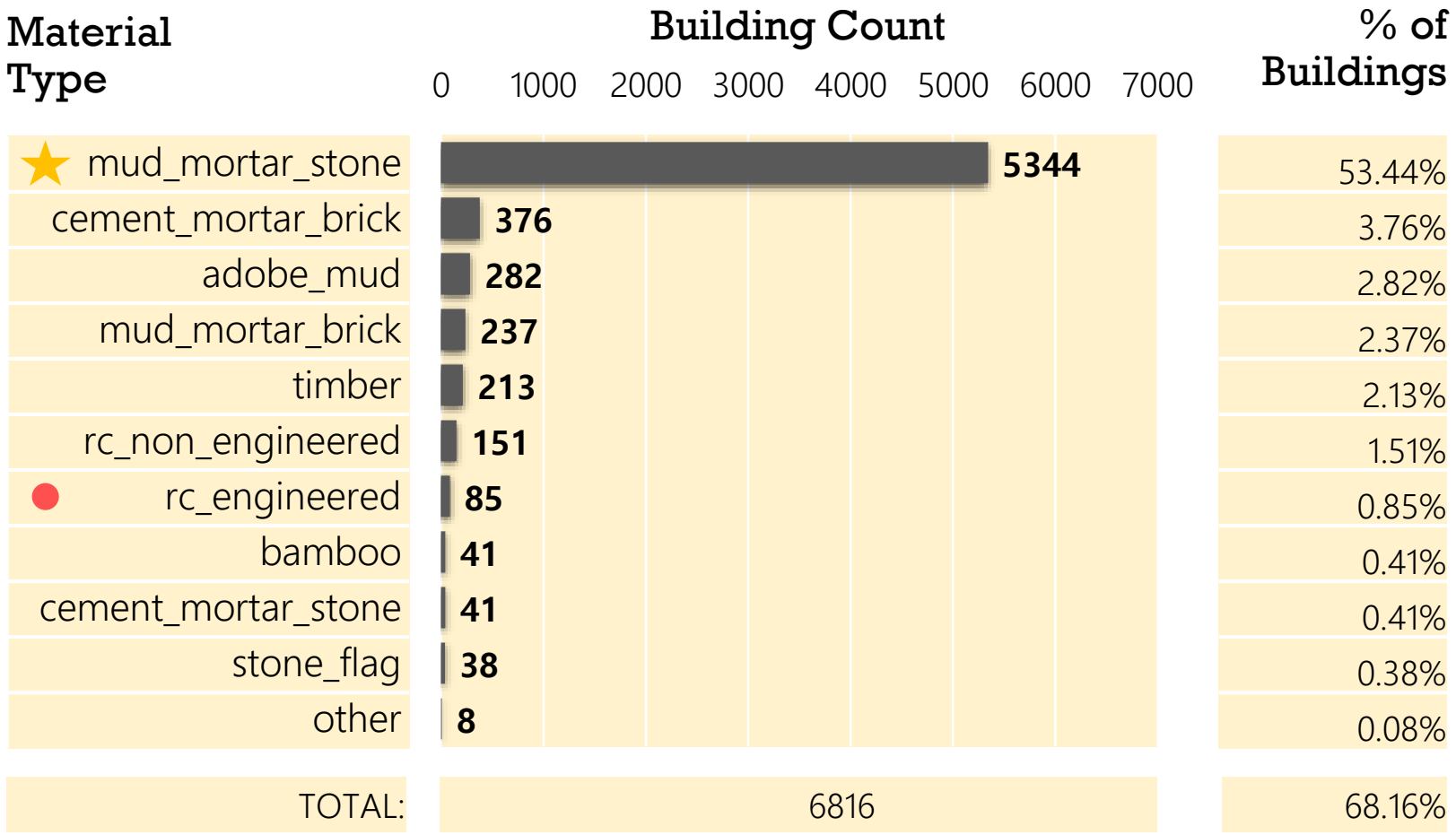
Building Count by Major Split



Building Count by Superstructure Material Types

"One Material Type Only" breakdown

- "mud_mortar_stone" style dominates with 53.44%
- Engineered reinforced-concrete superstructures ("rc_engineered") accounted only for 0.85%



