**Yellow indicates where contractor will need to adjust construction method to be under required .3 PPV in/sec.**

**Doyle Drive**
**Pre-construction Conditions Survey List: Historic Buildings**

| Resource | Soil type | Contract #3 Distance in feet from construction | Contract #3 Highest impact construction method | Contract #3 expected PPV in/sec resulting at the building from this method | Contract #4 Distance in feet from construction | Contract #4 highest impact construction method | Contract #4 expected PPV in/sec resulting at the building from this method | Contract #5 Distance in feet from Construction | Contract #5 highest impact construction method | Contract #5 expected PPV in/sec resulting at the building from this method | Contract #6 Distance in feet from construction | Contract #6 highest impact construction method | Contract #6 expected PPV in/sec resulting at the building from this method | Contract #7 Distance in feet from construction: new / demo | Contract #7 highest impact construction method | Contract #7 expected PPV in/sec reuslting at the building from this method |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 681 barracks | Qsr | | | | | | | | | | | | | | | |
| 682 en. barracks and mess | Qsr | 111 | vibratory roller | 0.03 | | | | | | | | | | | | |
| 683 barracks | Qsr | 55 | vibratory roller | 0.07 | | | | | | | | | | | | |
| 1263 enlisted family housing | Qd | 100 | vibratory roller | 0.03 | | | | | | | | | | | | |
| 1266 enlisted family housing | Qd | 120 | vibratory roller hydraulic breaker | 0.02 | | | | | | | | | | | | |
| 1270 enlisted family housing | Qd/Qsr | 134 | vibratory roller hydraulic breaker | 0.02 | | | | | | | | | | | | |
| 1289 enlisted family housing | Sp | 53 | vibratory roller | 0.07 | | | | | | | | | | | | |
| 1290 enlisted family housing | Sp | 65 | vibratory roller | 0.06 | | | | | | | | | | | | |
| 1291 enlisted family housing | Qsr | 74 | vibratory roller | 0.05 | | | | | | | | | | | | |
| 1293 enlisted family housing | Qsr | 96 | vibratory roller | 0.03 | | | | | | | | | | | | |
| 649 Army reserve center | Qaf/Qsr | 200 | vibratory roller oscilating pile at depth* | 0.01 | | | | | | | | | | 64 | vibratory roller / demo | 0.06 |
| 650 Stilwell Hall | Qaf/Qsr | 140 | vibratory roller oscilating pile at depth* | 0.02 | | | | | | | | | | 14 | vibratory roller / demo | 0.47 |
| 651 Administration | Qaf/Qsr | | | | | | | | | | | | | 147 | vibratory roller / demo | 0.02 |
| 652 transformer vault | Qd | 281 | vibratory roller oscilating pile at depth* | 0.01 | | | | | | | | | | 9 | vibratory roller / demo | 0.88 |
| 654 guard house | Qu | | | | | | | | | | | | | 96 | vibratory roller / demo | 0.03 |
| 661 stable | Qd | 166 | vibratory roller | 0.01 | | | | | | | | | | | | |
| 662 stable | Qd | 195 | vibratory roller oscilating pile at depth* | 0.01 | | | | | | | | | | | | |
| 667 stable | Qd | 183 | vibratory roller oscilating pile at depth* | 0.01 | | | | | | | | | | | | |
| 669 Incinerator | Qd | 130 | 24" CIDH no casing | 0.01 | 130 | 24" CIDH no casing | 0.01 | | | | | | | 170 | vibratory roller / new/demo | 0.01 |
| 966 Radio | Sp | 97 | vibratory roller | 0.03 | | | | | | | | | | 82 | vibratory roller / new/demo | 0.04 |
| 967 Film Vault | Qsr | 97 | vibratory roller | 0.03 | | | | | | | | | | 85 | vibratory roller / new/demo | 0.04 |
| 107 Switching Station | Qc | | | | 8.5 | vibratory roller | 0.95 | 139 | vibratory roller excavator/hoe ram | 0.02 | | | | | | |
| 108 Electric Shop | Qc/Qu | | | | 48 | vibratory roller | 0.08 | 183 | vibratory roller excavator/hoe ram | 0.01 | | | | | | |
| 123 Garage | Qu | | | | 119 | vibratory roller excavator/hoe ram | 0.02 | | | | | | | | | |
| 150 VAC chapel | Qc/Qu | | | | 12 | Drilling soil nails | 0.10 | 143 | vibratory roller excavator/hoe ram | 0.02 | | | | | | |
| 151 VAC house | Qd | | | | 36 | vibratory roller | 0.13 | 175 | vibratory roller excavator/hoe ram | 0.01 | | | | | | |
| 152 VAC restroom | Qd | | | | 50 | vibratory roller | 0.08 | 185 | vibratory roller excavator/hoe ram | 0.01 | | | | | | |
| 153 VAC garage | Qd | | | | 44 | vibratory roller | 0.10 | 177 | vibratory roller excavator/hoe ram | 0.01 | | | | | | |
| 154 VAC maint. Garage | Qd | | | | 4 | vibratory roller | 2.73 | 133 | vibratory roller excavator/hoe ram | 0.02 | | | | | | |
| VA Cemetery to first road | Qc/Qu/Qd | | | | | | | | | | | | | | | |
| 105 barrack | Qaf/Qu/Qc | | | | 6 | vibratory roller | 1.55 | 108 | vibratory roller | 0.03 | | | | | | |
| 106 band | Qaf | | | | 5 | vibratory roller | 2.00 | 92 | vibratory roller excavator/hoe ram | 0.03 | | | | | | |

