Työssä mukana paikallaolijoista:
Vesa Holmström, Jari Honkanen, Erkki Huotari, Tero Hynninen, Eero Jokimies, Janne Järvinen, Kati Kaskiala, Janne Paajanen, Juha Tuovinen, Simo Turunen

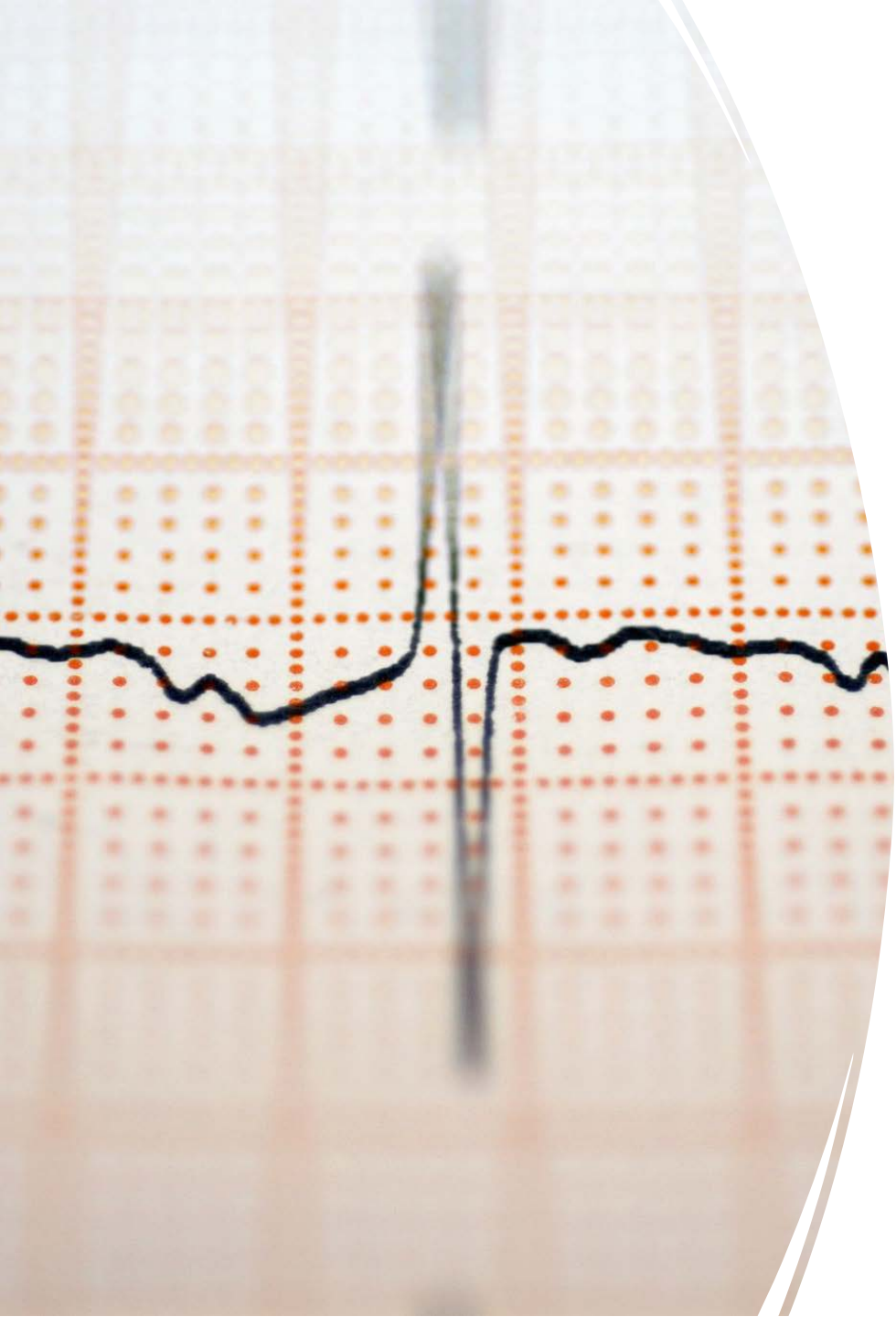
Louhintatärinän aiheuttamat vauriot betonirakenteissa

Damages in concrete structures due to rock blasting

Author: Pyry Venho
Thesis supervisor: Mikael Rinne
Thesis advisor: Tuomo Hänninen

Presentation structure

- Research questions
- Test arrangements
- Results
- Other observations
- Summary
- Results