Building Count by Superstructure Material Types

"Two or More Material Types" breakdown

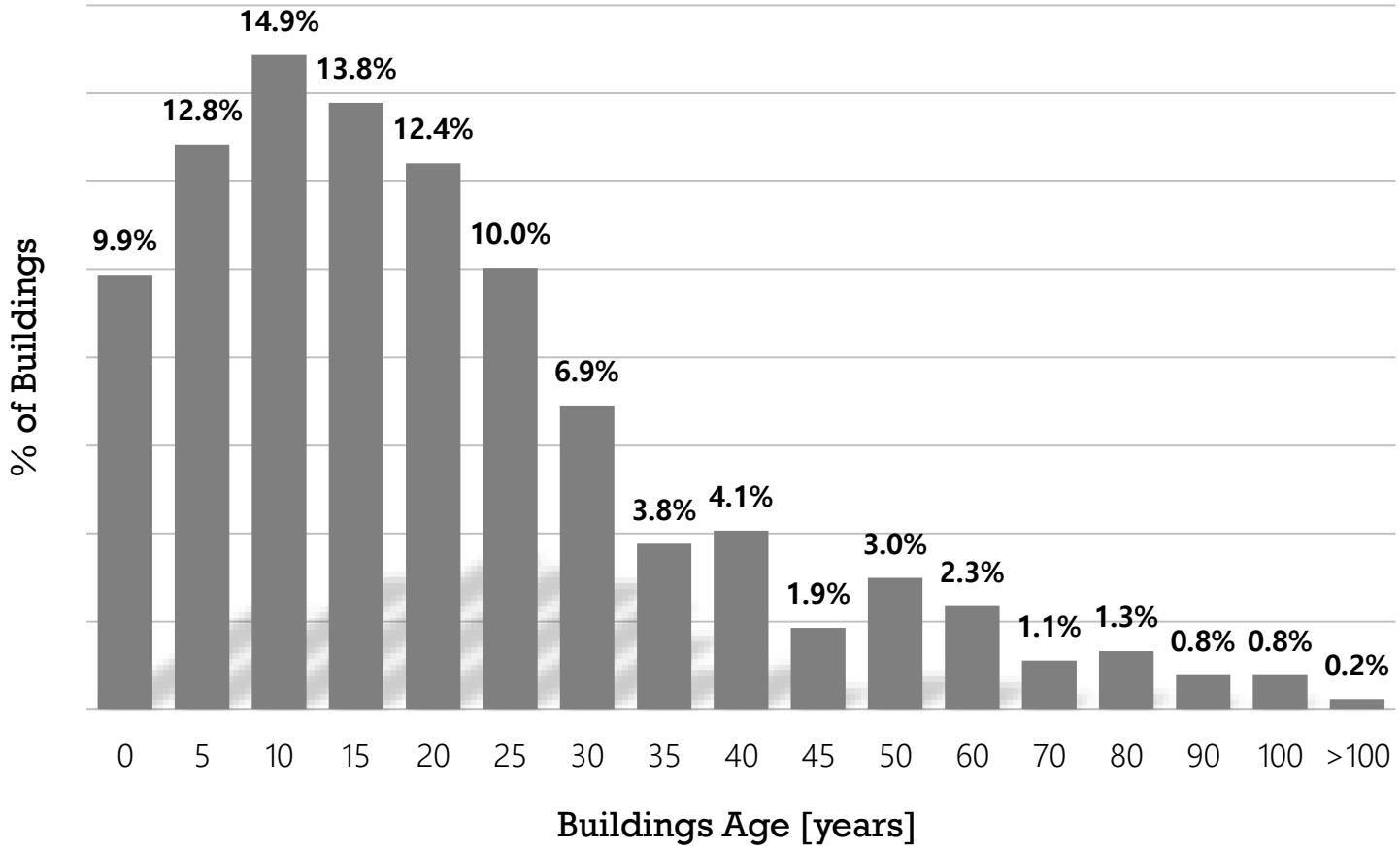
- "2 material types" is the most frequent combination making 21.58% of the surveyed buildings (and 2/3s of the current breakdown)
- Combinations of 6 and more styles in very small numbers - not significant