**Yellow indicates where contractor will need to adjust construction method to be under required .3 PPV in/sec.**

**Doyle Drive**
**Pre-construction Conditions Survey List: Historic Buildings**

| Resource | Soil type | Contract #3 Distance in feet from construction | Contract #3 Highest impact construction method | Contract #3 expected PPV in/sec resulting at the building from this method | Contract #4 Distance in feet from construction | Contract #4 highest impact construction method | Contract #4 expected PPV in/sec resulting at the building from this method | Contract #5 Distance in feet from Construction | Contract #5 highest impact construction method | Contract #5 expected PPV in/sec resulting at the building from this method | Contract #6 Distance in feet from construction | Contract #6 highest impact construction method | Contract #6 expected PPV in/sec resulting at the building from this method | Contract #7 Distance in feet from construction: new / demo | Contract #7 highest impact construction method | Contract #7 expected PPV in/sec reuslting at the building from this method |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 122 gymnasium | Qc/Qu | | | | 27 | vibratory roller | 0.19 | 173 | vibratory roller excavator/hoe ram | 0.01 | | | | | | |
| 128 enlisted family housing | Qu | | | | 100 | vibratory roller | 0.03 | | | | | | | | | |
| 129 enlisted family housing | Qc/Qu | | | | 35 | vibratory roller | 0.13 | 175 | vibratory roller excavator/hoe ram | 0.01 | | | | | | |
| 603 commisary | Qaf | | | | 65 | vibratory roller | 0.06 | | | | | | | | | |
| 631 ammunition magazine | Qaf | | | | 97 | vibratory roller | 0.03 | 44 | vibratory roller | 0.10 | | | | | | |
| 632 ammunition magazine | Qaf | | | | | | | 165 | vibratory roller hydraulic breaker | 0.01 | | | | | | |
| Palace of Fine Arts | Qb | | | | 184 | vibratory roller | 0.01 | | | | | | | | | |
| 1151 Pool | Qaf | | | | 2 | vibratory roller | 7.21 | | | | 2 | vibratory roller | 7.21 | | | |
| 1152 Gym | Qaf | | | | 9 | vibratory roller | 0.88 | | | | 5 | vibratory roller | 2.00 | | | |
| 1160 warehouse | Qaf | | | | 19 | vibratory roller | 0.31 | | | | 8 | vibratory roller | 1.04 | | | |
| 1170 warehouse | Qaf | | | | 22 | vibratory roller | 0.25 | | | | 7 | vibratory roller | 1.25 | | | |
| 1182 warehouse | Qd | | | | 18 | vibratory roller | 0.33 | | | | 20 | vibratory roller | 0.29 | | | |
| 1183 warehouse | Qd | | | | 25 | vibratory roller hydraulic breaker | 0.21 | | | | 60 | vibratory roller | 0.06 | | | |
| 1184 warehouse | Qd | | | | 14 | vibratory roller | 0.47 | | | | 98 | vibratory roller hydraulic breaker | 0.03 | | | |
| 1185 warehouse | Qd | | | | 77 | vibratory roller | 0.04 | | | | 161 | vibratory roller | 0.02 | | | |
| 1186 warehouse | Qd | | | | 98 | vibratory roller hydraulic breaker | 0.03 | | | | 125 | vibratory roller hydraulic breaker | 0.02 | | | |
