

APPENDIX C ANALYSIS OF RESULTS

Additional and more detailed results in support of the observations made in section 5.3 are presented in this appendix. In search of trends in the test data, data for all specimens are considered and grouped as a function of the stability factor for four ranges of that parameter, namely: $\theta \leq 0.1$, $0.1 < \theta \leq 0.3$, $0.3 < \theta \leq 0.5$, and $\theta > 0.5$.

Various peak response parameters for the specimens are considered for this purpose. The plastic base shear, V_{yo} , yield displacement, Δ_y , and ductility at the static stability limit, μ_s , each defined in section 2, are tabulated in table C-1 for specimens that did not collapse during the first trial of the testing schedule. The residual displacement at which plastic collapse mechanism is formed, is also tabulated and given by:

$$\Delta_{coll} = \frac{2 \cdot M_p}{W} \quad (C.1)$$

Each of these parameters is calculated with average specimen dimensions using the relationships presented in section 2. Material properties (elastic modulus and yield stress) are utilized as described in the section on tension testing from section 4. These critical values are used to normalize the recorded values of force and displacement as described below. The data used for the plot presented in this section is contained in table C-2.

First, the maximum estimated base shear (ignoring P- Δ effects) from each test, V_o^* , was normalized by the plastic base shear, V_{yo} , and plotted separately versus various normalized displacements: μ , u_r/Δ_{coll} , μ/μ_s , $u_r/u_{rel-max}$, and $u_{rel-max}/h$. Figures C-1 to C-5 show the results of that ratio, V_o^*/V_{yo} , versus: μ , u_r/Δ_{coll} , μ/μ_s , $u_r/u_{rel-max}$, and percent drift, respectively. The following general observations can be made regarding pattern of behavior: In figure C-1, the test data generally increase linearly towards $V_o^*/V_{yo}=1$ and $\mu=1$, followed by a decrease in slope as the specimen moves further into the inelastic range of behavior. Displacement ductility developed prior to collapse seems to decrease as θ increases. In figure C-2, all but two specimens (1 and 9) are observed to have a residual displacement of less than 50% of Δ_{coll} prior

to the final test that resulted in collapse. Figure C-3 shows that all but Specimen 1 have a maximum displacement ductility less than 75% of μ_s prior to the final test that resulted in collapse. No distinct pattern of behavior can be seen in figure C-4. Figure C-5 indicates that Specimen 1 is the only one with a maximum drift greater than 20% of its height prior to the final test.

Second, the same dimensionless displacement parameters were plotted against the elastic response spectral acceleration of the measured table acceleration, S_a , normalized by the spectral acceleration at plastic base shear, V_{yo}/W . These results are shown in figures C-6 to C-10. Similar to figure C-1, previously described, the data tends to a common trend and increases towards coordinate (1,1) of the plot before the slope gently decreases in the inelastic range. Since S_a is the elastic response to the ground motion and it is being normalized by the plastic spectral acceleration, this ratio should increase as the earthquake intensity progressively increases in the inelastic range. In fact, this ratio reflects the ability of the structure to dissipate energy, and should be conceptually related to the response modification factor. This factor should be at least equal to 4 for ordinary moment frames in actual buildings. Here, only Specimens 1 and 6 develop this amount of ductility, by reaching $S_a/(V_{yo}/W)$ values of 3.6 and 5.33, respectively. Note that where μ/μ_s was plotted versus V_o^*/V_{yo} (figure C-1), the grouping of data points suggested a comparable behavior amongst the specimens, but when the same μ/μ_s ratio is plotted versus $S_a/(V_{yo}/W)$ (figure C-5), no discernible pattern of behavior is observed.

Third, figures C-11 to C-15 provide a comparison of the maximum measured total acceleration of the specimen mass, \ddot{u}_{T-max} , normalized by the spectral acceleration at plastic base shear, V_{yo}/W , versus μ , u_r/Δ_{coll} , μ/μ_s , $u_r/u_{rel-max}$, and percent drift, respectively. In figure C-11, the test data generally increases linearly towards coordinate (1,0.75) of the graph followed by a decrease in slope as the specimens move further into the inelastic range of behavior. This emphasizes the trend displayed in figures C-1 and C-6. Figure C-15 shows eight of the twelve specimens behaving in a similar manner, with linear behavior until approximately $\ddot{u}_{T-max}/(V_{yo}/W)$ of 0.85 and a drift of 5.0%.

TABLE C-1 Shake Table Tests-Critical Parameters

| Specimen | V_{yo} (N) | Δ_y (mm) | Δ_{coll} (mm) | μ_s |
|------------------|------------------------------------|---------------------------------------|--|---------------------------|
| 1 | 172.5 | 4.3 | 65.9 | 15.4 |
| 2 | 186.2 | 4.5 | 36.1 | 8.1 |
| 4 | 173.2 | 4.4 | 25.3 | 5.7 |
| 5b ¹ | 132.4 | 5.6 | 12.9 | 2.3 |
| 6 | 367.3 | 16.3 | 160.8 | 9.9 |
| 7 | 255.0 | 14.4 | 93.1 | 6.5 |
| 8 | 168.7 | 13.1 | 49.2 | 3.8 |
| 9 | 115.4 | 9.8 | 25.2 | 2.6 |
| 10 | 33.1 | 4.4 | 9.5 | 2.2 |
| 10b ¹ | 85.9 | 12.5 | 24.8 | 2.0 |
| 11 | 295.8 | 31.7 | 229.5 | 7.2 |
| 12 | 145.9 | 20.2 | 94.3 | 4.7 |
| 13 | 128.6 | 23.8 | 66.4 | 2.8 |
| 14 | 84.8 | 17.5 | 33.0 | 1.9 |
| 15 | 23.7 | 7.6 | 12.1 | 1.6 |

TABLE C-2 Shake Table Tests-Normalized Peak Responses

| Test | C_s^* | $\frac{V_o^*}{V_{yo}}$ | $\frac{S_a}{(V_{yo}/W)}$ | $\frac{\ddot{u}_T}{(V_{yo}/W)}$ | μ | $\frac{u_r}{\Delta_{coll}}$ | $\frac{\mu}{\mu_s}$ | $\frac{u_r}{u_{relmax}}$ | Drift (%) |
|-------------|---------|------------------------|--------------------------|---------------------------------|----------|-----------------------------|---------------------|--------------------------|-----------|
| Specimen 1 | | | | | | | | | |
| 1 | 0.378 | 0.787 | 0.702 | 0.691 | 0.872 | 0.000 | 0.057 | 0.000 | 0.027 |
| 2 | 0.432 | 0.899 | 1.017 | 0.806 | 1.126 | 0.003 | 0.073 | 0.037 | 0.035 |
| 3 | 0.432 | 0.899 | 1.017 | 0.874 | 1.364 | 0.006 | 0.089 | 0.065 | 0.043 |
| 4 | 0.432 | 0.899 | 1.328 | 0.893 | 1.399 | 0.003 | 0.091 | 0.034 | 0.044 |
| 5 | 0.270 | 0.562 | 0.392 | 0.481 | 0.581 | 0.001 | 0.038 | 0.031 | 0.018 |
| 6 | 0.443 | 0.922 | 1.516 | 0.897 | 1.387 | 0.004 | 0.090 | 0.043 | 0.043 |
| 7 | 0.583 | 1.214 | 2.296 | 1.031 | 2.454 | 0.025 | 0.160 | 0.157 | 0.077 |
| 8 | 0.659 | 1.372 | 2.784 | 1.097 | 3.142 | 0.012 | 0.204 | 0.060 | 0.098 |
| 9 | 0.637 | 1.326 | 3.183 | 1.135 | 3.741 | 0.047 | 0.243 | 0.195 | 0.117 |
| 10 | 0.778 | 1.620 | 3.589 | 1.264 | 20.346 | 1.307 | 1.323 | 0.988 | 0.635 |
| 11 | 0.897 | 1.868 | 3.341 | -- | ∞ | ∞ | ∞ | -- | -- |
| Specimen 2 | | | | | | | | | |
| 1 | 0.133 | 0.506 | 0.640 | 0.521 | 0.724 | 0.014 | 0.089 | 0.157 | 0.023 |
| 2 | 0.168 | 0.639 | 0.866 | 0.643 | 0.918 | 0.026 | 0.113 | 0.230 | 0.030 |
| 3 | 0.185 | 0.704 | 1.153 | 0.708 | 1.043 | 0.025 | 0.129 | 0.197 | 0.034 |
| 4 | 0.214 | 0.814 | 1.444 | 0.772 | 1.117 | 0.025 | 0.138 | 0.184 | 0.036 |
| 5 | 0.220 | 0.837 | 1.719 | 0.825 | 1.169 | 0.019 | 0.144 | 0.132 | 0.038 |
| 6 | 0.231 | 0.879 | 1.876 | 0.863 | 1.294 | 0.020 | 0.160 | 0.123 | 0.042 |
| 7 | 0.237 | 0.902 | 2.092 | 0.886 | 1.477 | 0.028 | 0.182 | 0.154 | 0.048 |
| 8 | 0.266 | 1.012 | 2.503 | 0.936 | 1.670 | 0.075 | 0.206 | 0.365 | 0.054 |
| 9 | 0.312 | 1.187 | 2.588 | 0.962 | 2.673 | 0.224 | 0.330 | 0.680 | 0.087 |
| 10 | 0.497 | 1.891 | 2.567 | -- | ∞ | ∞ | ∞ | -- | -- |
| Specimen 4 | | | | | | | | | |
| 1 | 0.037 | 0.201 | 0.350 | 0.190 | 0.270 | 0.005 | 0.047 | 0.106 | 0.009 |
| 2 | 0.099 | 0.538 | 0.848 | 0.527 | 0.688 | 0.010 | 0.120 | 0.083 | 0.022 |
| 3 | 0.144 | 0.783 | 1.212 | 0.734 | 1.193 | 0.025 | 0.209 | 0.120 | 0.038 |
| 4 | 0.169 | 0.919 | 1.678 | 0.859 | 1.675 | 0.059 | 0.293 | 0.202 | 0.054 |
| 5 | 0.177 | 0.962 | 2.162 | 0.941 | 2.392 | 0.211 | 0.419 | 0.504 | 0.077 |
| 6 | 0.510 | 2.773 | 2.575 | -- | ∞ | ∞ | ∞ | -- | -- |
| Specimen 5b | | | | | | | | | |
| 1 | 0.061 | 0.434 | 0.197 | 0.121 | 0.656 | 0.154 | 0.286 | 0.538 | 0.040 |
| 2 | 2.703 | 19.228 | 0.479 | -- | ∞ | ∞ | ∞ | -- | -- |