Material Type	Building Count	% of Buildings
2 material types	2158	21.58%
3 material types	766	7.66%
4 material types	201	2.01%
5 material types	49	0.49%
6 material types	8	0.08%
7 material types	1	0.01%
8 material types	1	0.01%
TOTAL:	3184	31.84%

Building Distribution by Age

Descriptive Statistics:

- Sample Range: 0 - 200 years(*)
- Median: 15 years
- Mode (most freq. age): 10 years
- Mean: 21.5 years
- Std Dev: 19.58 years



(*) Buildings logged with "Age 995" (undefined age) have not been considered here.

B

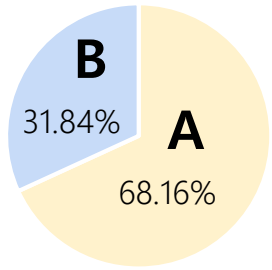
Buildings' Superstructure Material Types & Damage Levels

Average Damage by Material Type

Material Type Major Splits

A. Buildings with **one material type only**

B. Buildings with **two or more material types**



- Average Damage of combined material types (2.19) is only 4.39% lower than single types one (2.28)
- Will such difference be statistically significant?

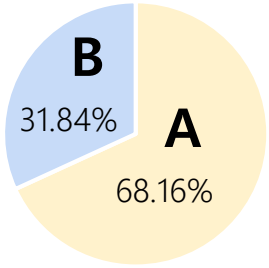
Material Type	Average Damage	% of Buildings
one_material_type_only	2.28	68.16%
two_or_more_material_types	2.19	31.84%
entire sample	2.25	100.00%

Average Damage by Material Type

Material Type Major Splits

A. Buildings with **one material type only**

B. Buildings with **two or more material types**



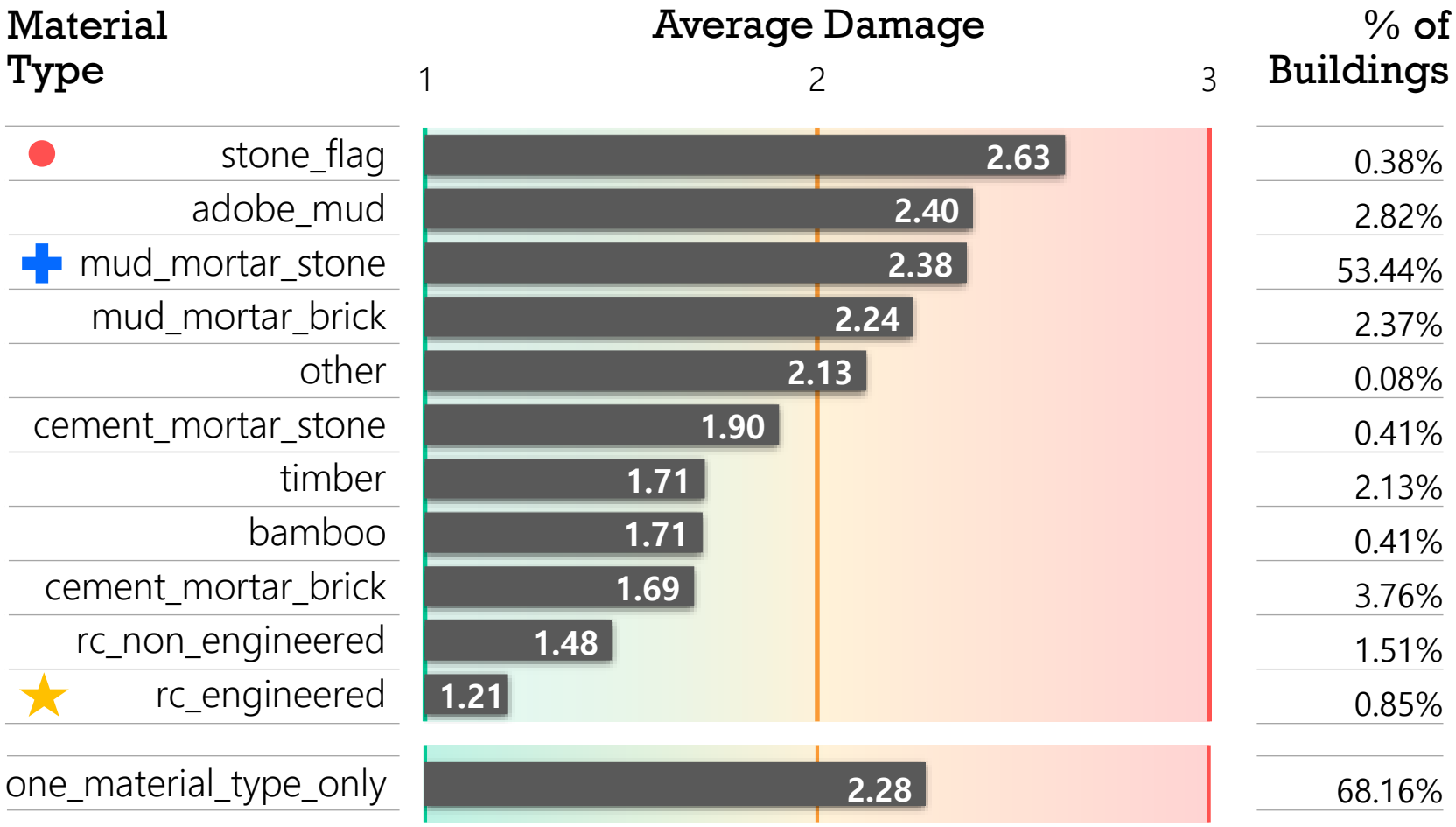
- t-test and p value reveal the difference of 4.39% is Statistically Significant, i.e. it is real (not due to change)