| 1187 warehouse | Qd | | | | 84 | vibratory roller | 0.04 | | | | 83 | vibratory roller | 0.04 | | | |
| 1188 warehouse | Qd | | | | 9 | vibratory roller | 0.88 | | | | 16 | vibratory roller | 0.39 | | | |
| 210 Guard House | Qu | | | | | | | 47 | vibratory roller | 0.09 | | | | | | |
| 222 Warehouse | Qu | | | | | | | 165 | vibratory roller hydraulic breaker | 0.01 | | | | | | |
| 223 Warehouse | Qu | | | | | | | 5 | vibratory roller | 2.00 | | | | | | |
| 227 Warehouse | | | | | | | | 8 | vibratory roller | 1.04 | 11 | vibratory roller | 0.66 | | | |
| 228 bakery | Qaf | | | | | | | 5 | vibratory roller | 2.00 | 16 | vibratory roller | 0.39 | | | |
| 229 bakery | Qaf/Qu | | | | | | | 90 | vibratory roller hydraulic breaker | 0.03 | 41 | vibratory roller | 0.11 | | | |
| 1161 warehouse | Qaf | | | | 85 | vibratory roller hydraulic breaker | 0.04 | | | | 83 | vibratory roller | 0.04 | | | |
| 1162 warehouse | Qaf | | | | 143 | vibratory roller | 0.02 | | | | 3 | vibratory roller | 4.09 | | | |
| 1163 warehouse | Qaf | | | | 186 | vibratory roller | 0.01 | | | | 3 | vibratory roller | 4.09 | | | |
| 1169 warehouse | Qaf | | | | 81 | vibratory roller hydraulic breaker | 0.04 | | | | | | | | | |
| 1063 med supply | Qaf | | | | | | | | | | | | | | | |
| 1167 warehouse | Qaf | | | | | | | | | | | | | | | |
| 1170 warehouse | Qaf | | | | | | | | | | | | | | | |
| Battery Slaughter | Ks/Qc | | | | | | | 3 | vibratory roller | 4.09 | | | | | | |
| 635 Battery Blaney | Ks/Qc | | | | | | | 3 | vibratory roller | 4.09 | | | | | | |
| 636 Battery Sherwood | Qc | | | | | | | 71 | vibratory roller | 0.05 | | | | | | |

**Yellow indicates where contractor will need to adjust construction method to be under required .3 PPV in/sec.**

**Doyle Drive**
**Pre-construction Conditions Survey List: Historic Buildings**

| Resource | Soil type | Contract #3 Distance in feet from construction | Contract #3 Highest impact construction method | Contract #3 expected PPV in/sec resulting at the building from this method | Contract #4 Distance in feet from construction | Contract #4 highest impact construction method | Contract #4 expected PPV in/sec resulting at the building from this method | Contract #5 Distance in feet from Construction | Contract #5 highest impact construction method | Contract #5 expected PPV in/sec resulting at the building from this method | Contract #6 Distance in feet from construction | Contract #6 highest impact construction method | Contract #6 expected PPV in/sec resulting at the building from this method | Contract #7 Distance in feet from construction: new / demo | Contract #7 highest impact construction method | Contract #7 expected PPV in/sec reuslting at the building from this method |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Equations taken from *CaltransTransportation- and Construction-Induced Vibration Guidance Manual*