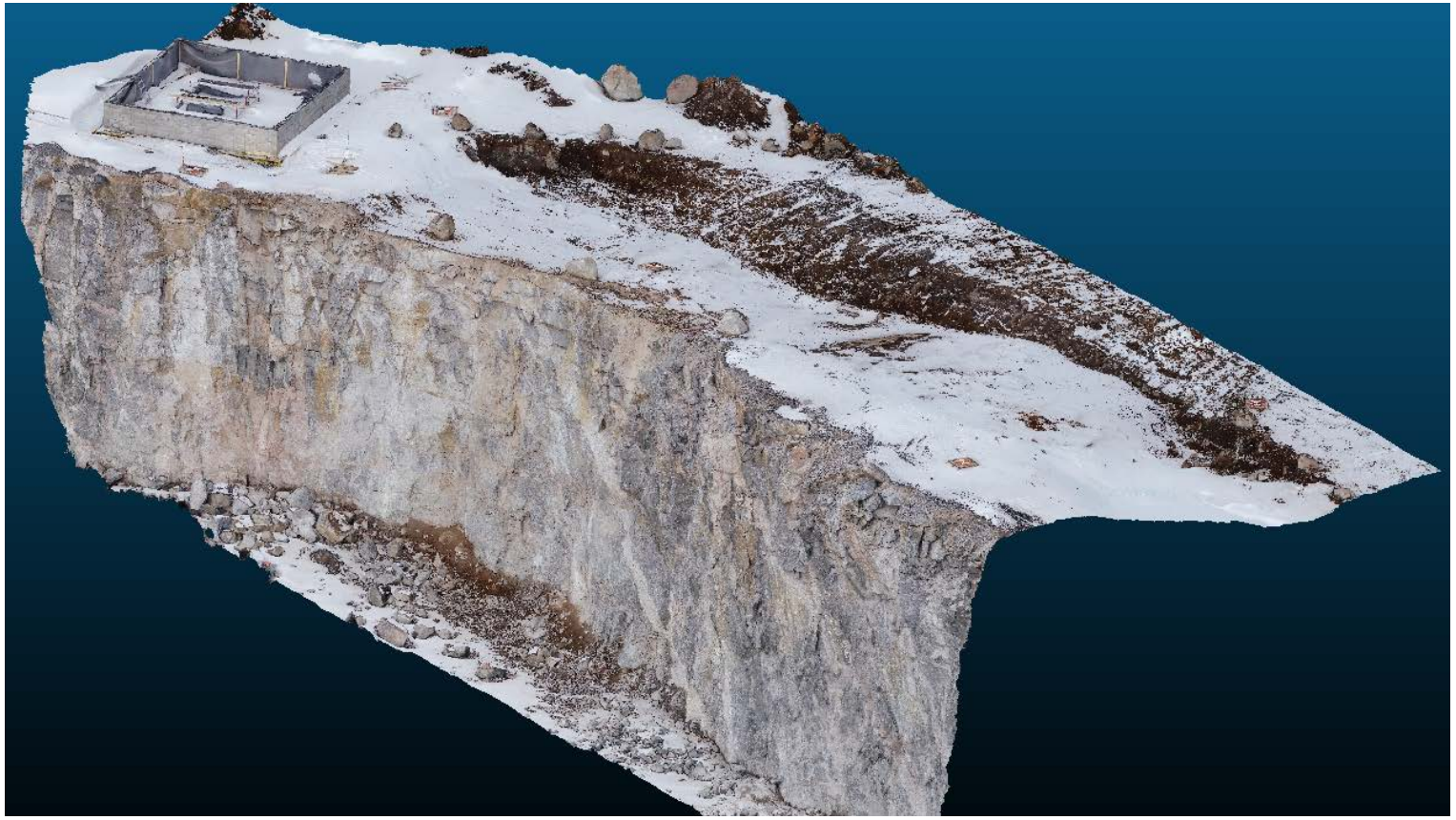
Research questions

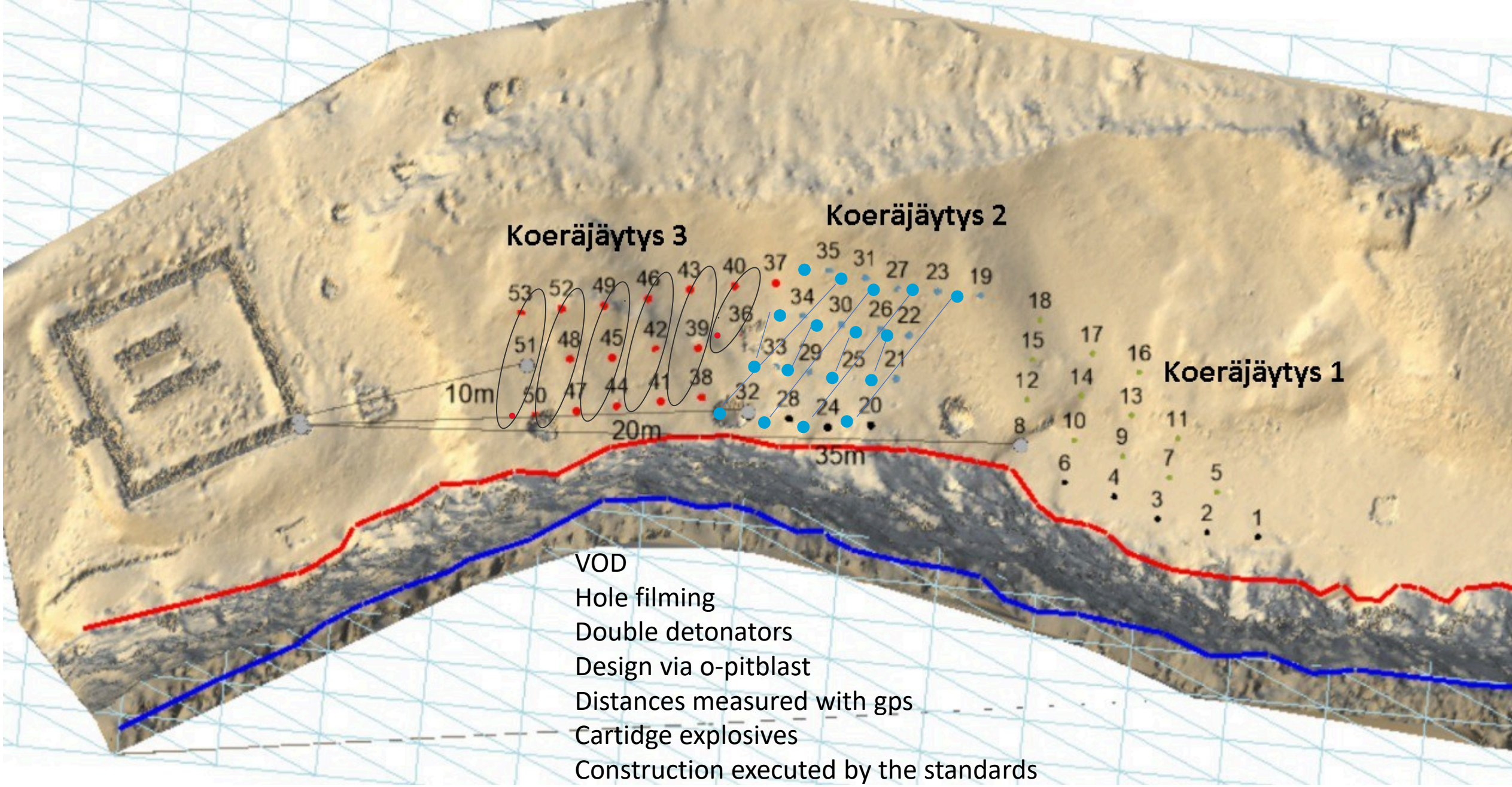
- Which factors affects to vibration's velocity, amplitude and frequency?
- What kind of vibration may cause damages to structure?