one material type only	two or more material types	*t*	*p*	*Significant?*
2.28	2.19	-6.86	<0.001	True

Average Damage by Material Type

"One Material Type Only" buildings

- "stone_flag" type has the highest Average Damage (2.63)
- "rc_engineered" style is the least damaging one (1.21)
- Dominant style - "mud_mortar_stone" – on the top 3 highest average values (2.38). Main responsible for the average of the group (2.28)



Average Damage by Material Type

"One Material Type Only" Buildings

- Apart from types "mud_mortar_brick" and "other", the differences in averages for each material are real (i.e., not due to chance)
- Statistical significance of the above assessed by *t*-tests and *p*-values

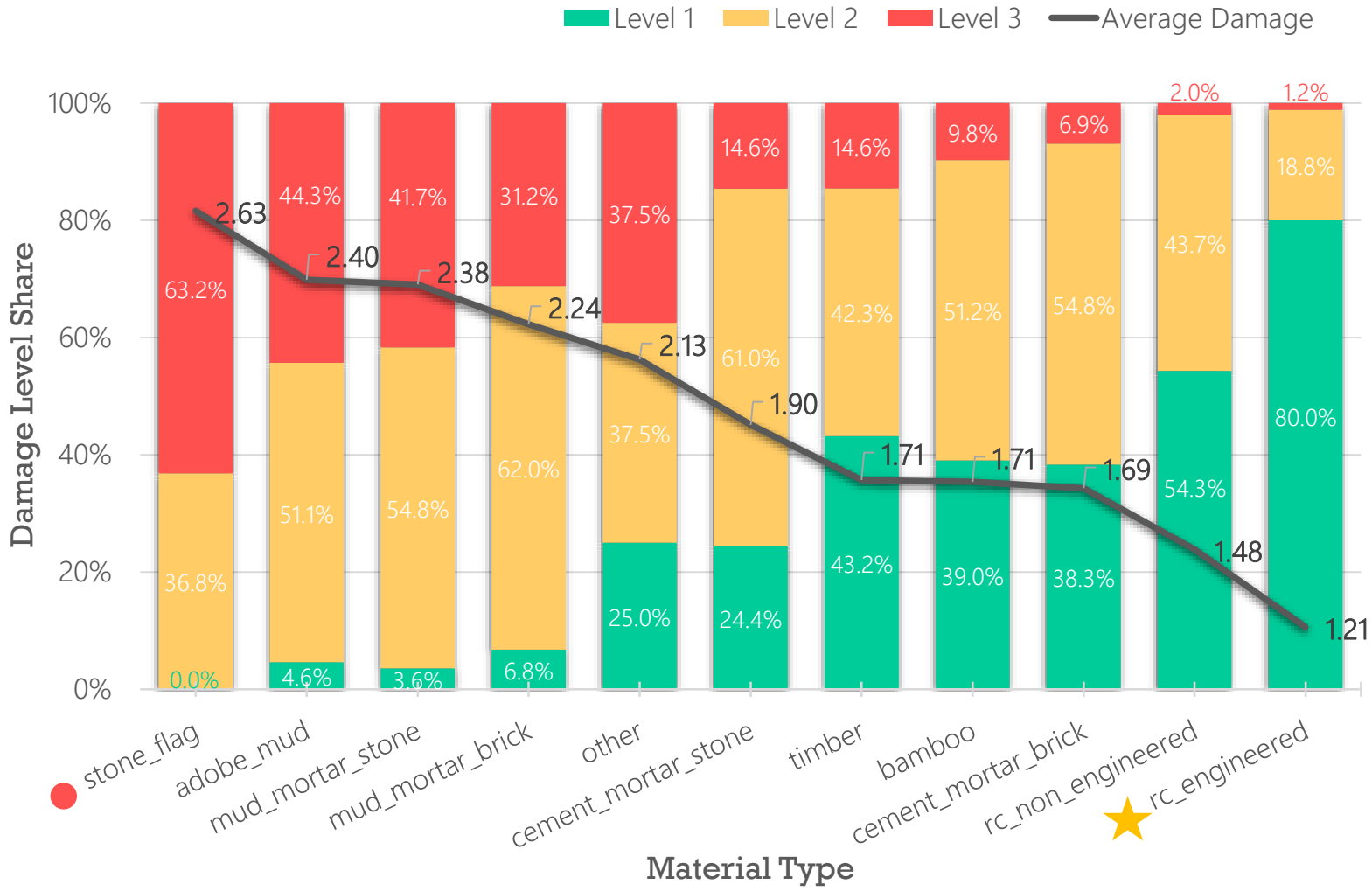
Material Type	Average Damage (type NOT USED)	Average Damage (type USED)	*t*	*p*	*Significant?*
stone_flag	2.28	2.63	-3.53	<0.001	True
adobe_mud	2.27	2.40	-3.31	<0.001	True
mud_mortar_stone	1.90	2.38	-27.69	<0.001	True
mud_mortar_brick	2.28	2.24	0.82	0.4096	False
other	2.28	2.13	0.69	0.4876	False
cement_mortar_stone	2.28	1.90	3.88	<0.001	True
timber	2.30	1.71	13.63	<0.001	True
bamboo	2.28	1.71	5.91	<0.001	True
cement_mortar_brick	2.31	1.69	19.50	<0.001	True
rc_non_engineered	2.30	1.48	16.32	<0.001	True
rc_engineered	2.29	1.21	16.21	<0.001	True

Damage Level share by Material Type

"One Material Type Only" buildings

Damage Level	Mean by Mat Type
1 low or no damage	29.0%
2 medium damage	46.7%
3 almost total destruction	24.3%

- Worst case scenario for "stone_flag" buildings – majority (63%) completely destroyed while the remaining suffered from considerable damages
- Engineered reinforced concrete (rc) buildings only saw damages in 20% of the cases