Eq. 9 PPVImpact Pile Driver = PPVRef $(25/D)^n$ x $(Eequip/ERef)^{0.5}$ (in/sec)
Where:
PPVRef = 0.65 in/sec for a reference pile driver at 25 ft.
D = distance from pile driver to the receiver in ft. (Distance from Construction Column)
n = 1.4 is a value related to the vibration attenuation rate through ground
ERef = 36,000 ft-lb (rated energy of reference pile driver)
Eequip = rated energy of impact pile driver in ft-lbs. Pileco D225-22 - Pile Driver =555,300 ft-lb, APE HI 400U= 400,000 ft-lb

Eq. 11 PPVHydraulic Breaker = PPVRef $(25/D)^n$ x $(Eequip/ERef)^{0.5}$ (in/sec)
Where:
PPVRef = 0.24 in/sec for a reference hydraulic breaker at 25 ft.
D = distance from hydraulic breaker to the receiver in ft. (Distance from Construction Column)
n = 1.4 (the value related to the attenuation rate through ground)
ERef = rated energy of reference hydraulic breaker Catarpillar H115 S (203-0905) = 5,000 ft-lbs.

Eq. 12 PPVEquipment = PPVRef $(25/D)^n$ (in/sec)
Where:
PPVRef = reference PPV at 25 ft. Taken from Table 18 below - Highest value used Vibratory Roller
D = distance from equipment to the receiver in ft. (Distance from Construction Column)
n = 1.4 ( the value related to the attenuation rate through ground)

**Table 18. Vibration Source Amplitudes for Construction Equipment**

| Equipment | Reference PPV at 25 ft. (in/sec) |
|---|---|
| Vibratory roller | 0.210 |
| Large bulldozer | 0.089 |
| Caisson drilling | 0.089 |
| Loaded trucks | 0.076 |
| Jackhammer | 0.035 |
| Small bulldozer | 0.003 |
| Crack-and-seat operations | 2.4 |

Sources: Federal Transit Administration 1995 (except Hanson 2001 for vibratory rollers) and Caltrans 2000 for crack-and seat-operations.

**n value**

N value of 1.4 was choosen (from Table 17) for the following reason:
1. Many of the soils within the Presidio are dune sands, soft bay muds, top soils.
2. Building 228 is built on fill that has been poorly consolidated.

| Soil Class | | | Description of Soil Material |
|---|---|---|---|
| I | | | Weak or soft soils: loose soils, dry or partially saturated peat and muck, mud, |
| II | | | Competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered |
| III | | | Hard soils: dense compacted sand, dry consolidated clay,consolidated glacial till, some exposed rock. (Cannot dig with shovel, need pick to break up) |
| IV | | | Hard, competent rock: bedrock, freshly exposed hard rock. (difficult to break |

Soil Type
Qar =Slope debris and ravine fill
Qd = Dune sand
Qu = Surficial deposits (undifferentiated)
Qc = Colma Formation
Qaf = Artificial fill
Qb = Modern beach deposits
Sp = Serpentinite
Ks = Sheared rocks (undifferentiated

* piles in contract #3 are as follows (rock drill socket)

| | |
|---|---|
| bent 2 | 45' |
| bent 3R | 160' |
| bent 3L | 140' |
| bent 4R | 75' |
| bent 4L | 65' |