$$v = 2\pi FA$$

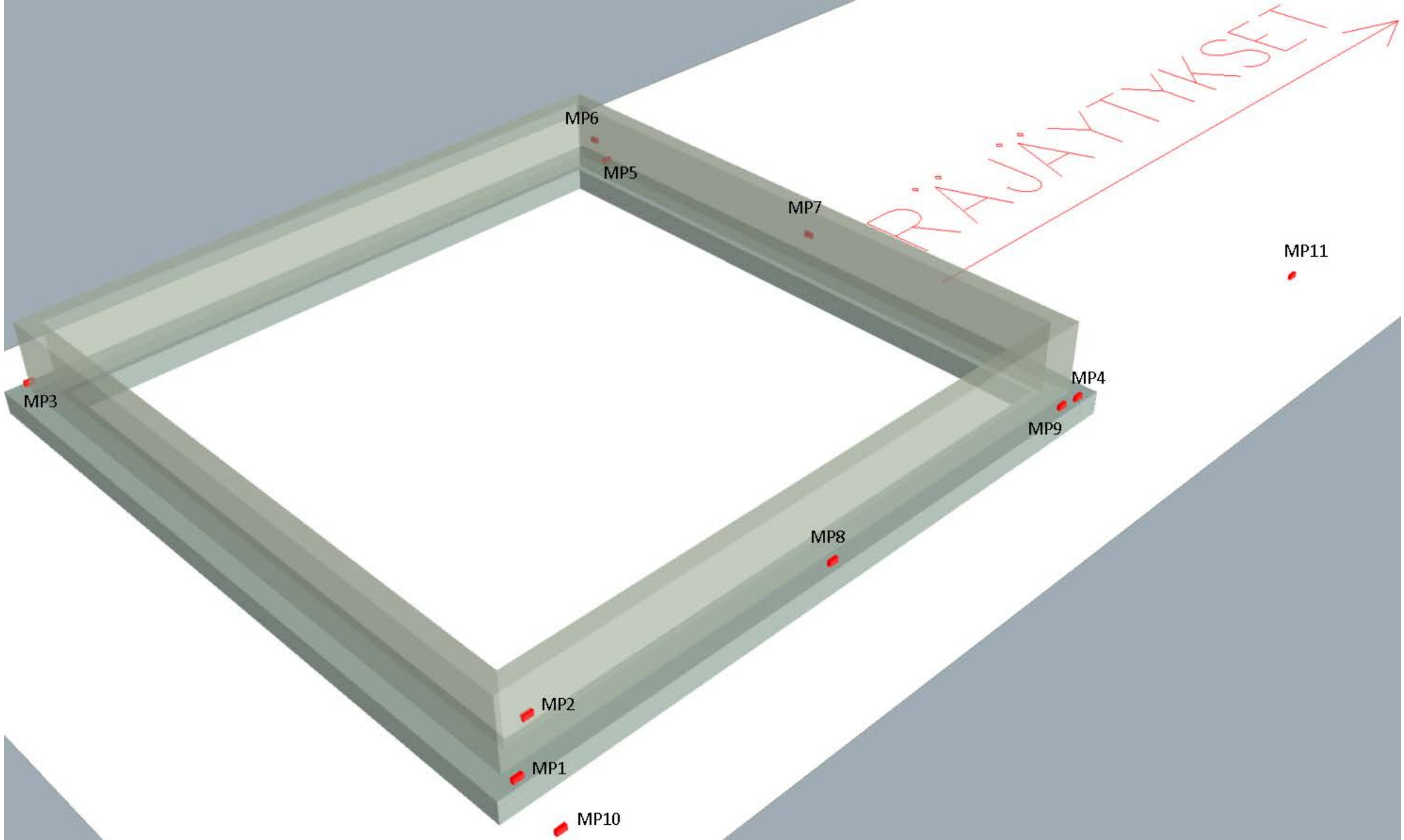
F & A correlation

Test arrangements



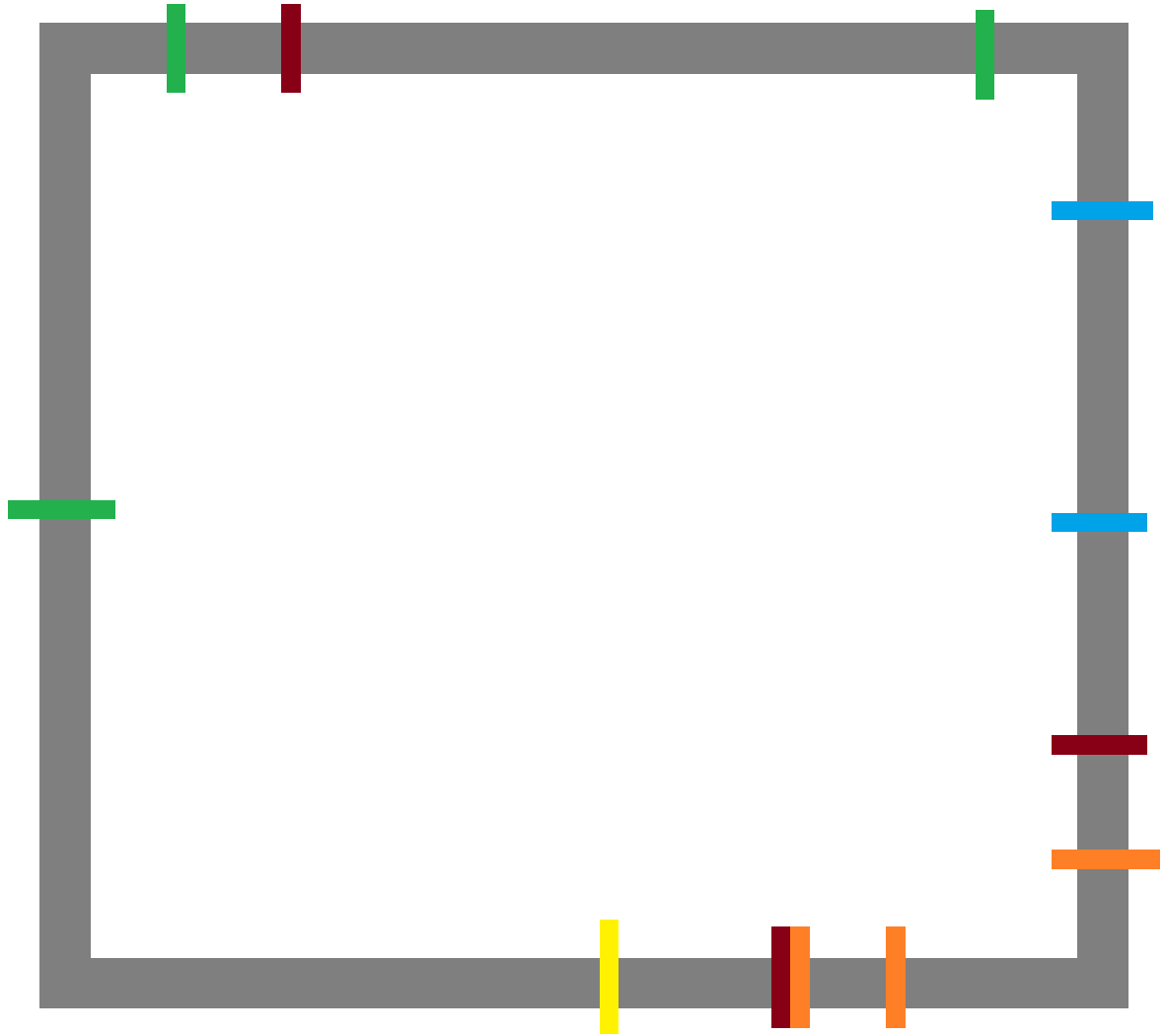


VOD
Hole filming
Double detonators
Design via o-pitblast
Distances measured with gps
Cartidge explosives
Construction executed by the standards