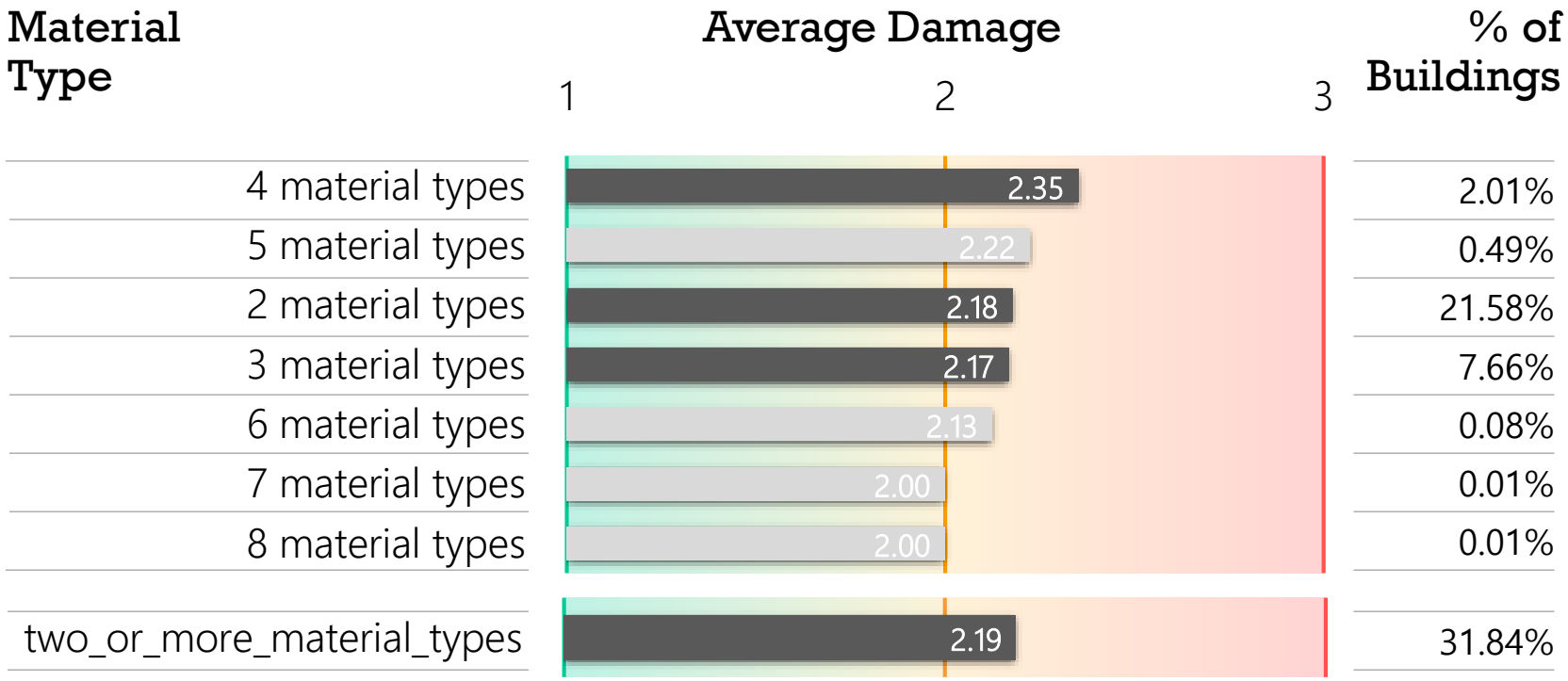
Average Damage by Material Type

"Two or More Material Types" buildings

- Combinations of 2 and 3 material types dictating the group's average due to their share (92% in the group)

- Dataset with not enough information to assess the contribution (in damage levels) of each material type in a combination

- Material Types wise, no further analysis has been carried out on this group of buildings