| | Contract #3 Distance in feet from construction | Expected PPV form other type of construction vibratory roller or CIDH | Expected PPV* form Hydraulic Breaker (Caterpillar Model # H115 S (203-0905)) | Contract #4 Distance in feet from construction | Expected PPV form other type of construction vibratory roller | Expected PPV* form Hydraulic Breaker (Caterpillar Model # H115 S (203-0905)) | Contract #5 Distance in feet from Construction | Expected PPV form other type of construction vibratory roller | Expected PPV* form Hydraulic Breaker (Caterpillar Model # H115 S (203-0905)) | Contract #6 Distance in feet from construction | Expected PPV form other type of construction vibratory roller | Expected PPV* form Hydraulic Breaker (Caterpillar Model # H115 S (203-0905)) | Contract #7 Distance in feet from construction: new | Contract #7 Distance in feet from construction: demo | Expected PPV form other type of construction vibratory roller new | Expected PPV form other type of construction vibratory roller demo | Expected PPV* form Hydraulic Breaker (Caterpillar Model # H115 S (203-0905)) new | Expected PPV* form Hydraulic Breaker (Caterpillar Model # H115 S (203-0905)) demo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 681 barracks | | | | | | | | | | | | | | | | | | |
| 682 en. barracks and mess | 88 | 0.04 | 0.03 | | | | | | | | | | | | | | | |
| 683 barracks | 28 | 0.18 | 0.14 | | | | | | | | | | | | | | | |
| 1263 enlisted family housing | 69 | 0.05 | 0.04 | | | | | | | | | | | | | | | |
| 1266 enlisted family housing | 98 | 0.03 | 0.03 | | | | | | | | | | | | | | | |
| 1270 enlisted family housing | 117 | 0.02 | 0.02 | | | | | | | | | | | | | | | |
| 1289 enlisted family housing (soil nails) | 21 | 0.27 | 0.22 | | | | | | | | | | | | | | | |
| 1290 enlisted family housing (soil nails) | 46 | 0.09 | 0.07 | | | | | | | | | | | | | | | |
| 1291 enlisted family housing (soil nails) | 57 | 0.07 | 0.05 | | | | | | | | | | | | | | | |
| 1293 enlisted family housing (soil nails) | 85 | 0.04 | 0.03 | | | | | | | | | | | | | | | |
| 649 Army reserve center | 166 | 0.01 | 0.01 | | | | | | | | | | 98 | 60 | 0.03 | 0.06 | 0.03 | 0.05 |
| 650 Stilwell Hall | 123 | 0.02 | 0.02 | | | | | | | | | | 51 | 9 | 0.08 | 0.88 | 0.06 | 0.71 |
| 651 Administration | | | | | | | | | | | | | 183 | 141 | 0.01 | 0.02 | 0.01 | 0.02 |
| 652 transformer vault | 123 | 0.02 | 0.02 | | | | | | | | | | 51 | 9 | 0.08 | 0.88 | 0.06 | 0.71 |
| 654 guard house | | | | | | | | | | | | | 131 | 96 | 0.02 | 0.03 | 0.02 | 0.03 |
| 661 stable | 143 | 0.02 | 0.01 | | | | | | | | | | | | | | | |
| 662 stable | 183 | 0.01 | 0.01 | | | | | | | | | | | | | | | |
| 667 stable | 197 | 0.01 | 0.01 | | | | | | | | | | | | | | | |
| 669 Incinerator | 82 | 0.02 | 0.03 | 82 | 0.02 | 0.03 | | | | | | | 170 | 170 | 0.01 | 0.01 | | |
| 966 Radio | 166 | 0.01 | 0.01 | | | | | | | | | | 82 | 82 | 0.04 | 0.04 | | |
| 967 Film Vault | 174 | 0.01 | 0.01 | | | | | | | | | | 85 | 85 | 0.04 | 0.04 | | |
| 107 Switching Station | | | | 35 | 0.13 | 0.11 | 139 | 0.02 | 0.02 | | | | | | | | | |
| 108 Electric Shop | | | | 74 | 0.05 | 0.04 | 183 | 0.01 | 0.01 | | | | | | | | | |
| 123 Garage | | | | 119 | 0.02 | 0.02 | | | | | | | | | | | | |