RAJAYTYKSET
MP6
MP5
MP7
MP11
MP3
MP4
MP9
MP8
MP2
MP1
MP10

Results

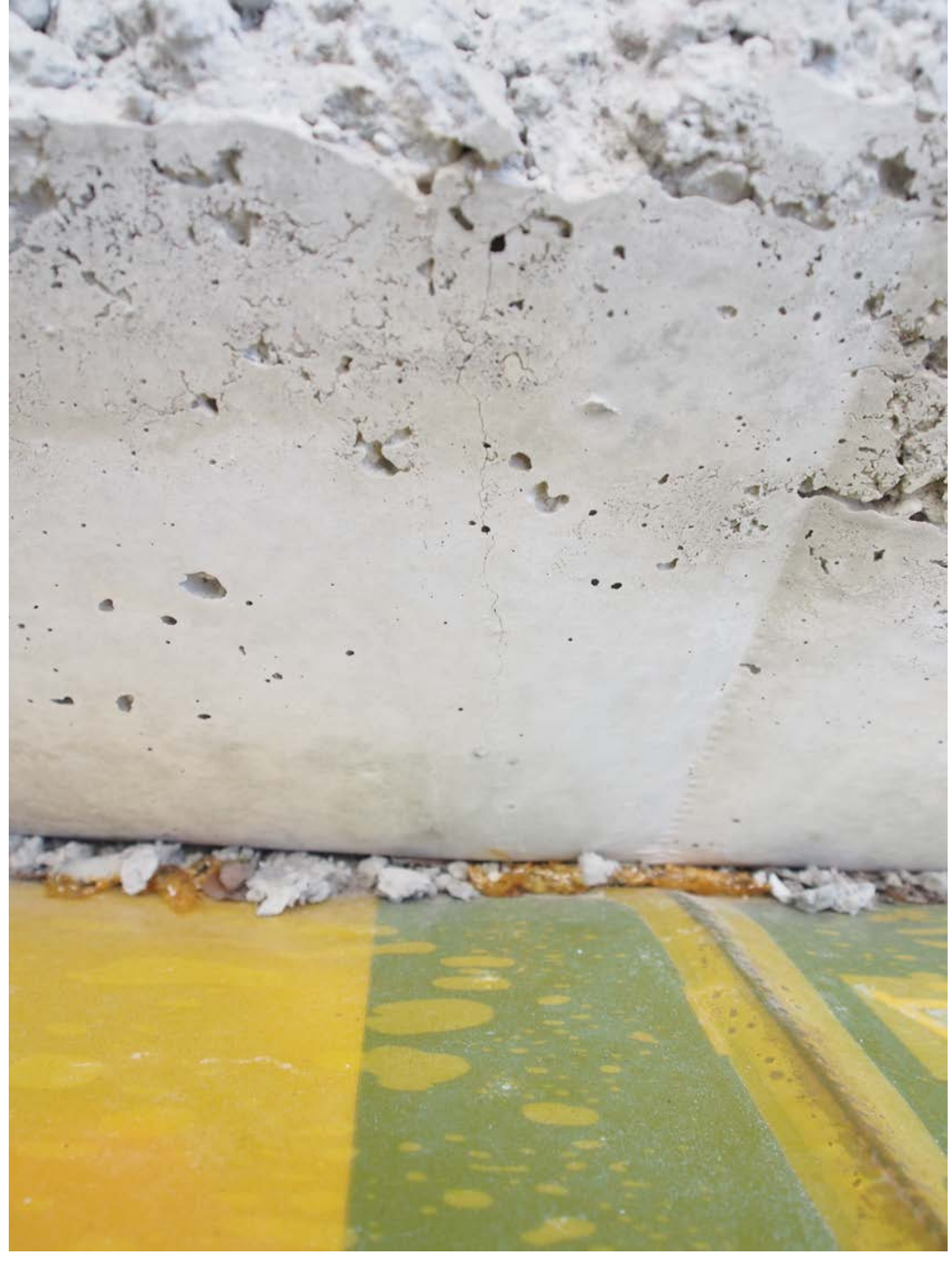
Blast	PPV (mm/s)	Amplitude (mm)	Frequency (Hz)	Distance (m)	Qmom (kg)
1.Production	44,5	0,15	43	96	479,6
2.Production	38,8	0,221	29	124	406,2
1.Test	82,7	0,399	30	41	65,1
2.Test	68,5	0,366	50	34	112,2
3.Test	155	1,34	18	23	150,7



1. Production blast
2. Production blast
1. test blast
2. test blast
3. test blast

Effect of vibration's amplitude on damage

- Foundation ruptured when amplitude and peak particle velocity was the highest
- No significant correlation with frequency or distance