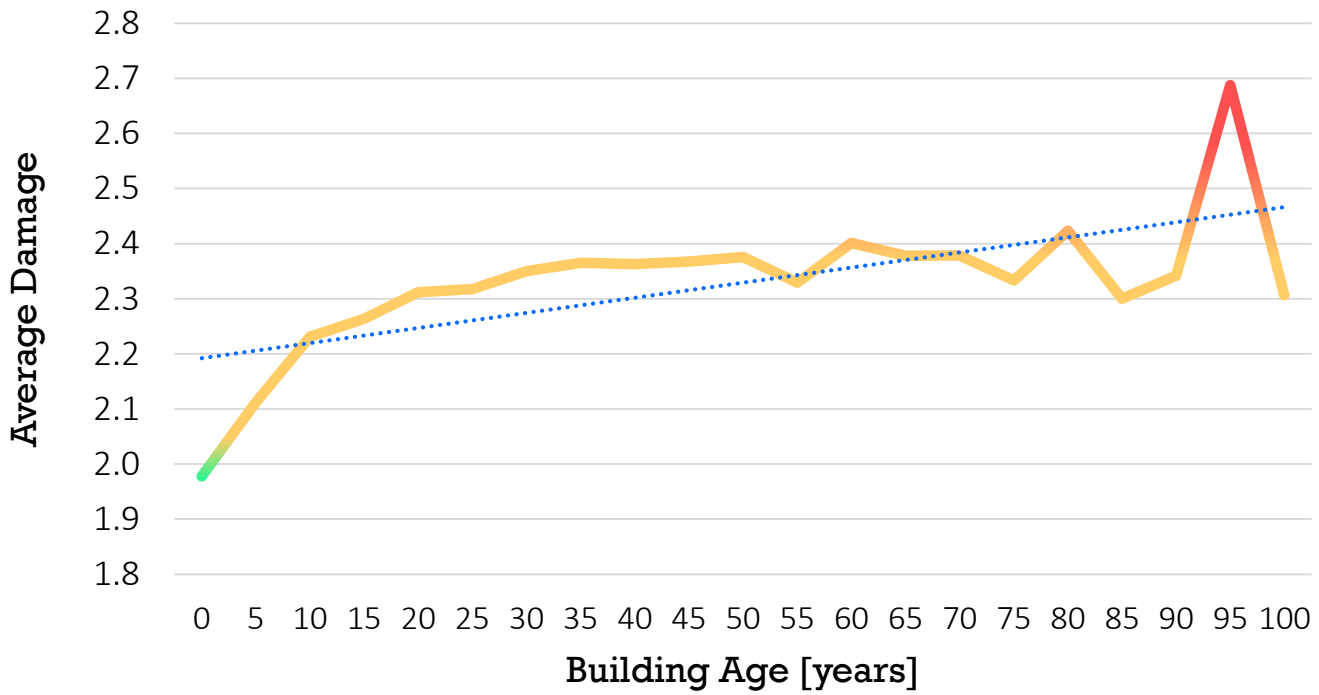
C

Building Age & Damage Levels

Building Age & Damage Level

Average Damage by Ages:

- Mean: 2.33
- Max: 2.69 (95 years)
- Min: 1.98 (0 years)
- Damage increase with building age
- Accelerated damage decline < 35 years