| 150 VAC chapel (soil nails) | | | soil nail drilling | 1 | 3.17 | | 143 | 0.02 | | | | | | | | | | |
| 151 VAC house (soil nails) | | | | 36 | 0.13 | 0.10 | 175 | 0.01 | 0.01 | | | | | | | | | |
| 152 VAC restroom (soil nails) | | | | 50 | 0.08 | 0.06 | 185 | 0.01 | 0.01 | | | | | | | | | |
| 153 VAC garage (soil nails) | | | | 44 | 0.10 | 0.08 | 177 | 0.01 | 0.01 | | | | | | | | | |
| 154 VAC maint. Garage (soil nails) | | | | 4 | 2.73 | 2.21 | 133 | 0.02 | 0.02 | | | | | | | | | |
| VA Cemetery to first road | | | | | | | | | | | | | | | | | | |
| 105 barrack | | | | 14 | 0.47 | 0.38 | 108 | 0.03 | 0.02 | | | | | | | | | |
| 106 band | | | | 5 | 2.00 | 1.62 | 92 | 0.03 | 0.03 | | | | | | | | | |
| 122 gymnasium | | | | 48 | 0.08 | 0.07 | 173 | 0.01 | 0.01 | | | | | | | | | |
| 128 enlisted family housing | | | | 112 | 0.03 | 0.02 | | | | | | | | | | | | |
| 129 enlisted family housing | | | | 51 | 0.08 | 0.06 | 175 | 0.01 | 0.01 | | | | | | | | | |
| 603 commisary | | | | 63 | 0.06 | 0.05 | | | | | | | | | | | | |
| 631 ammunition magazine | | | | 155 | 0.02 | 0.01 | 44 | 0.10 | 0.08 | | | | | | | | | |
| 632 ammunition magazine | | | | | | | 165 | 0.01 | 0.01 | | | | | | | | | |
| Palace of Fine Arts | | | | 164 | 0.02 | 0.01 | | | | | | | | | | | | |
| 1151 Pool | | | | 2 | 7.21 | 5.83 | | | | 2 | 7.21 | 5.83 | | | | | | |
| 1152 Gym | | | | 5 | 2.00 | 1.62 | | | | 5 | 2.00 | 1.62 | | | | | | |
| 1160 warehouse | | | | 8 | 1.04 | 0.84 | | | | 8 | 1.04 | 0.84 | | | | | | |
| 1170 warehouse | | | | 7 | 1.25 | 1.01 | | | | 7 | 1.25 | 1.01 | | | | | | |
| 1182 warehouse | | | | 28 | 0.18 | 0.14 | | | | 20 | 0.29 | 0.23 | | | | | | |
| 1183 warehouse | | | | 124 | 0.02 | 0.02 | | | | 60 | 0.06 | 0.05 | | | | | | |
| 1184 warehouse | | | | 10 | 0.76 | 0.61 | | | | 98 | 0.03 | 0.03 | | | | | | |
| 1185 warehouse | | | | 72 | 0.05 | 0.04 | | | | 161 | 0.02 | 0.01 | | | | | | |
| 1186 warehouse | | | | 182 | 0.01 | 0.01 | | | | 125 | 0.02 | 0.02 | | | | | | |
| 1187 warehouse | | | | 89 | 0.04 | 0.03 | | | | 83 | 0.04 | 0.03 | | | | | | |
| 1188 warehouse | | | | 18 | 0.33 | 0.27 | | | | 16 | 0.39 | 0.32 | | | | | | |
| 210 Guard House | | | | | | | 47 | 0.09 | 0.07 | | | | | | | | | |
| 222 Warehouse | | | | | | | 165 | 0.01 | 0.01 | | | | | | | | | |
| 223 Warehouse | | | | | | | 5 | 2.00 | 1.62 | | | | | | | | | |
| 227 Warehouse | | | | | | | 8 | 1.04 | 0.84 | 112 | 0.03 | 0.02 | | | | | | |
| 228 bakery | | | | | | | 5 | 2.00 | 1.62 | 16 | 0.39 | 0.32 | | | | | | |
| 229 bakery | | | | | | | 90 | 0.03 | 0.03 | 41 | 0.11 | 0.08 | | | | | | |
| 1161 warehouse | | | | 95 | 0.03 | 0.03 | | | | 83 | 0.04 | 0.03 | | | | | | |
| 1162 warehouse | | | | 150 | 0.02 | 0.01 | | | | 3 | 4.09 | 3.30 | | | | | | |
| 1163 warehouse | | | | | | | | | | 3 | 4.09 | 3.30 | | | | | | |
| 1169 warehouse | | | | 92 | 0.03 | 0.03 | | | | | | | | | | | | |
| 1063 med supply | | | | | | | | | | | | | | | | | | |
| 1167 warehouse | | | | | | | | | | | | | | | | | | |
| 1170 warehouse | | | | | | | | | | | | | | | | | | |
| Battery Slaughter | | | | | | | 3 | 4.09 | 3.30 | | | | | | | | | |
| 635 Battery Blaney | | | | | | | 3 | 4.09 | 3.30 | | | | | | | | | |
| 636 Battery Sherwood | | | | | | | 71 | 0.05 | 0.04 | | | | | | | | | |