TABLE C-2 (cont'd) Shake Table Tests-Displacement Comparison

| Test | C_s^* | $\frac{V_o^*}{V_{yo}}$ | $\frac{S_a}{(V_{yo}/W)}$ | $\frac{\ddot{u}_T}{(V_{yo}/W)}$ | μ | $\frac{u_r}{\Delta_{coll}}$ | $\frac{\mu}{\mu_s}$ | $\frac{u_r}{u_{relmax}}$ | Drift (%) |
|--------------|---------|------------------------|--------------------------|---------------------------------|----------|-----------------------------|---------------------|--------------------------|-----------|
| Specimen 6 | | | | | | | | | |
| 1 | 0.440 | 1.128 | 0.782 | 0.813 | 0.986 | 0.001 | 0.100 | 0.008 | 0.039 |
| 2 | 0.482 | 1.236 | 1.096 | 0.923 | 1.390 | 0.015 | 0.141 | 0.104 | 0.055 |
| 3 | 0.492 | 1.261 | 1.468 | 0.928 | 1.624 | 0.029 | 0.164 | 0.174 | 0.064 |
| 4 | 0.492 | 1.261 | 1.447 | 0.918 | 1.546 | 0.024 | 0.157 | 0.153 | 0.061 |
| 5 | 0.293 | 0.751 | 0.621 | 0.577 | 1.666 | 0.007 | 0.169 | 0.041 | 0.066 |
| 6 | 0.471 | 1.208 | 2.179 | 0.900 | 1.589 | 0.008 | 0.161 | 0.048 | 0.063 |
| 7 | 0.503 | 1.290 | 3.267 | 0.936 | 1.746 | 0.001 | 0.177 | 0.004 | 0.069 |
| 8 | 0.524 | 1.343 | 3.939 | 0.913 | 2.214 | 0.028 | 0.224 | 0.124 | 0.087 |
| 9 | 0.503 | 1.290 | 4.569 | 0.920 | 2.785 | 0.088 | 0.282 | 0.312 | 0.110 |
| 10 | 0.503 | 1.290 | 5.328 | 0.977 | 4.516 | 0.372 | 0.457 | 0.813 | 0.178 |
| 11 | 11.329 | 29.046 | 4.658 | -- | ∞ | ∞ | ∞ | - | - |
| Specimen 7 | | | | | | | | | |
| 1 | 0.140 | 0.517 | 0.498 | 0.543 | 0.599 | 0.002 | 0.093 | 0.027 | 0.025 |
| 2 | 0.189 | 0.698 | 0.775 | 0.728 | 0.850 | 0.002 | 0.132 | 0.019 | 0.036 |
| 3 | 0.245 | 0.905 | 1.029 | 0.820 | 1.125 | 0.031 | 0.174 | 0.176 | 0.047 |
| 4 | 0.245 | 0.905 | 1.293 | 0.768 | 1.740 | 0.144 | 0.269 | 0.534 | 0.073 |
| 5 | 0.400 | 1.477 | 1.556 | -- | ∞ | ∞ | ∞ | - | - |
| Specimen 8 | | | | | | | | | |
| 1 | 0.079 | 0.441 | 0.408 | 0.402 | 0.989 | 0.002 | 0.263 | 0.006 | 0.047 |
| 2 | 0.120 | 0.670 | 0.845 | 0.586 | 1.588 | 0.040 | 0.423 | 0.094 | 0.076 |
| 3 | 0.199 | 1.111 | 1.160 | 0.614 | 2.295 | 0.405 | 0.612 | 0.662 | 0.110 |
| 4 | 0.365 | 2.037 | 1.529 | -- | ∞ | ∞ | ∞ | - | - |
| Specimen 9 | | | | | | | | | |
| 1 | 0.092 | 1.326 | 0.812 | 0.692 | 0.773 | 0.032 | 0.301 | 0.107 | 0.037 |
| 2 | 0.122 | 1.758 | 0.981 | 0.792 | 1.023 | 0.096 | 0.399 | 0.240 | 0.049 |
| 3 | 0.147 | 2.118 | 1.172 | 0.836 | 1.788 | 0.531 | 0.697 | 0.762 | 0.085 |
| 4 | 0.415 | 5.980 | 1.336 | -- | ∞ | ∞ | ∞ | - | - |
| Specimen 10 | | | | | | | | | |
| 1 | 0.206 | 2.968 | 0.574 | -- | ∞ | ∞ | ∞ | - | - |
| Specimen 10b | | | | | | | | | |
| 1 | 0.039 | 0.216 | 0.112 | 0.122 | 0.289 | 0.045 | 0.146 | 0.310 | 0.026 |
| 2 | 0.077 | 0.427 | 0.184 | 0.216 | 0.551 | 0.085 | 0.278 | 0.306 | 0.050 |
| 3 | 0.110 | 0.610 | 0.247 | 0.283 | 0.716 | 0.115 | 0.361 | 0.318 | 0.065 |
| 4 | 0.153 | 0.848 | 0.321 | 0.288 | 0.988 | 0.275 | 0.498 | 0.551 | 0.090 |
| 5 | 0.149 | 0.826 | 0.372 | 0.266 | 1.008 | 0.326 | 0.508 | 0.641 | 0.092 |
| 6 | 0.173 | 0.959 | 0.439 | -- | ∞ | ∞ | ∞ | - | - |

TABLE C-2 (cont'd) Shake Table Tests-Displacement Comparison

| Test | C_s^* | $\frac{V_o^*}{V_{yo}}$ | $\frac{S_a}{(V_{yo}/W)}$ | $\frac{\ddot{u}_T}{(V_{yo}/W)}$ | μ | $\frac{u_r}{\Delta_{coll}}$ | $\frac{\mu}{\mu_s}$ | $\frac{u_r}{u_{relmax}}$ | Drift (%) |
|-------------|---------|------------------------|--------------------------|---------------------------------|----------|-----------------------------|---------------------|--------------------------|-----------|
| Specimen 11 | | | | | | | | | |
| 1 | 0.260 | 0.623 | 0.638 | 0.649 | 0.750 | 0.003 | 0.103 | 0.031 | 0.043 |
| 2 | 0.291 | 0.697 | 0.849 | 0.776 | 1.016 | 0.014 | 0.140 | 0.096 | 0.059 |
| 3 | 0.291 | 0.697 | 1.208 | 0.843 | 1.443 | 0.056 | 0.199 | 0.280 | 0.083 |
| 4 | 0.312 | 0.747 | 1.602 | 0.828 | 1.833 | 0.106 | 0.253 | 0.419 | 0.106 |
| 5 | 0.312 | 0.747 | 1.611 | 0.757 | 2.011 | 0.156 | 0.278 | 0.561 | 0.116 |
| 6 | 0.322 | 0.771 | 1.608 | 0.726 | 2.602 | 0.276 | 0.359 | 0.768 | 0.150 |
| 7 | 0.749 | 1.793 | 1.608 | -- | ∞ | ∞ | ∞ | - | - |
| Specimen 12 | | | | | | | | | |
| 1 | 0.279 | 1.355 | 1.163 | 0.889 | 1.300 | 0.050 | 0.279 | 0.180 | 0.057 |
| 2 | 0.300 | 1.457 | 1.698 | 0.894 | 1.706 | 0.150 | 0.366 | 0.410 | 0.075 |
| 3 | 0.845 | 4.104 | 2.466 | -- | ∞ | ∞ | ∞ | - | - |
| Specimen 13 | | | | | | | | | |
| 1 | 0.162 | 0.893 | 0.737 | 0.551 | 1.062 | 0.011 | 0.381 | 0.030 | 0.069 |
| 2 | 0.174 | 0.959 | 1.047 | 0.545 | 1.174 | 0.039 | 0.421 | 0.094 | 0.076 |
| 3 | 0.186 | 1.025 | 1.330 | 0.568 | 1.349 | 0.015 | 0.484 | 0.031 | 0.088 |
| 4 | 0.224 | 1.234 | 1.650 | 0.562 | 1.924 | 0.426 | 0.690 | 0.617 | 0.125 |
| 5 | 0.327 | 1.802 | 1.937 | -- | ∞ | ∞ | ∞ | - | - |
| Specimen 14 | | | | | | | | | |
| 1 | 0.086 | 0.718 | 0.326 | 0.250 | 0.728 | 0.044 | 0.388 | 0.113 | 0.046 |
| 2 | 0.105 | 0.877 | 0.382 | 0.276 | 0.892 | 0.081 | 0.475 | 0.170 | 0.057 |
| 3 | 0.110 | 0.918 | 0.456 | 0.284 | 0.967 | 0.120 | 0.515 | 0.234 | 0.062 |
| 4 | 0.121 | 1.010 | 0.510 | 0.292 | 1.164 | 0.311 | 0.620 | 0.501 | 0.074 |
| 5 | 0.239 | 1.996 | 0.576 | -- | ∞ | ∞ | ∞ | - | - |
| Specimen 15 | | | | | | | | | |
| 1 | 0.169 | 2.561 | 0.711 | -- | ∞ | ∞ | ∞ | - | - |

(a) V_o^*/V_{yo} vs μ ($\theta \leq 0.1$)



(b) V_o^*/V_{yo} vs μ ($0.1 < \theta \leq 0.3$)

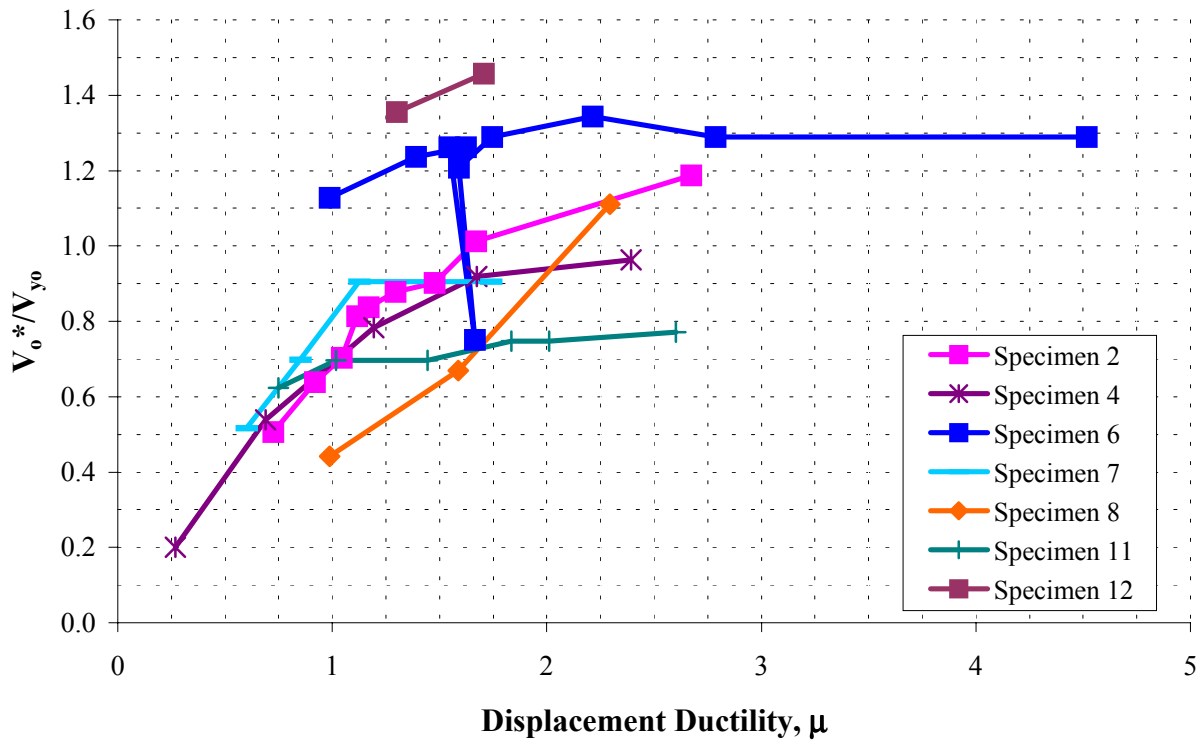
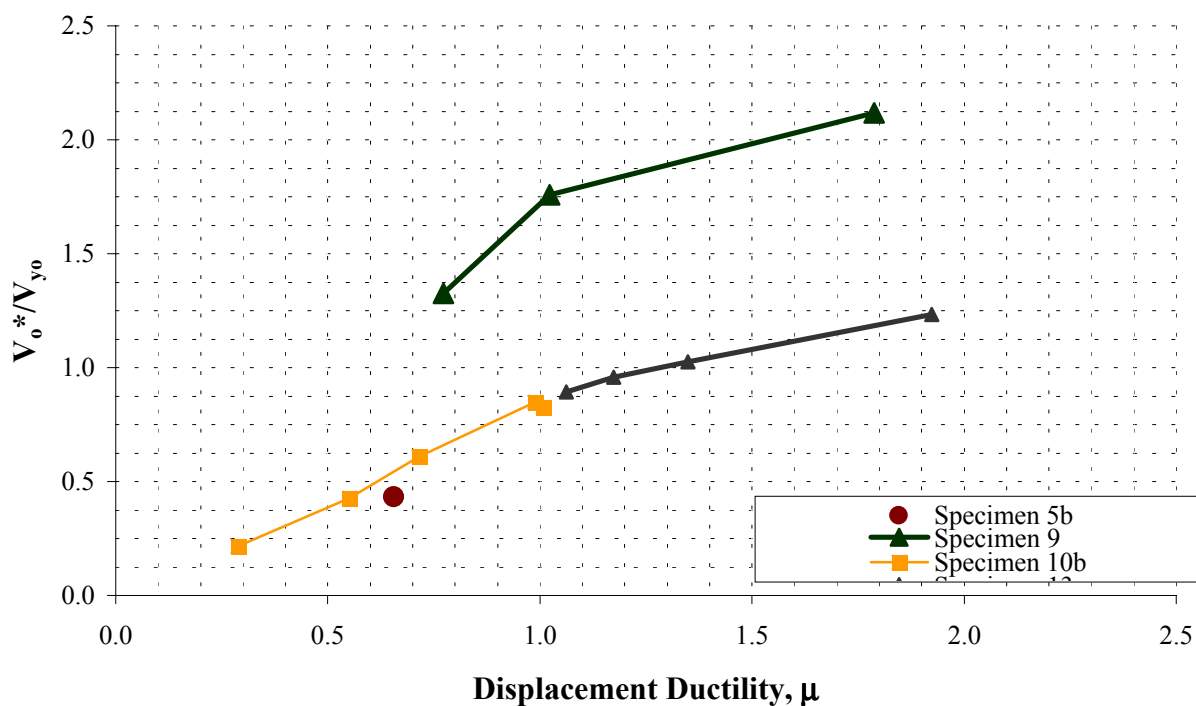