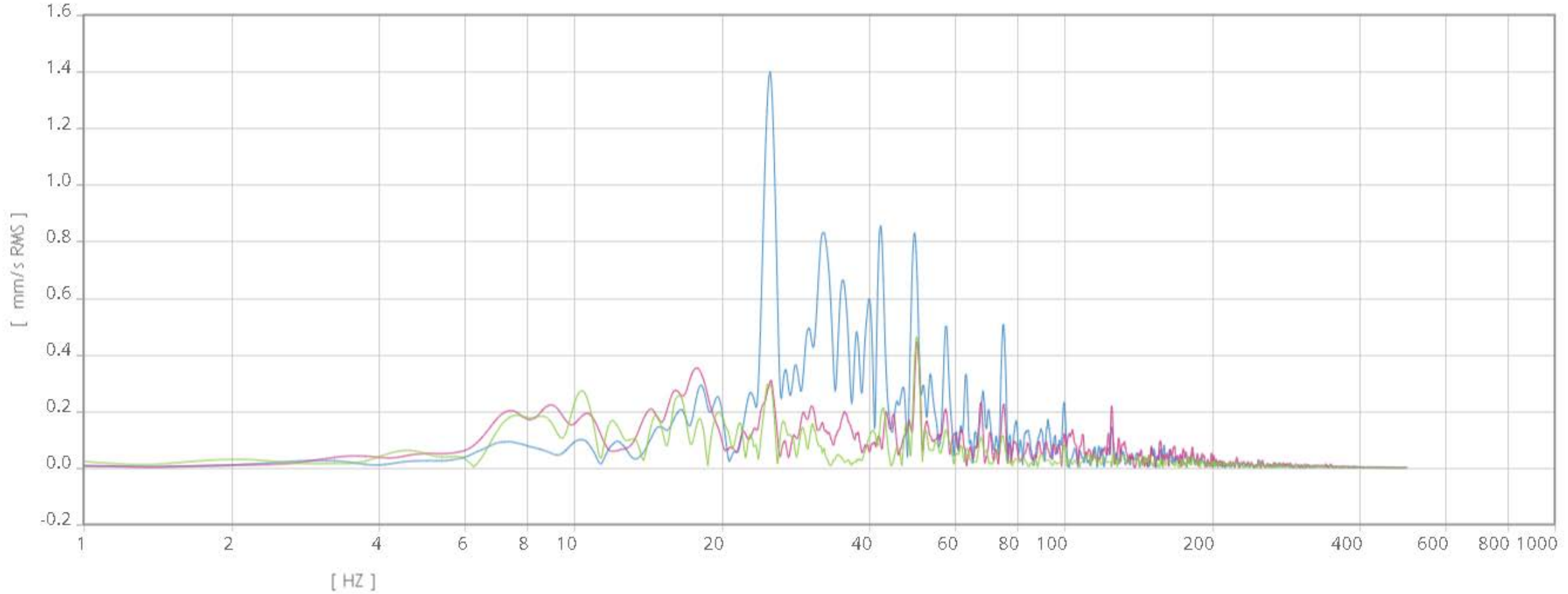


Correlation between delay and frequency

- Significant correlation with shorter <40m distances
  - No correlation with 100m distances