soil nails- need depth tpo soil nails

| Resource Name | Effect | Mitigation Measures | Notes |
|---|---|---|---|
| **Buildings** | | | |
| 670 | demolish | | |
| 201 | move temporarily | | |
| 204 | move to a new location | | |
| 230 | deconstruct | | |
| 228 | potentially lift in place | | |
| 106 | close proximity to construction | | |
| 105 | close proximity to construction | | |
| Battery Sherwood | close proximity to construction | | |
| Battery Slaughter | close proximity to construction | | |
| Battery Blaney | close proximity to construction | | |
| Palace of Fine Arts | | | |
| | | | |
| **Structures** | | | |

Government of Australia, Department of Transportation, Energy and Infastructure: Northern Expressway Environmental Report

Table 15.1

**Approximate generated vibration levels for various sources**

| Activity | Typical levels of ground vibration |
|---|---|
| Vibratory rollers | Up to 1.5 mm/s at distances of 25 m<br>Higher levels could occur at closer distances; however, no damage would be expected for any building at distances greater than approximately 12 m (for a medium to heavy roller) |
| Hydraulic rock breakers<br>(levels typical of a large rock breaker operating in hard sandstone) | 4.50 mm/s at 5 m<br>1.30 mm/s at 10 m<br>0.4 mm/s at 20 m<br>0.10 mm/s at 50 m |
| Compactor | 20 mm/s at distances of approximately 5 m, 2 mm/s at distances of 15 m. At distances greater than 30 m, vibration is usually below 0.3 mm/s |
| Pile driving/removal | 1 to 3 mm/s at distances of 25 m to 50 m depending on soil conditions and the energy of the pile driving hammer<br>These levels are well below the threshold of any possibility of damage to structures in the vicinity of these works. At closer distances to the piling operations, some compaction of loose fill would occur due to vibratory effects |
| Bulldozers | 1 to 2 mm/s at distances of approximately 5 m. At distances greater than 20 m, vibration is usually below 0.2 mm/s |
| Air track drill | 4 to 5 mm/s at a distance of approximately 5 m, and 1.5 mm/s at 10 m. At distances greater than 25 m, vibration is usually below 0.6 mm/s, and at 50 m or more, vibration is usually below 0.1 mm/s |
| Truck traffic (over normal (smooth) road surfaces) | 0.01 to 0.2 mm/s at the footings of buildings located 10 to 20 m from a roadway |
| Truck traffic<br>(over irregular surfaces) | 0.1 to 2.0 mm/s at the footings of buildings located 10 m to 20 m from a roadway |

Construction Vibrations and Their Imapct on vibration-Senitive Facilities: Hal Amick and Michael Gendreau, Colin Gordon & Associates