FIGURE C-1 Normalized Base Shear vs Displacement Ductility

(c) V_o^*/V_{yo} vs μ ($0.3 < \theta \leq 0.5$)



(d) V_o^*/V_{yo} vs μ ($\theta \geq 0.5$)

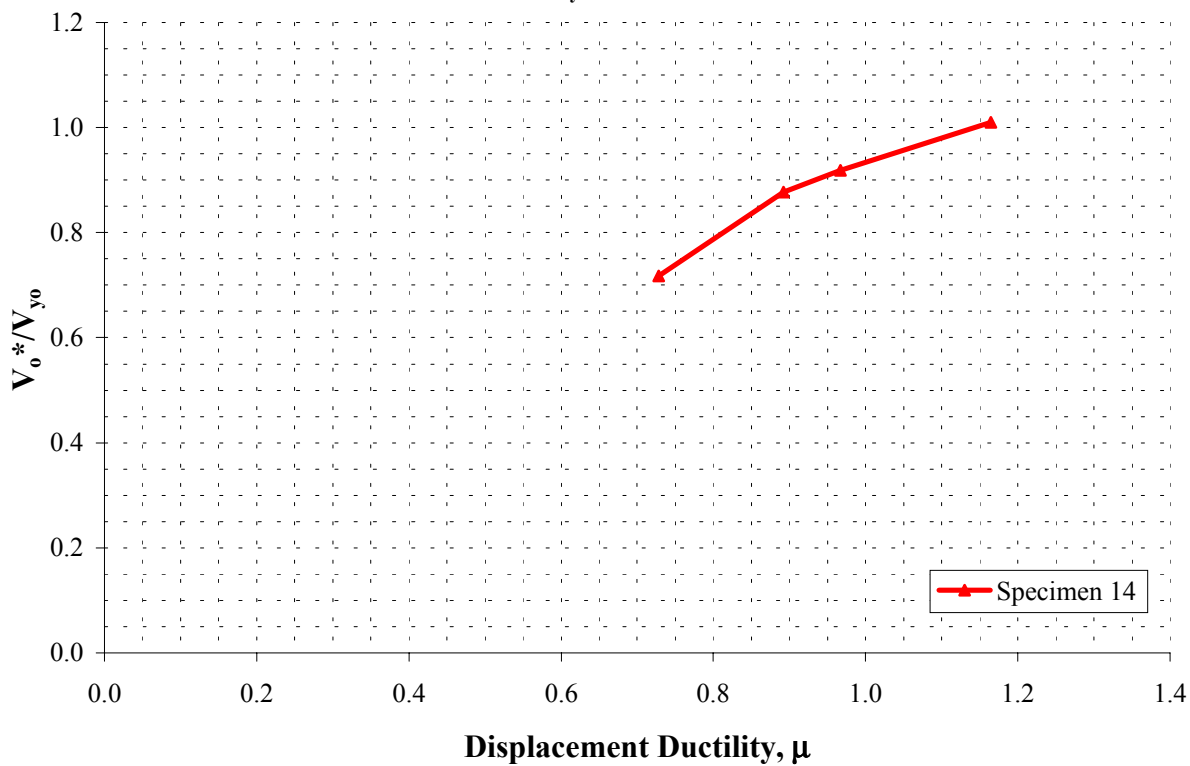


FIGURE C-1 (cont'd) Normalized Base Shear vs Displacement Ductility

(e) V_o^*/V_{y0} vs. μ - all specimens

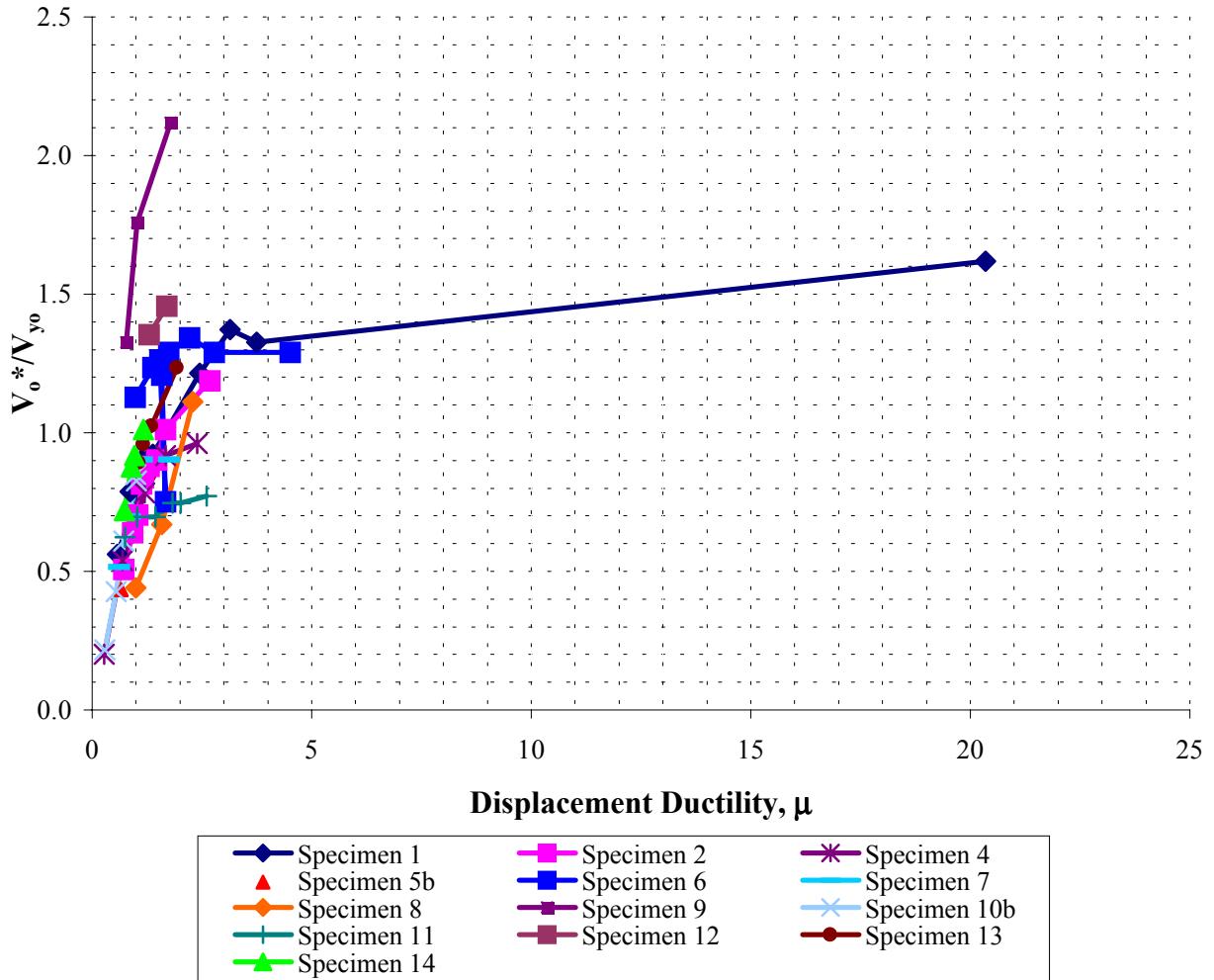
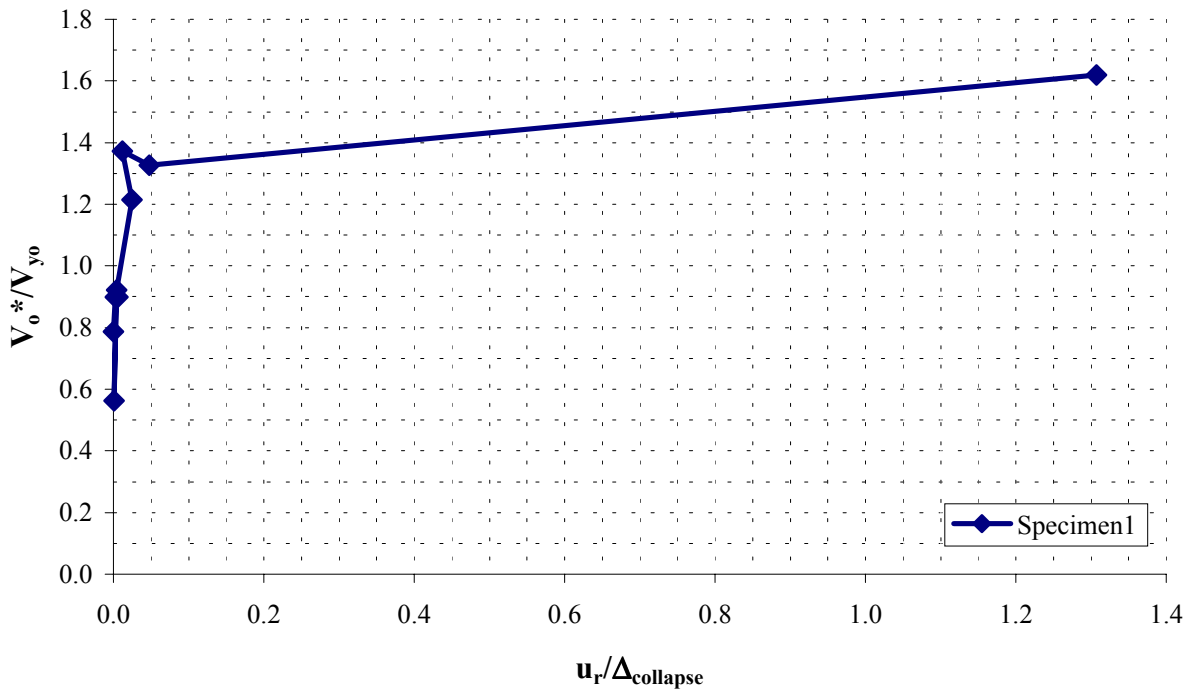


FIGURE C-1 (cont'd) Normalized Base Shear vs Displacement Ductility

(a) V_o^*/V_{yo} vs $u_r/\Delta_{collapse}$ ($\theta \leq 0.1$)



(b) V_o^*/V_{yo} vs $u_r/\Delta_{collapse}$ ($0.1 < \theta \leq 0.3$)