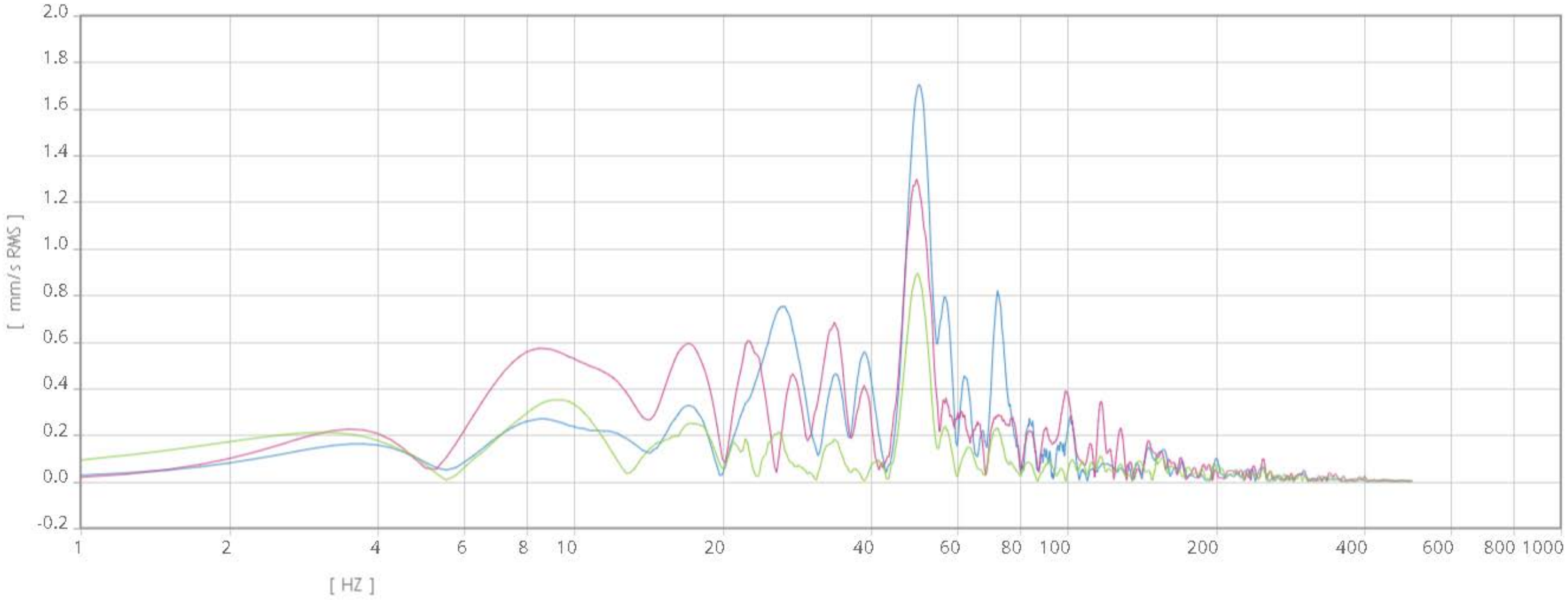
Delay affected to frequency

MP2, Test 1, delay 40ms=25Hz



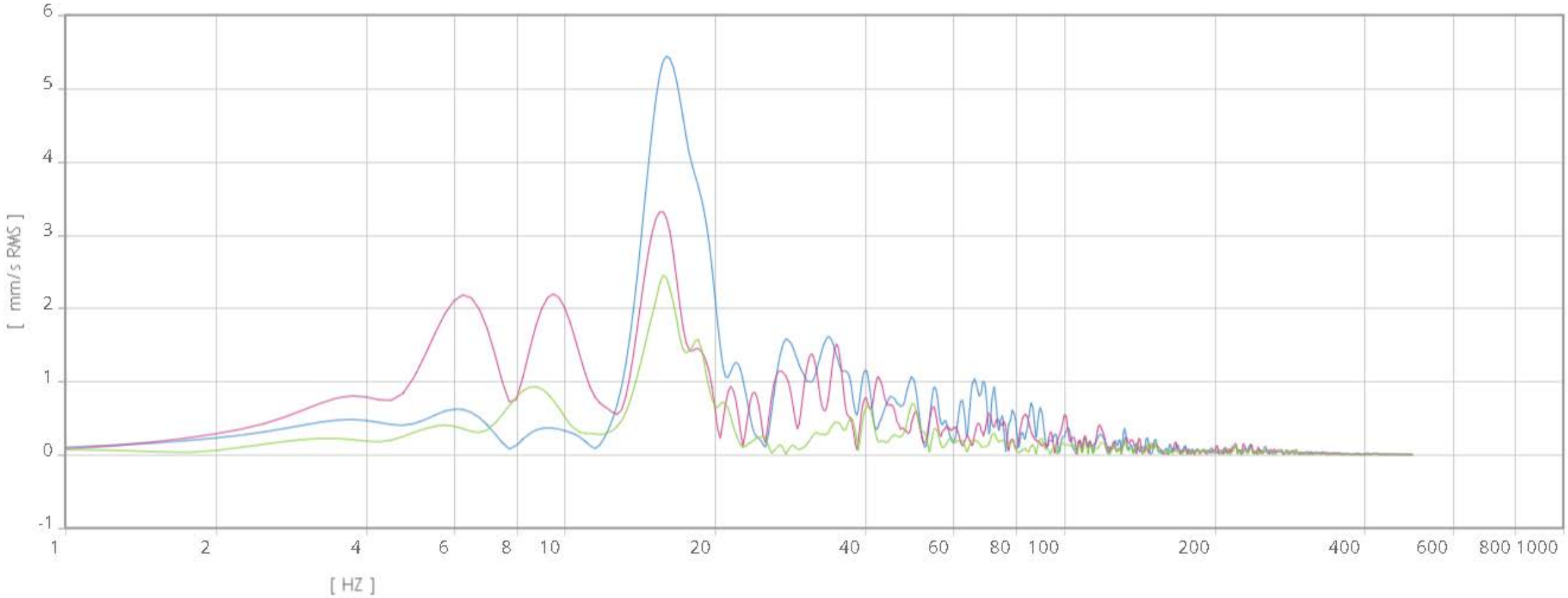
Delay affected to frequency

MP2, Test 2, delay 20ms=50Hz



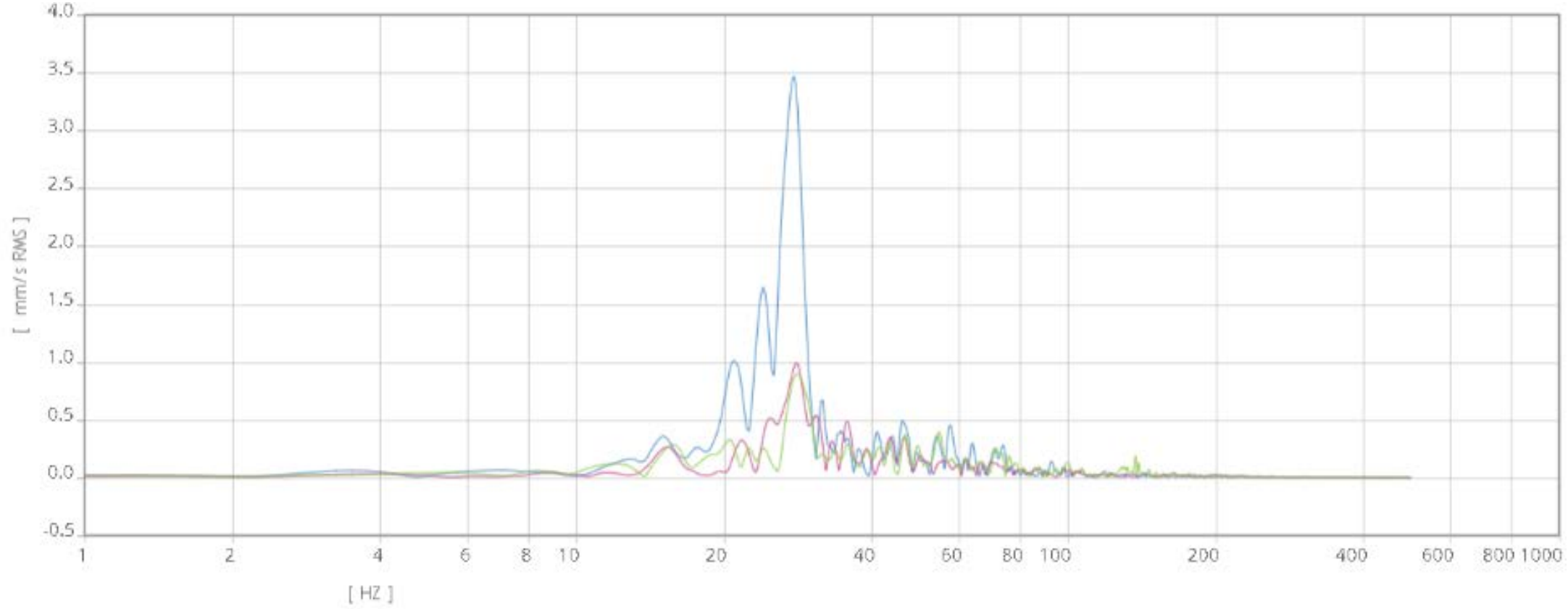
Delay affected to frequency

MP1, Test 3, delay 60ms=16,7Hz



No correlation when distance is 100 meters

MP3, production blast 1, delay 10-20ms (50-100Hz)



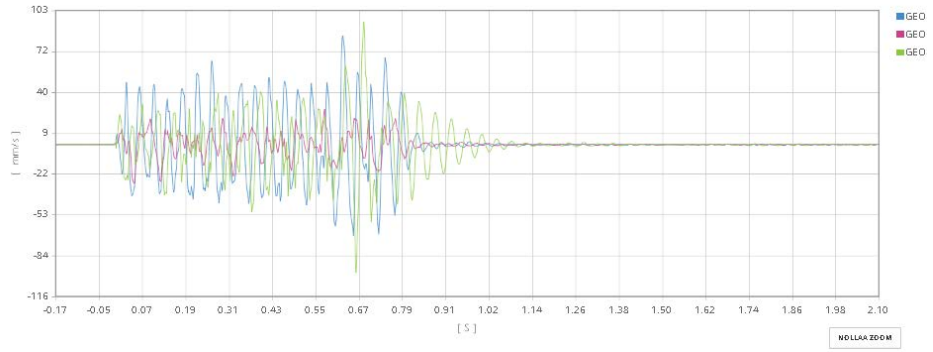
Effect of distance and instantaneous charge on vibration values

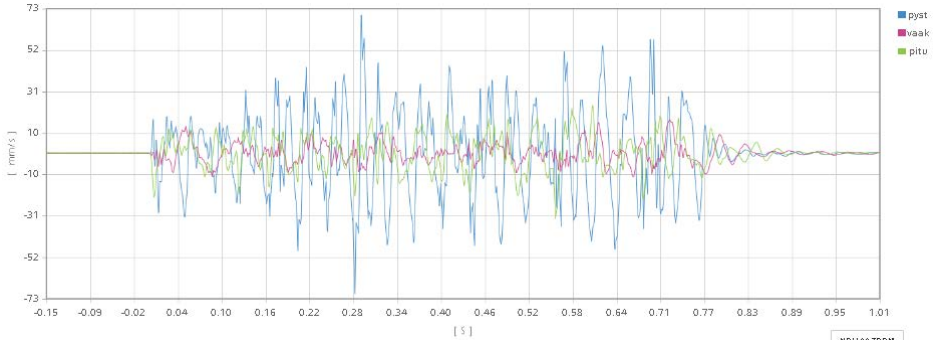
- Shorter distance and greater instantaneous charge increases the amplitude
  - relation between frequency was not that significant