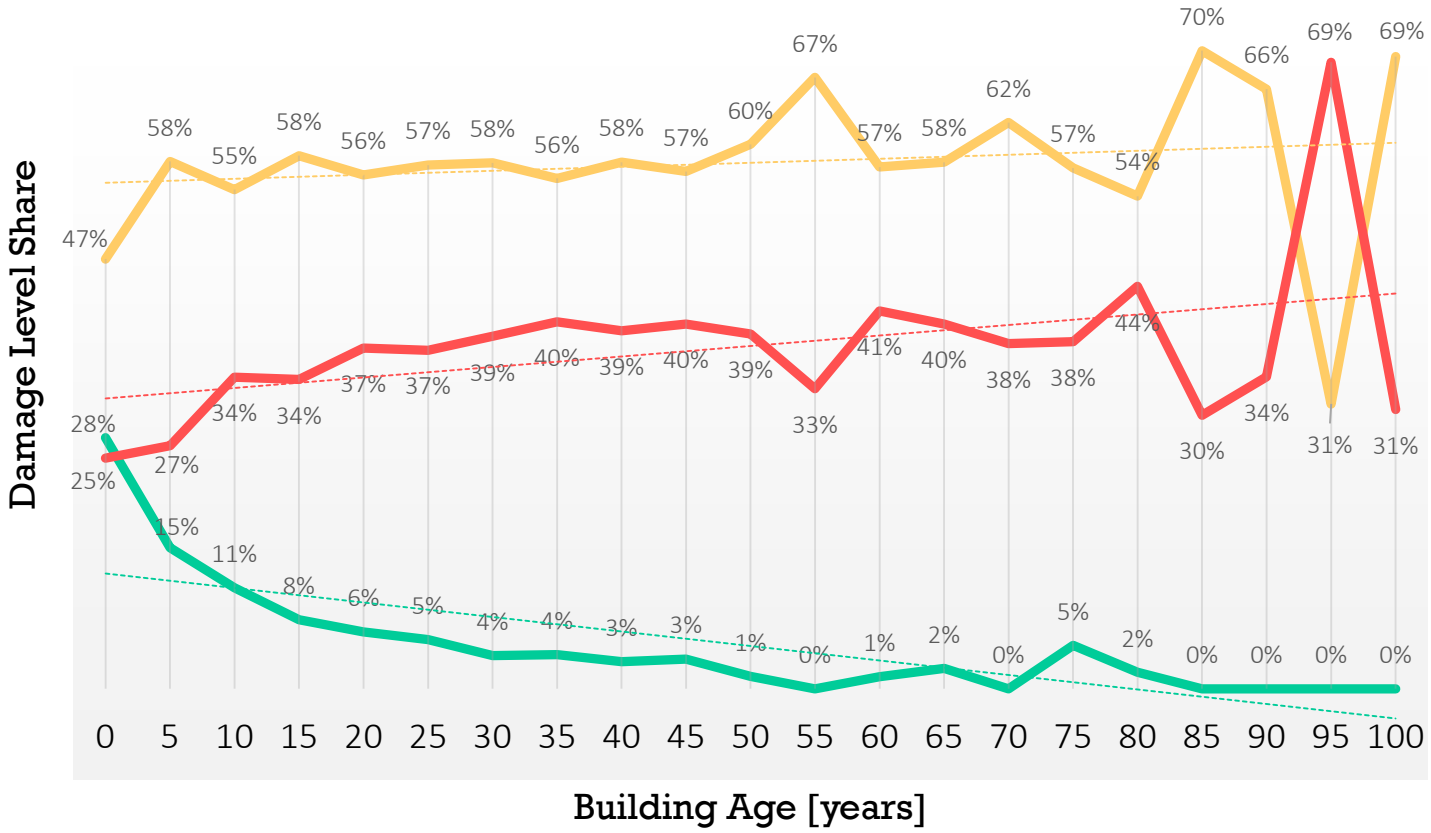
Note: Sample Range considered: 0 - 100 years (ages >100 years: 'outliers')

Building Age & Damage Level

Damage Level share by Ages:

(Breakdown of the Average Damage by Ages)

Damage Level	Mean by Ages
1 low or no damage	4.7%
2 medium damage	57.7%
3 almost total destruction	37.6%



- Almost all buildings **over 50 years** were medium damaged or totally destroyed
- Unique case at **Age 0**:
  Level 1 (27.5%) > Level 3 (25.3%)

Note: Sample Range considered: 0 - 100 years (ages >100 years: 'outliers')

Final Conclusions

U.S. Marine Corps photo by Lance Cpl. Mandaline Hatch [Public domain] Wikimedia Commons. Retrieved 19:18 GMT, April 15, 2019 from this permanent URL

Final Conclusions:

- 34.3% of surveyed buildings were almost or completely destroyed, and 56.4 % suffered from medium damages – nearly 91% in total.

- Material Types revealed a strong relationship with the extent of building damage:
  - The strongest type is “rc_enginneered” and the weakest is “stone_flag”
  - The most common type - “mud_mortar_stone” - is amongst the weaker types
  - Overall, material type combinations showed a marginal better performance than single type ones

- Building age was also related with the level of damage:
  - Level of damage increased almost gradually with age
  - Buildings from 50 to 0 years showed a growing “no damage level” rate, while their older counterparts had it fixed at nearly 0%

End of Report

U.S. Marine Corps photo by Staff Sgt. Jeffrey D. Anderson [Public domain] Wikimedia Commons. Retrieved 11:33 GMT, April 15, 2019 from this permanent URL