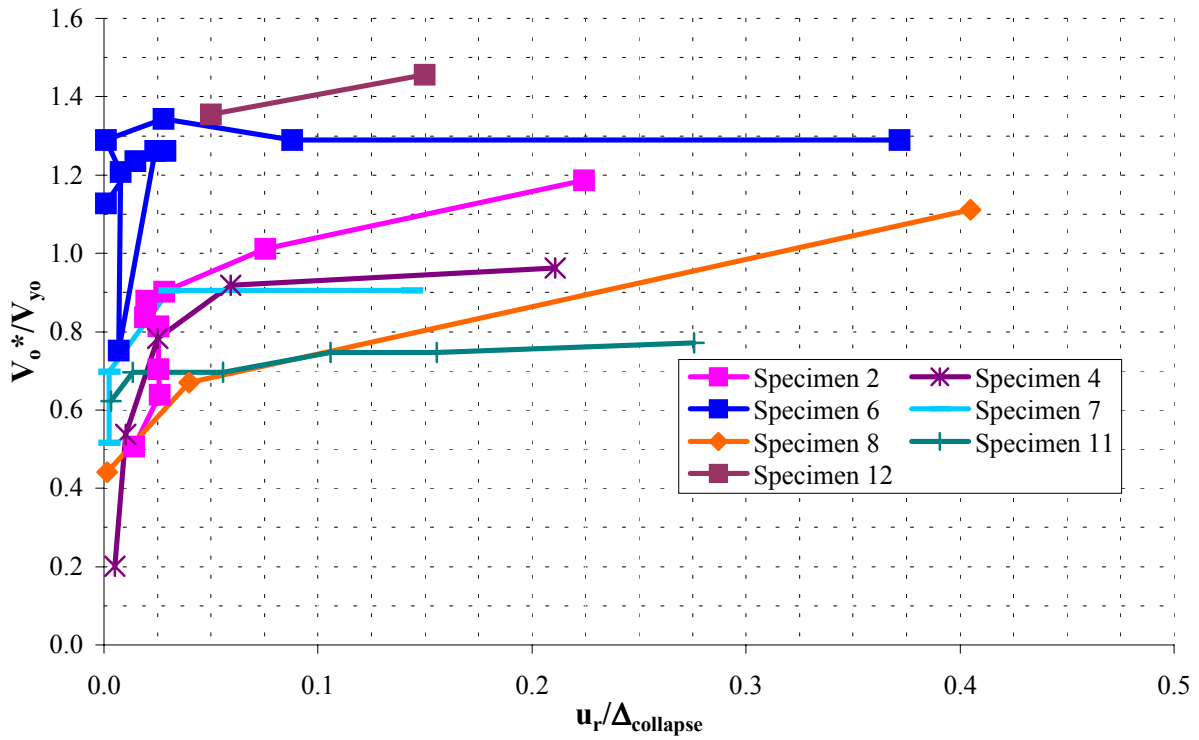
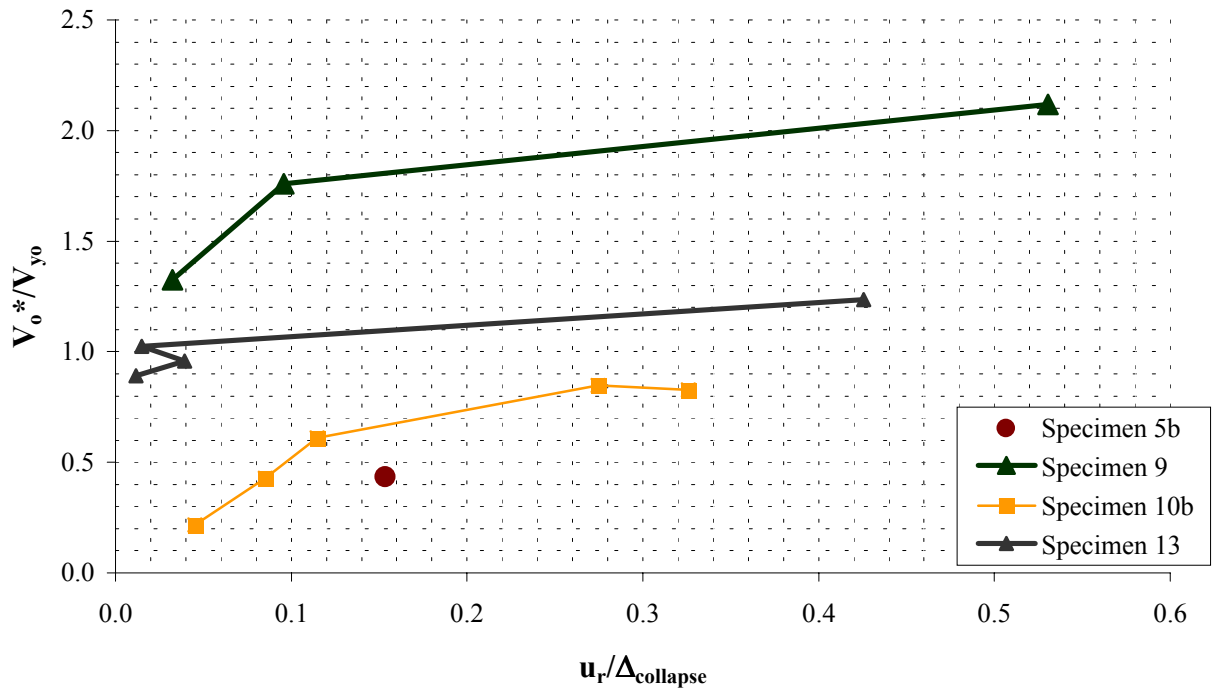


FIGURE C-2 Normalized Base Shear vs Normalized Residual Displacement

(c) V_o^*/V_{yo} vs $u_r/\Delta_{collapse}$ ($0.3 < \theta \leq 0.5$)



(d) V_o^*/V_{yo} vs $u_r/\Delta_{collapse}$ ($\theta \geq 0.5$)

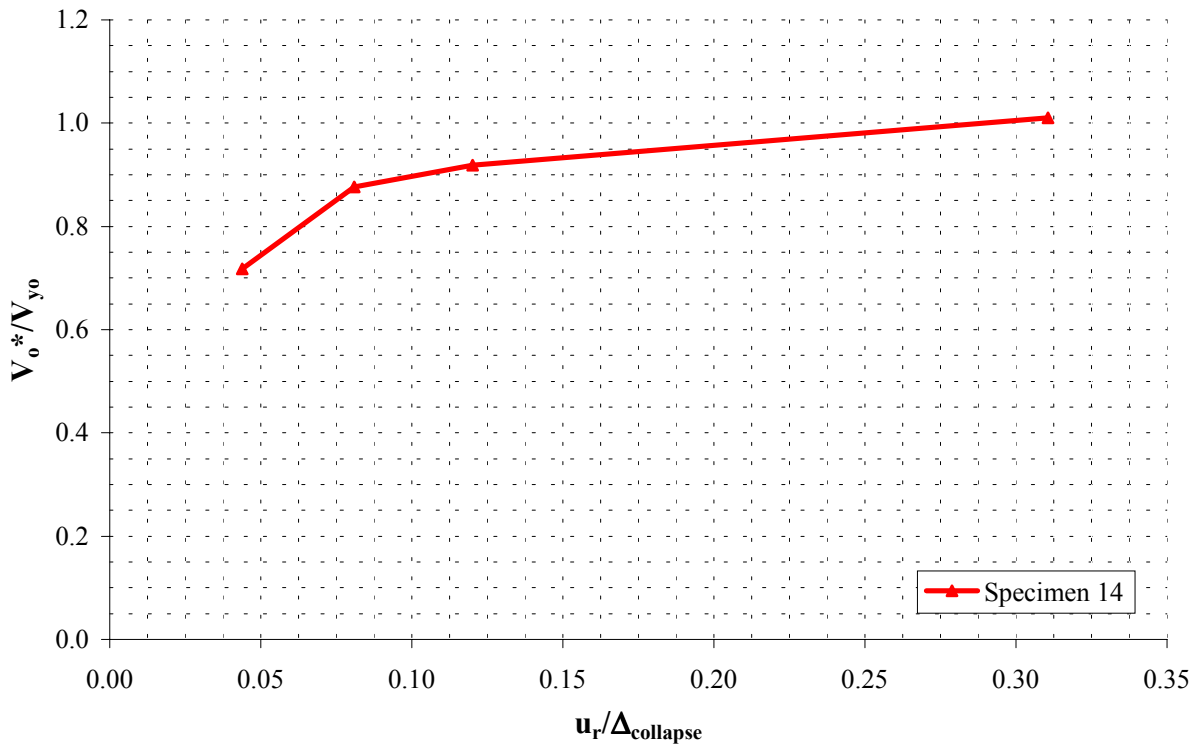


FIGURE C-2 (cont'd) Normalized Base Shear vs Normalized Residual Displacement

(e) V_o^*/V_{yo} vs. $u_r/\Delta_{collapse}$ - all specimens

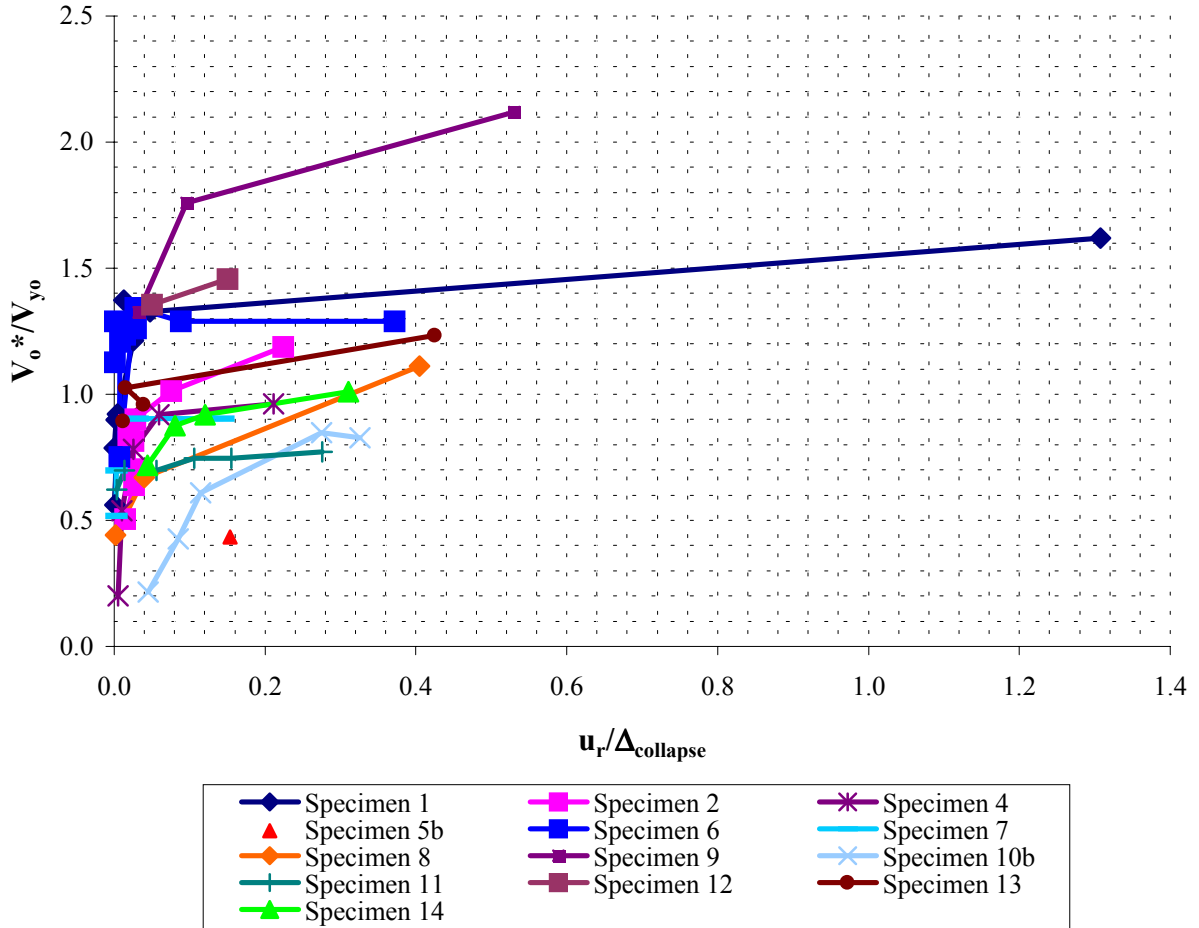
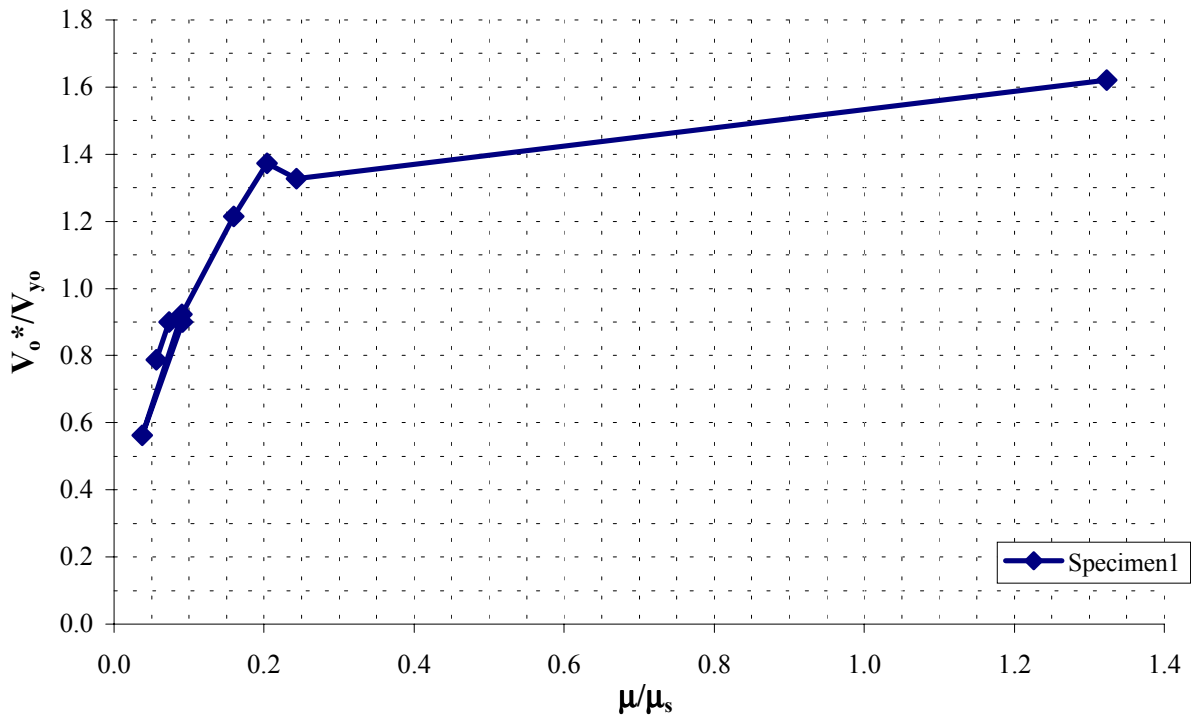