- Decreasing distance and increasing instantaneous charge will increase the risk of damage

Other observations

Vertical vibration is dominant in structure, horizontal vibration is dominant in bedrock

Nimi	tulos	m/s2	Siirtymä	Hz
MPkallio10_lounaskulmaT	303,00 mm/s	385.0 m/s²	2050 um	69.2 hz
MPkallio10_lounaskulmaL	263,00 mm/s	156.0 m/s²	1160 um	51.4 hz
MPkallio10_lounaskulmaV	231,00 mm/s	174.0 m/s²	1570 um	70.0 hz
MP3_luoteiskulma, anturaT	36,70 mm/s	12.6 m/s²	398 um	10.7 hz
MP3_luoteiskulma, anturaL	51,20 mm/s	17.7 m/s²	417 um	17.5 hz
MP3_luoteiskulma, anturaV	155,00 mm/s	27.0 m/s²	1340 um	17.7 hz
MPkallio11_ 10 metrin päästä kaakkoiskulmastaT	192,00 mm/s	119.0 m/s²	551 um	20.3 hz
MPkallio11_ 10 metrin päästä kaakkoiskulmastaL	95,50 mm/s	92.3 m/s²	646 um	36.5 hz
MPkallio11_ 10 metrin päästä kaakkoiskulmastaV	97,20 mm/s	53.9 m/s²	760 um	13.8 hz
MP1_lounaskulma, anturaT	90,20 mm/s	56.4 m/s²	594 um	36.2 hz
MP1_lounaskulma, anturaL	49,30 mm/s	18.8 m/s²	362 um	19.5 hz
MP1_lounaskulma, anturaV	136,00 mm/s	49.4 m/s²	1200 um	22.6 hz





Wall ”wobbles” in the middle

- Different type of mechanism for damages comparing vertical stresses

Summary

- Damages are related to amplitude
- Vertical component is typically dominant component that will cause the damage
  - Exception in the middle of wall
- Delays may cause the dominant frequency, significant for amplitude and peak particle velocity

Kiitos!