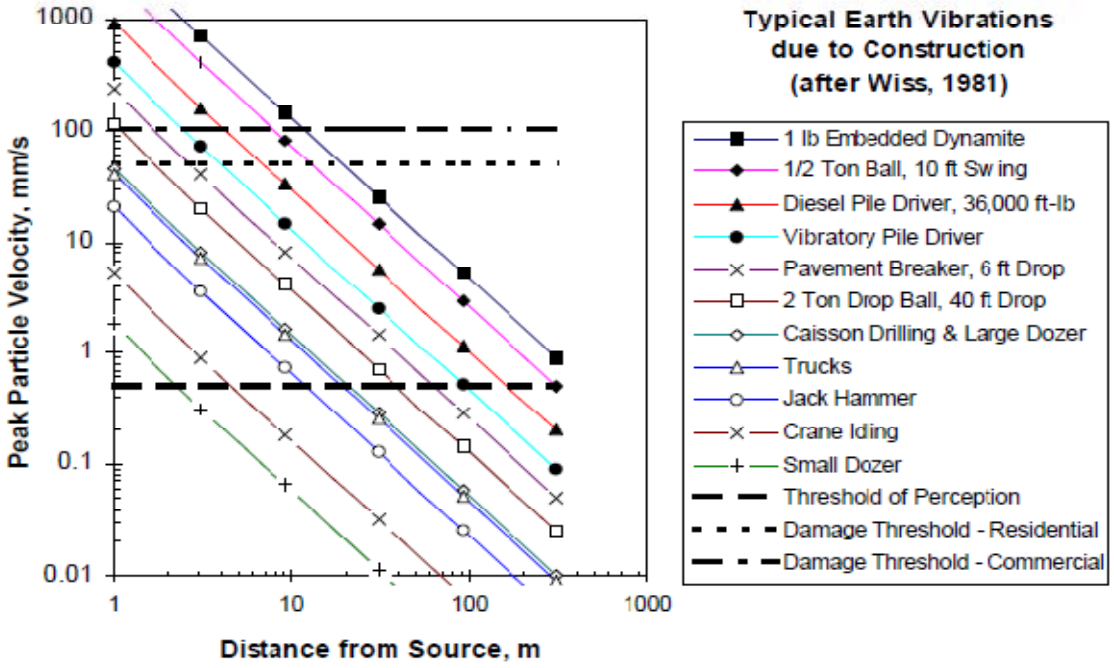


**Figure 1. Construction vibrations as a function of distance, after Wiss (1981)**

Transportation- and Construction-Induced Vibration Guidance Manual
California Department of Transportation
Environmental Program
Environmental Engineering
Noise, Vibration, and Hazardous Waste Management Office

Prepared by:
Jones & Stokes
2600 V Street
Sacramento, CA 95818

**Table 18. Vibration Source Amplitudes for Construction Equipment**

| Equipment | Reference PPV at 25 ft. (in/sec) |
|---|---|
| Vibratory roller | 0.210 |
| Large bulldozer | 0.089 |
| Caisson drilling | 0.089 |
| Loaded trucks | 0.076 |
| Jackhammer | 0.035 |
| Small bulldozer | 0.003 |
| Crack-and-seat operations | 2.4 |

Sources: Federal Transit Administration 1995 (except Hanson 2001 for vibratory rollers) and Caltrans 2000 for crack-and seat-operations.

Vibratory roller

PPVEquipment = PPVRef (25/D)n (in/sec)

| | PPVref | 25/D | (25/D)n | |
|---|---|---|---|---|
| 25 | 0.21 | 1.00 | 1.00 | 0.21 |
| 30 | 0.21 | 0.83 | 0.82 | 0.171838 |
| 45 | 0.21 | 0.56 | 0.52 | 0.110007 |
| 100 | 0.21 | 0.25 | 0.22 | 0.045704 |

**Table 19. Guideline Vibration Damage Potential Threshold Criteria**

| | Maximum PPV (in/sec) | |
|---|---|---|
| **Structure and Condition** | **Transient Sources** | **Continuous/Frequent Intermittent Sources** |
| Extremely fragile historic buildings, ruins, ancient monuments | 0.12 | 0.08 |
| Fragile buildings | 0.2 | 0.1 |
| Historic and some old buildings | 0.5 | 0.25 |
| Older residential structures | 0.5 | 0.3 |
| New residential structures | 1.0 | 0.5 |
| Modern industrial/commercial buildings | 2.0 | 0.5 |

Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.

**Table 20. Guideline Vibration Annoyance Potential Criteria**

| | Maximum PPV (in/sec) | |
|---|---|---|
| **Human Response** | **Transient Sources** | **Continuous/Frequent Intermittent Sources** |
| Barely perceptible | 0.04 | 0.01 |
| Distinctly perceptible | 0.25 | 0.04 |
| Strongly perceptible | 0.9 | 0.10 |
| Severe | 2.0 | 0.4 |

Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.