FIGURE C-2 (cont'd) Normalized Base Shear vs Normalized Residual Displacement

(a) V_o^*/V_{yo} vs μ/μ_s ($\theta \leq 0.1$)



(b) V_o^*/V_{yo} vs μ/μ_s ($0.1 < \theta \leq 0.3$)

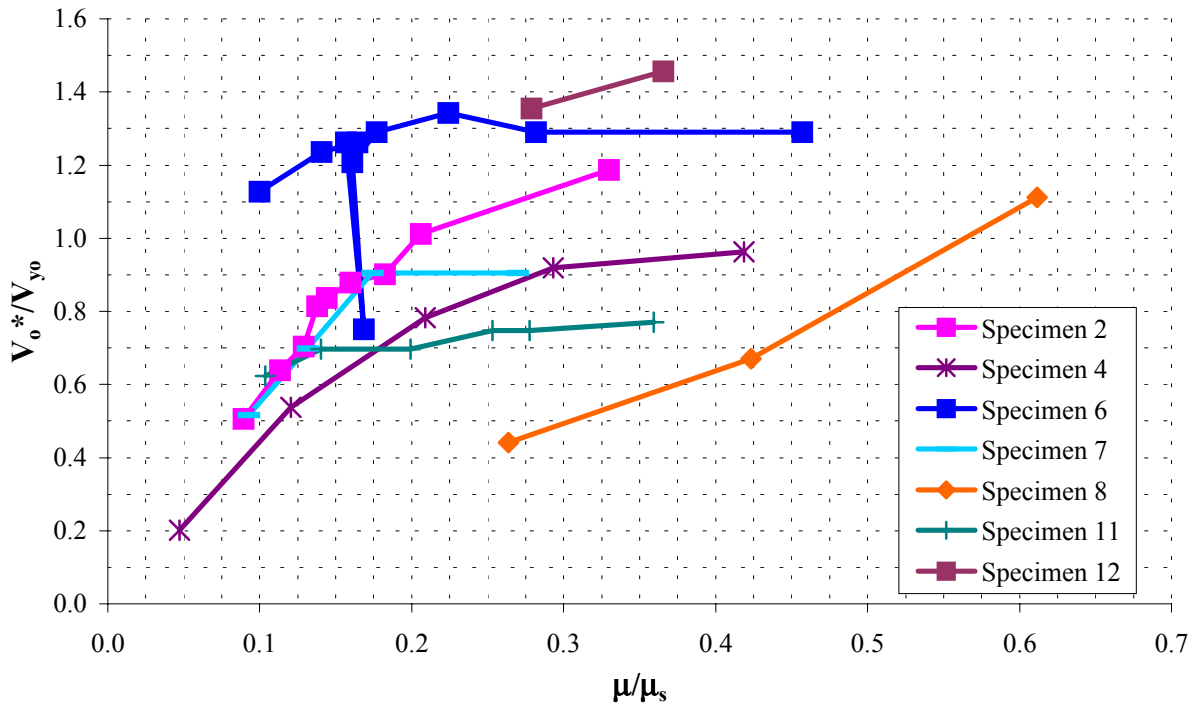


FIGURE C-3 Normalized Base Shear vs Normalized Ductility

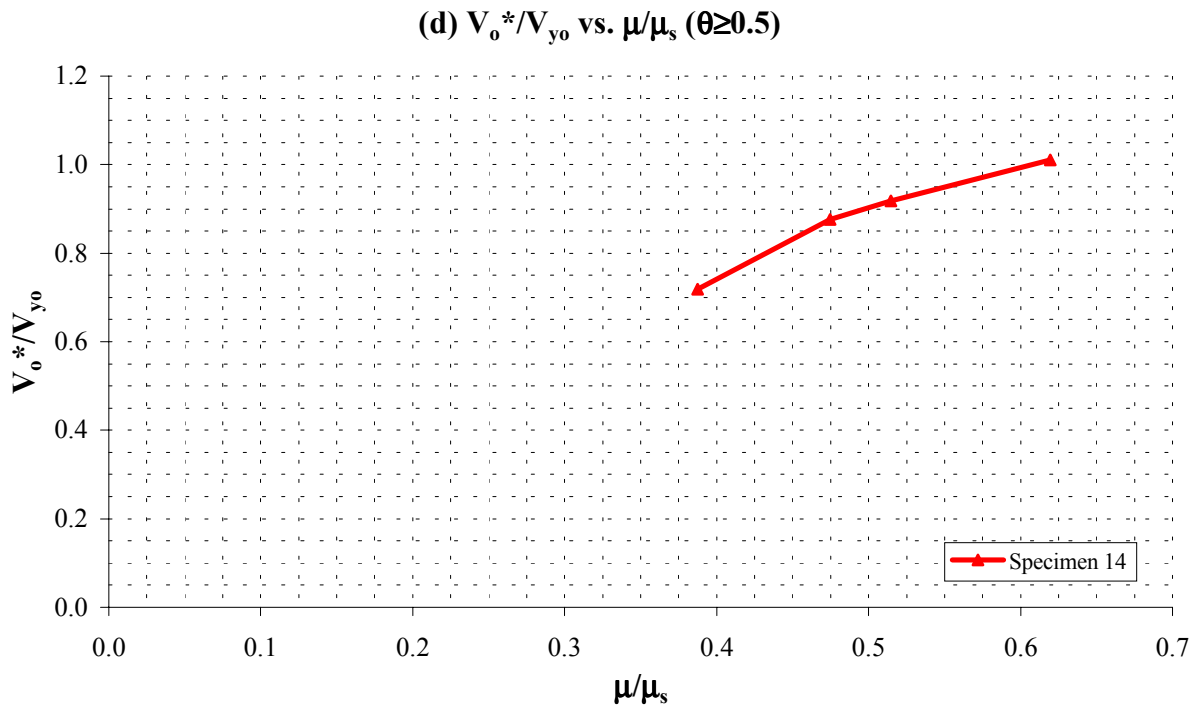
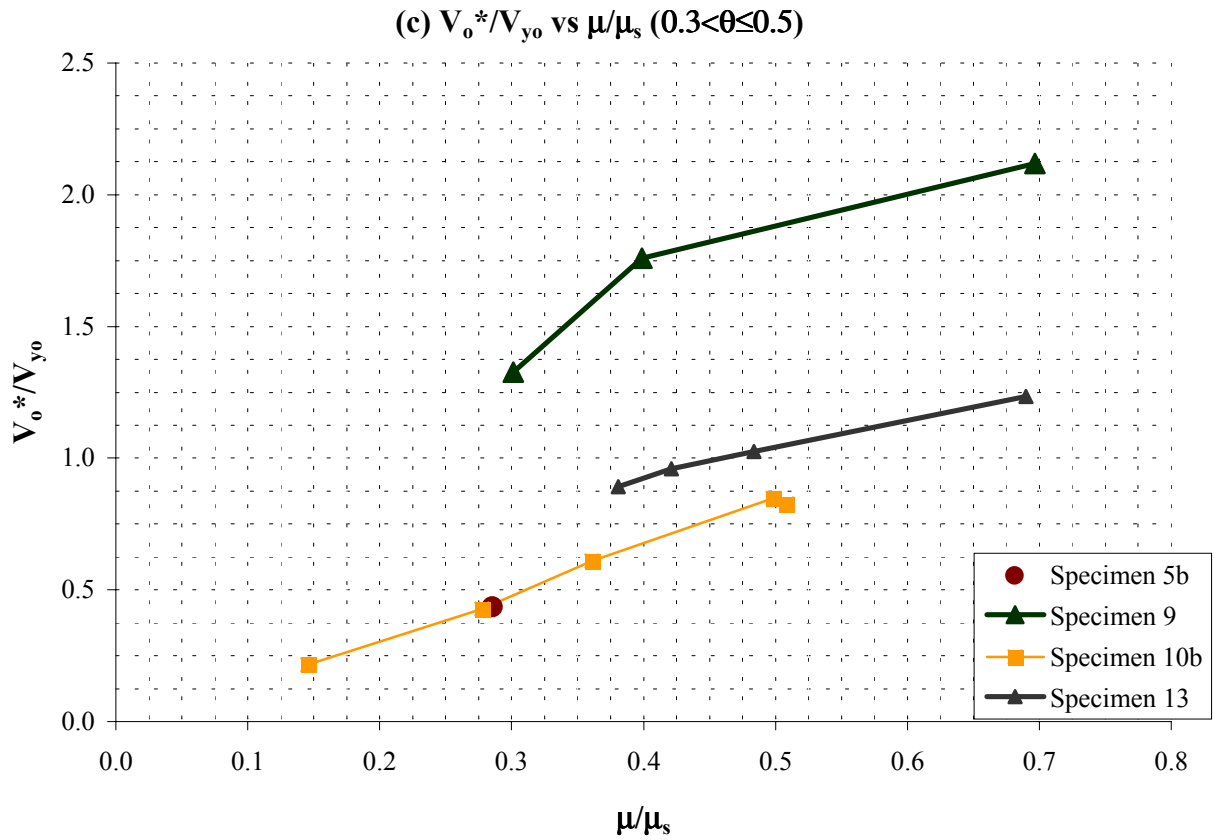


FIGURE C-3 (cont'd) Normalized Base Shear vs Normalized Ductility

(e) V_o^*/V_{yo} vs. μ/μ_s - all specimens

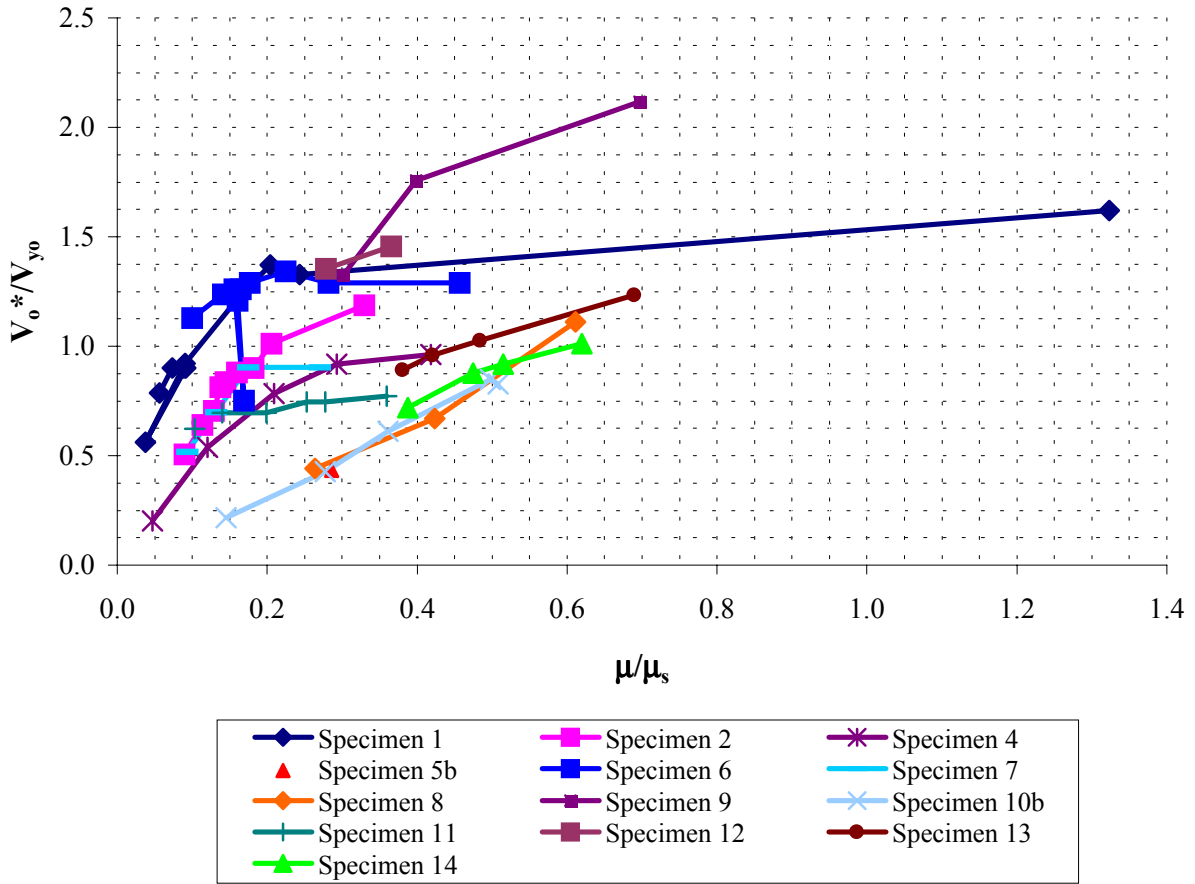


FIGURE C-3 (cont'd) Normalized Base Shear vs Normalized Ductility

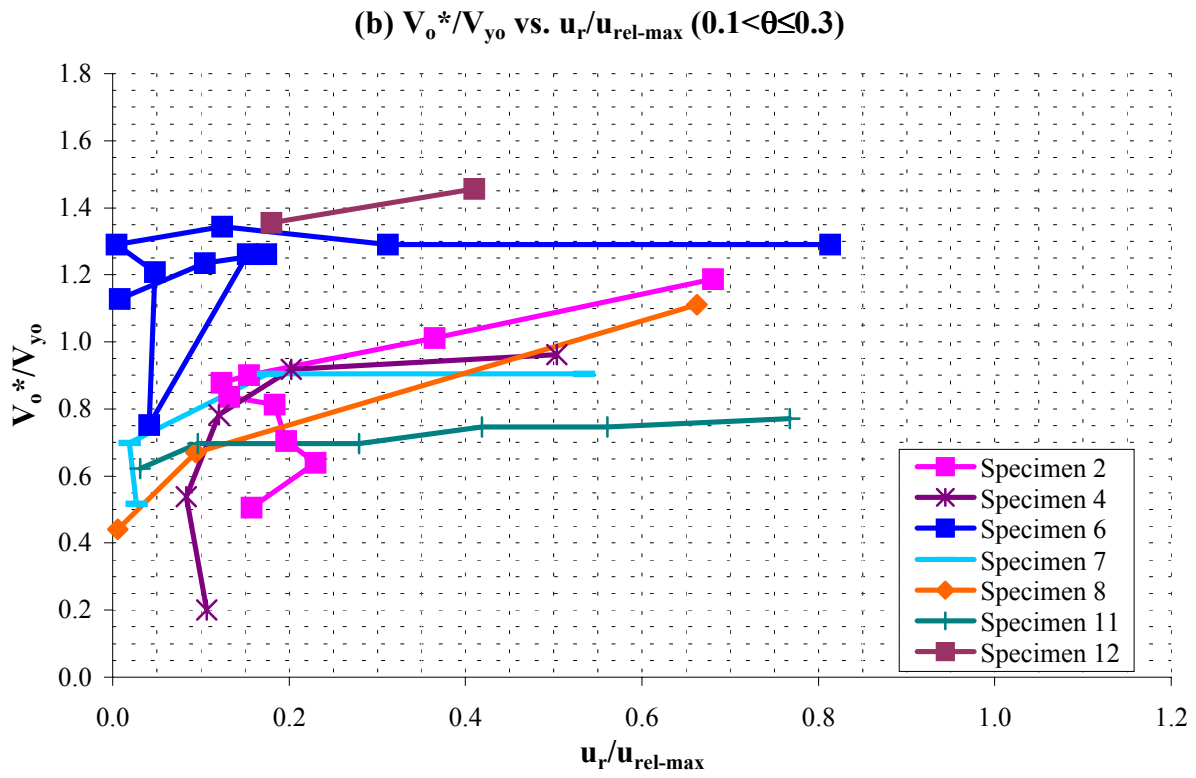
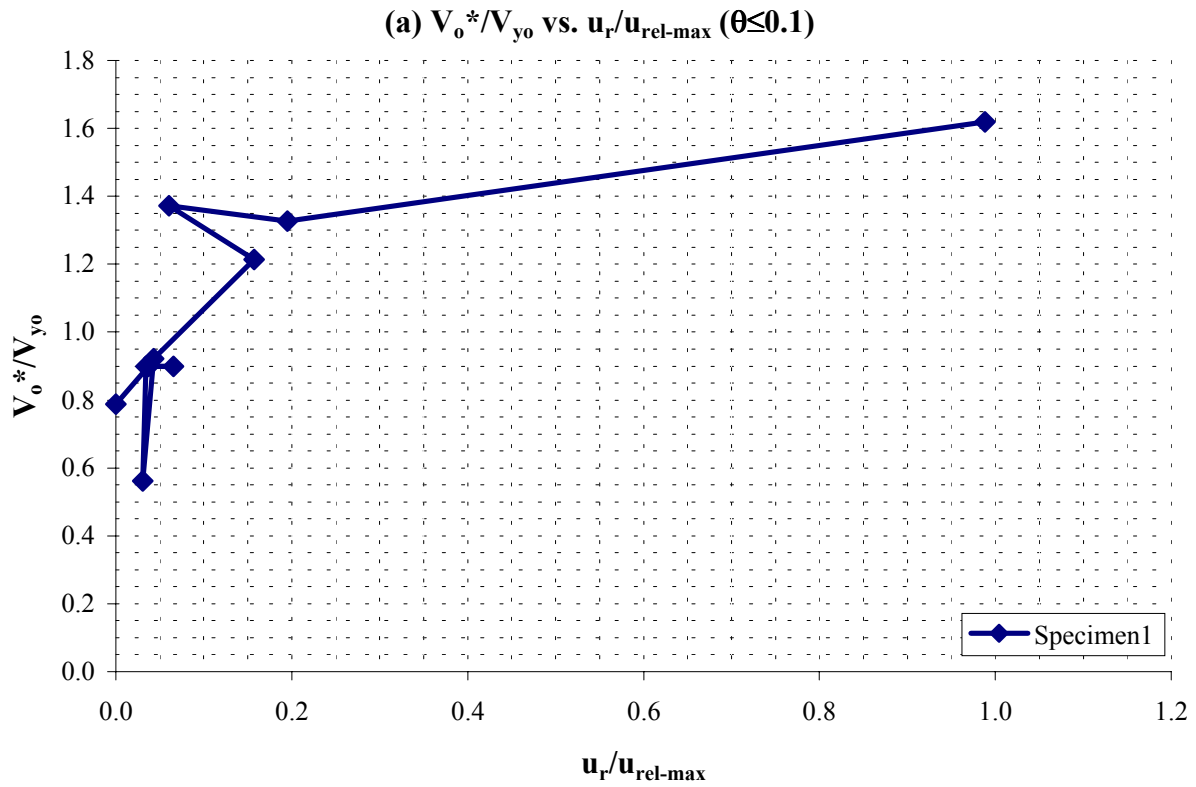
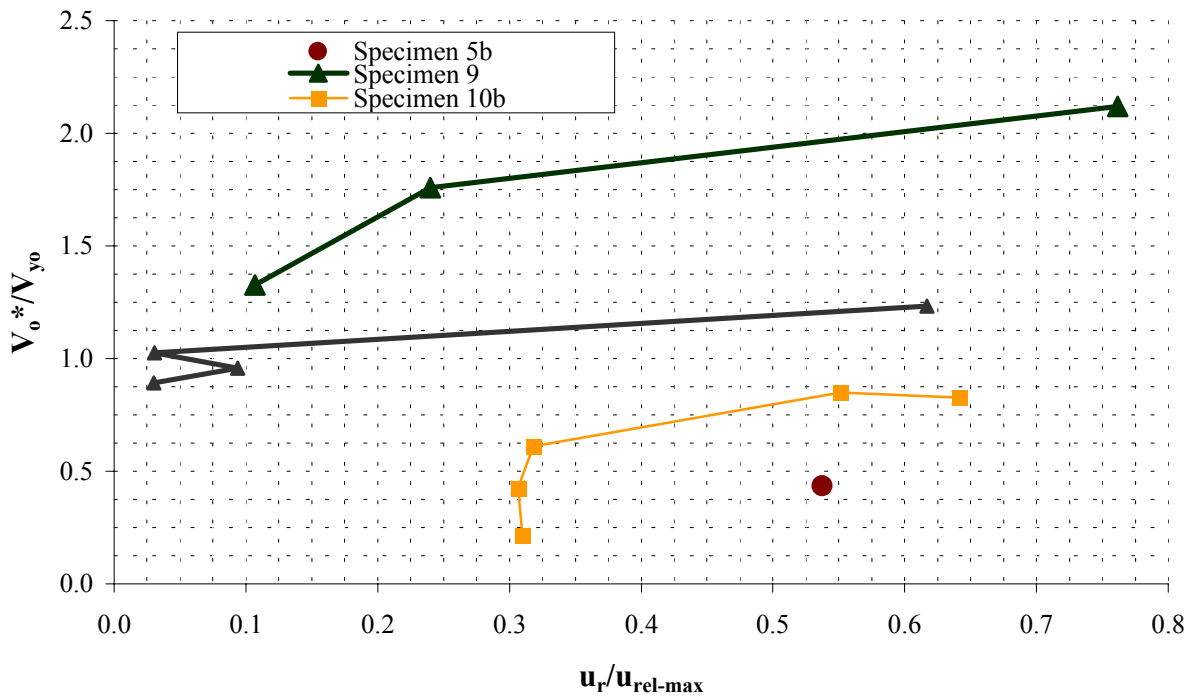


FIGURE C-4 Normalized Base Shear vs Displacement Ratio

(c) V_o^*/V_{yo} vs. $u_r/u_{rel-max}$ ($0.3 < \theta \leq 0.5$)



(d) V_o^*/V_{yo} vs. $u_r/u_{rel-max}$ ($\theta \geq 0.5$)

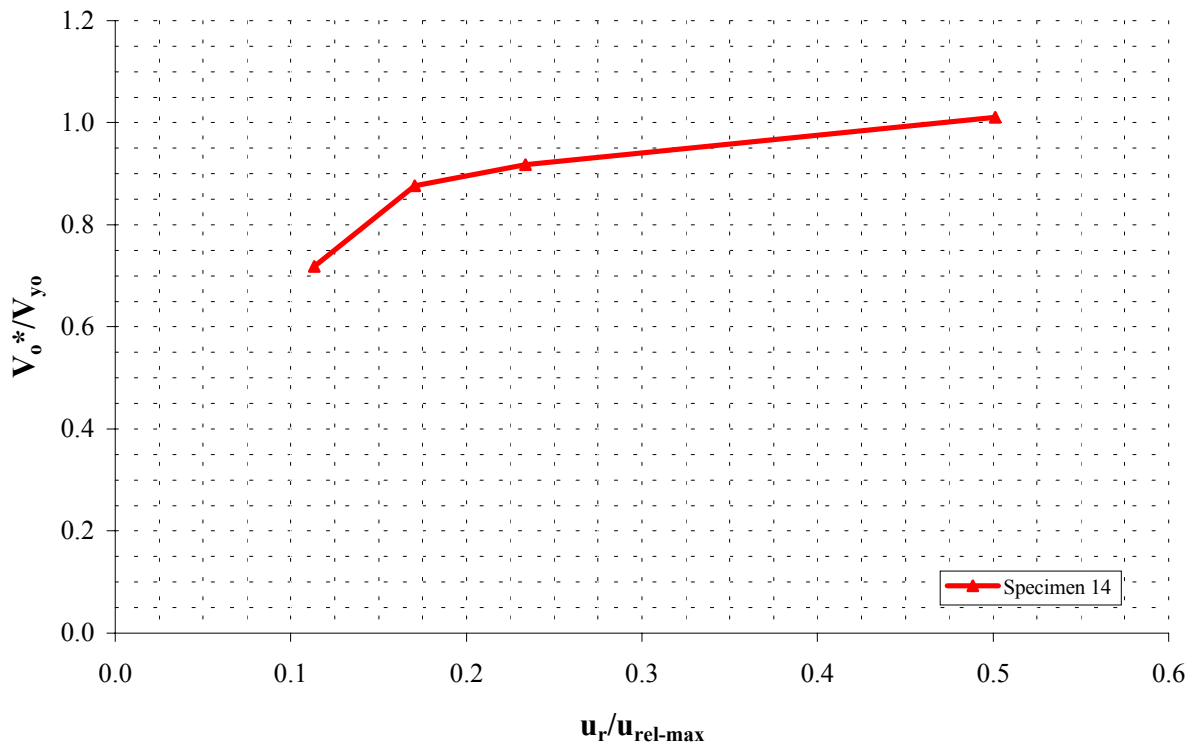


FIGURE C-4 (cont'd) Normalized Base Shear vs Displacement Ratio

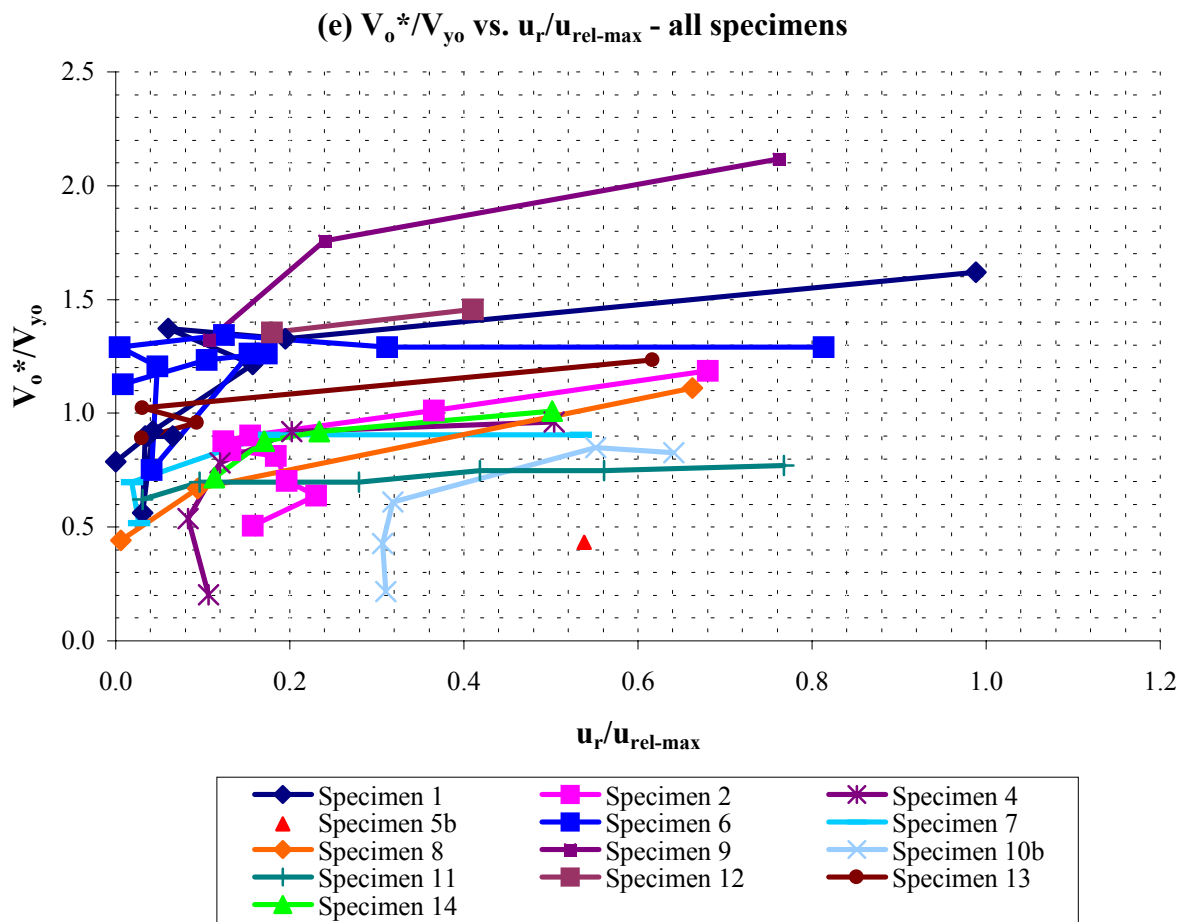
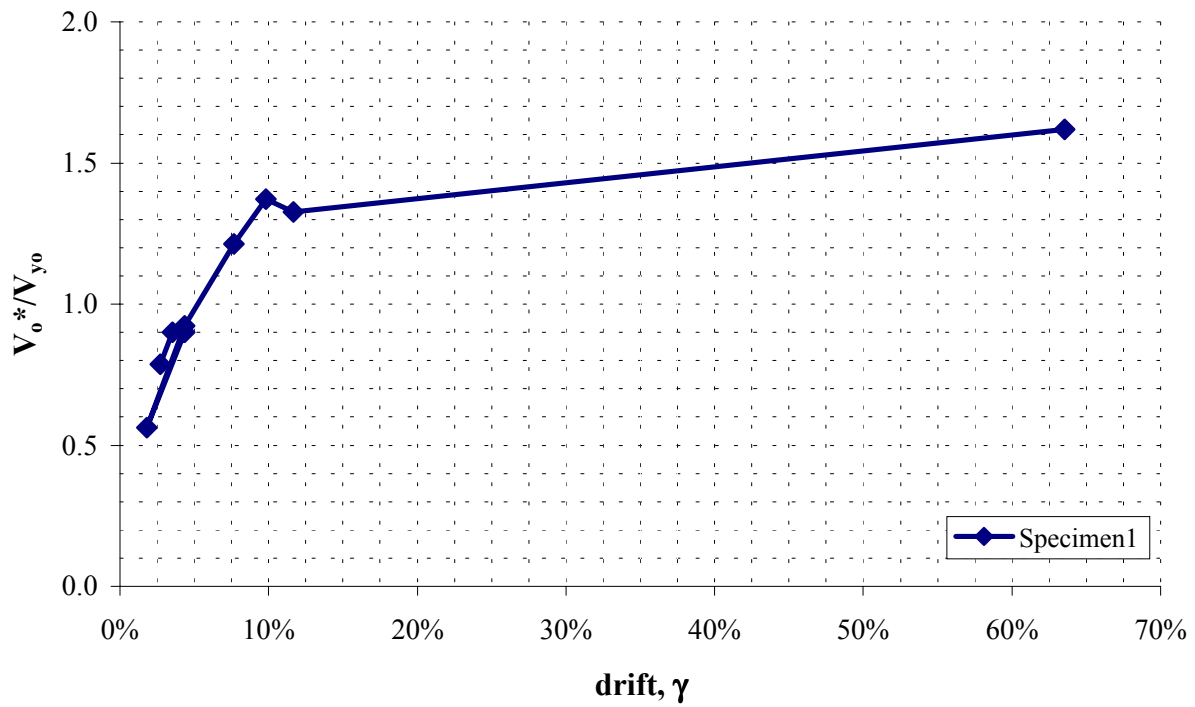


FIGURE C-4 (cont'd) Normalized Base Shear vs Displacement Ratio

(a) V_o^*/V_{yo} vs. drift ($\theta \leq 0.1$)



(b) V_o^*/V_{yo} vs. drift ($0.1 < \theta \leq 0.3$)

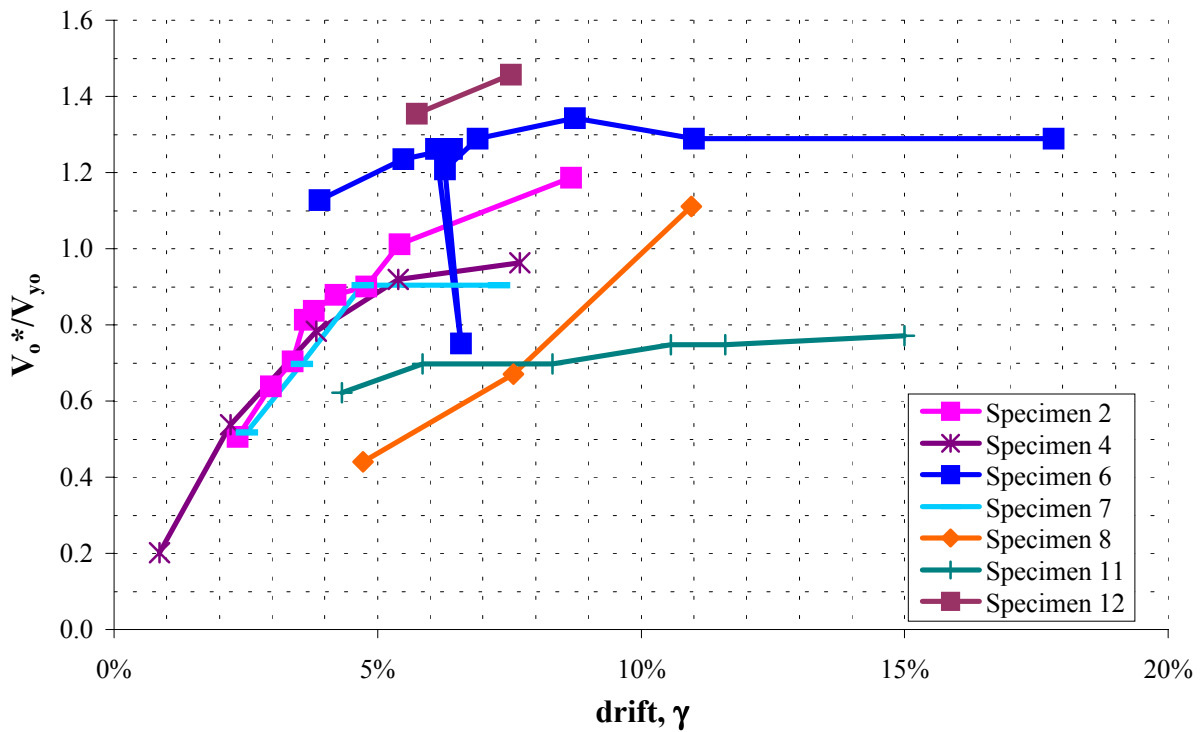


FIGURE C-5 Normalized Base Shear vs Drift

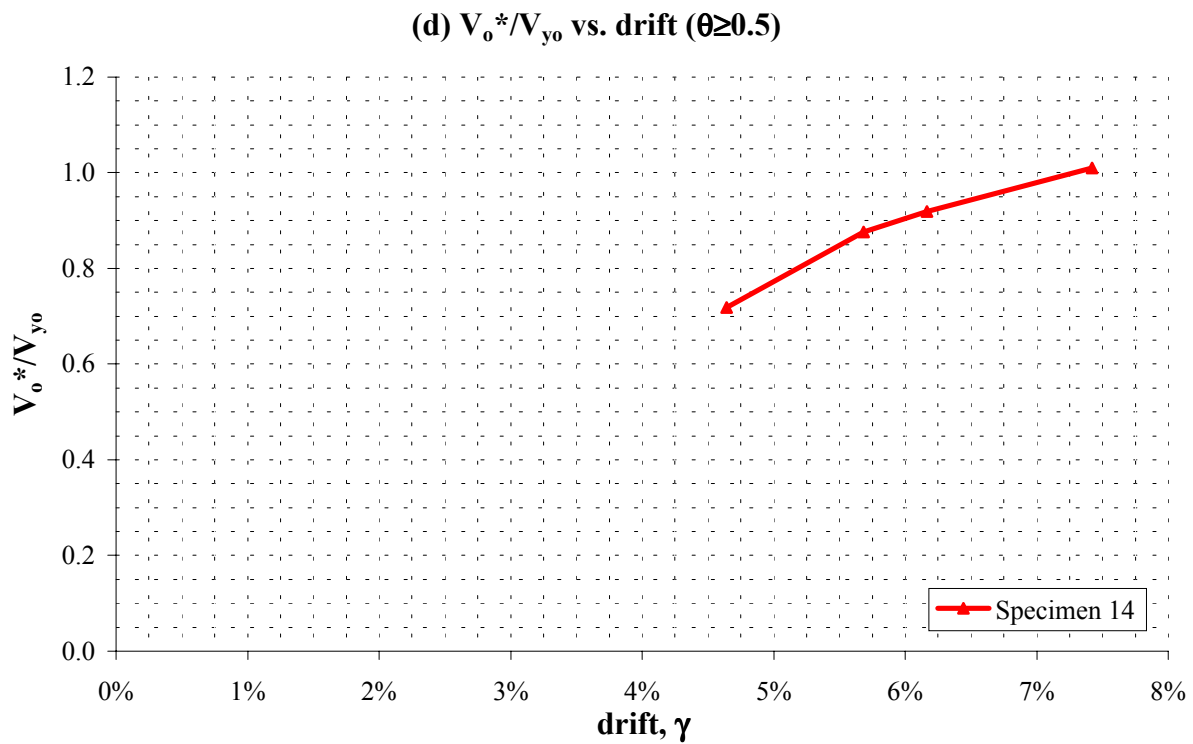
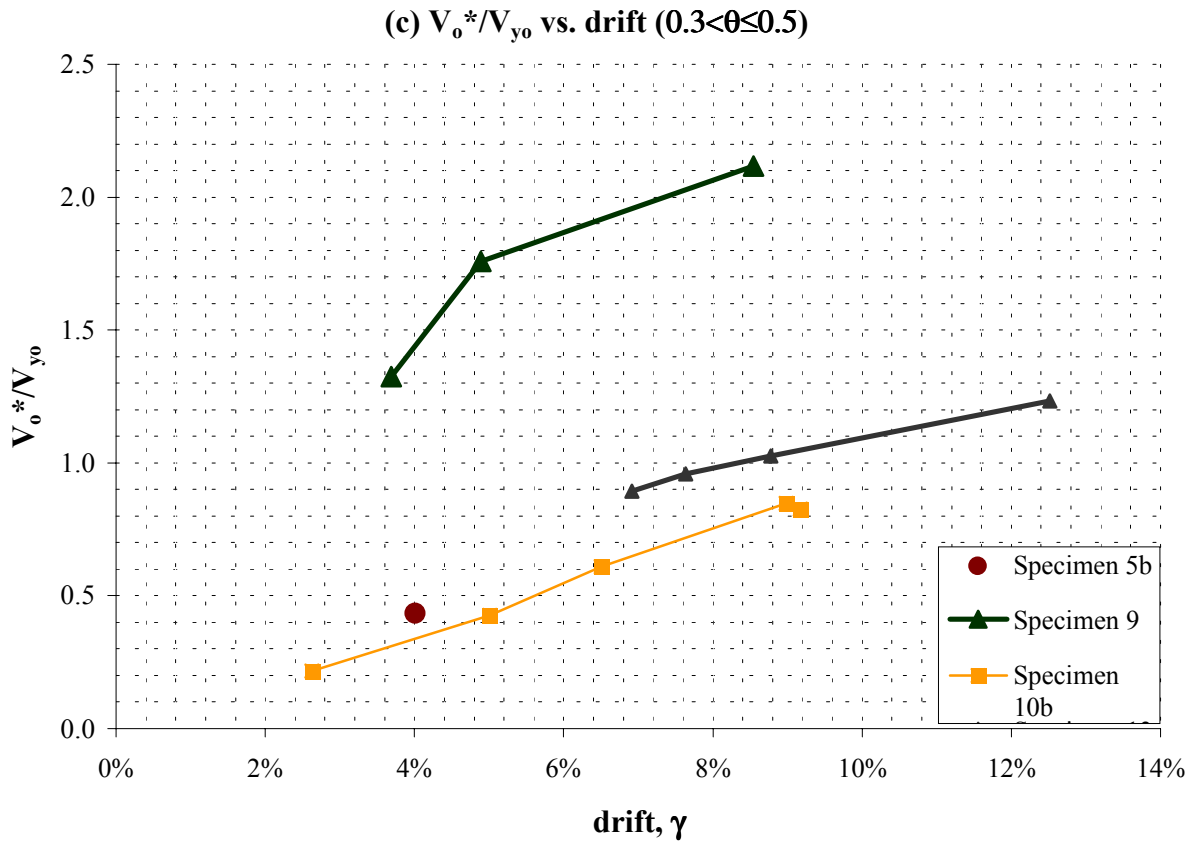


FIGURE C-5 (cont'd) Normalized Base Shear vs Drift

(e) V_o^*/V_{y0} vs. drift - all specimens

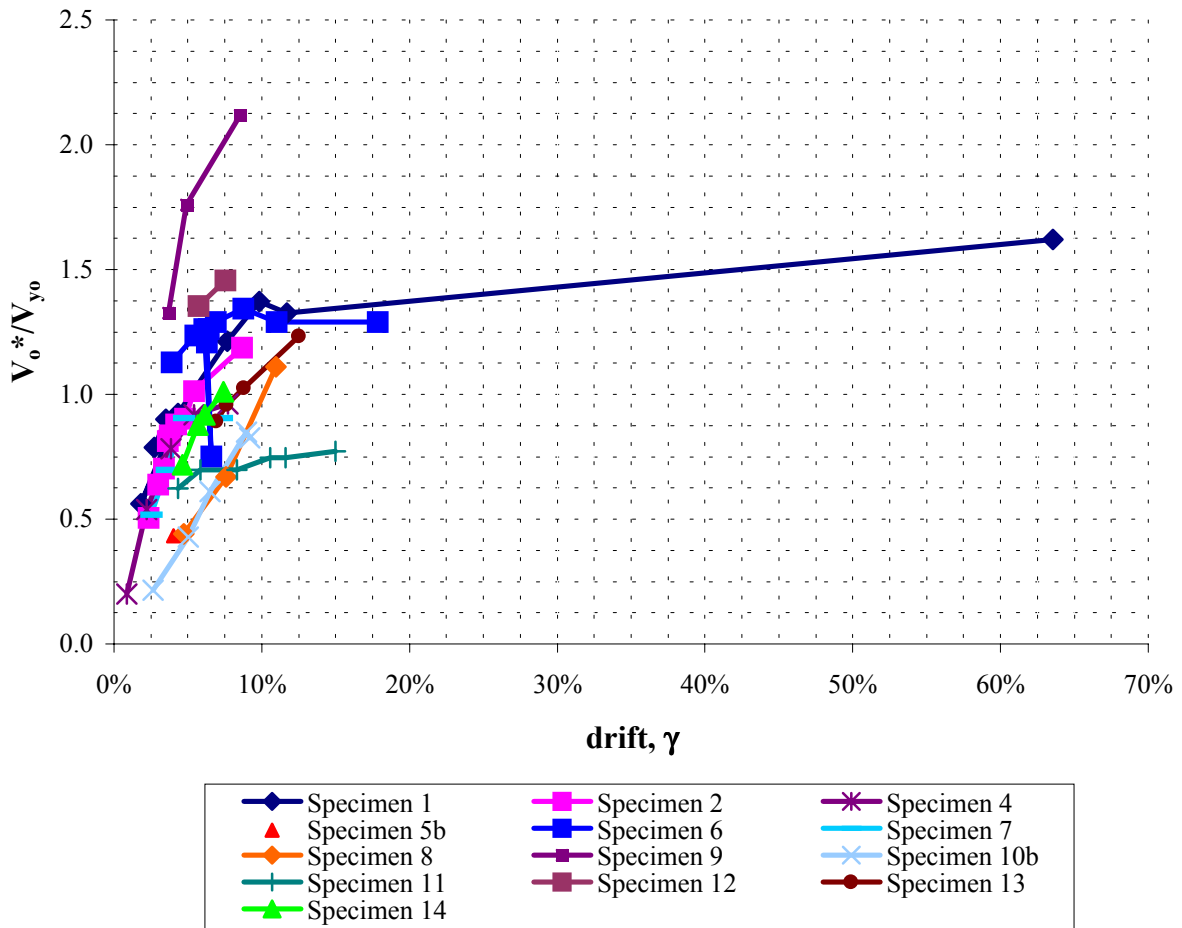
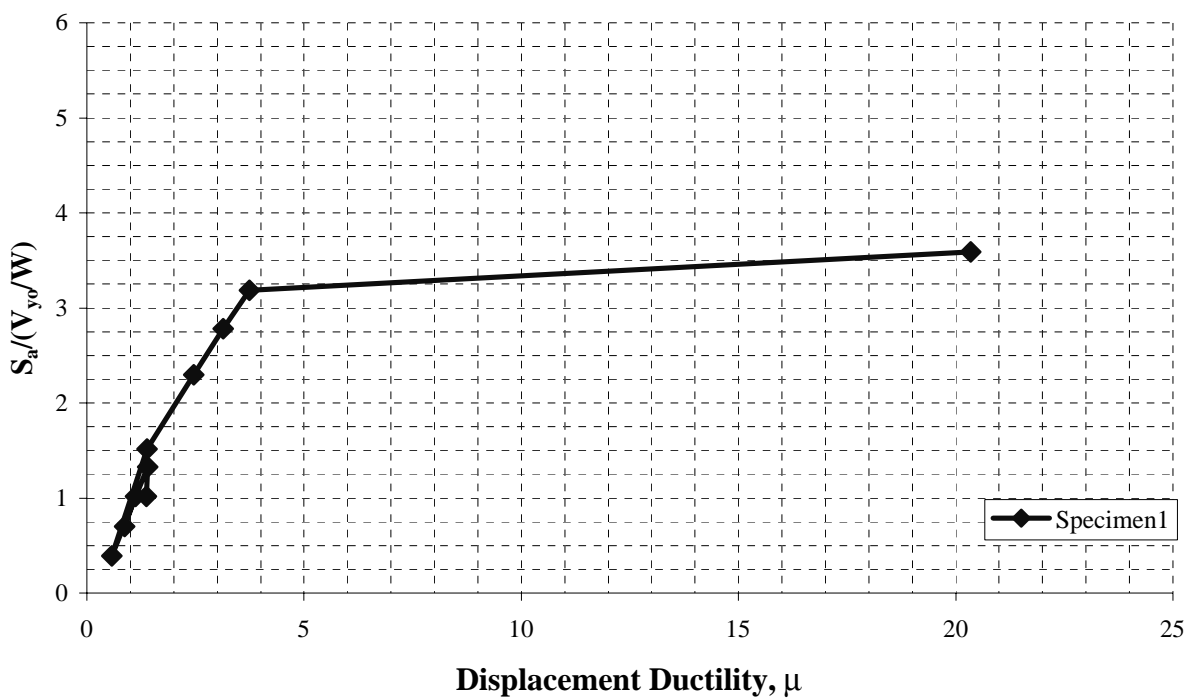


FIGURE C-5 (cont'd) Normalized Base Shear vs Drift

(a) $S_a/(V_{y0}/W)$ vs μ ($\theta \leq 0.1$)



(b) $S_a/(V_{y0}/W)$ vs μ ($0.1 < \theta \leq 0.3$)

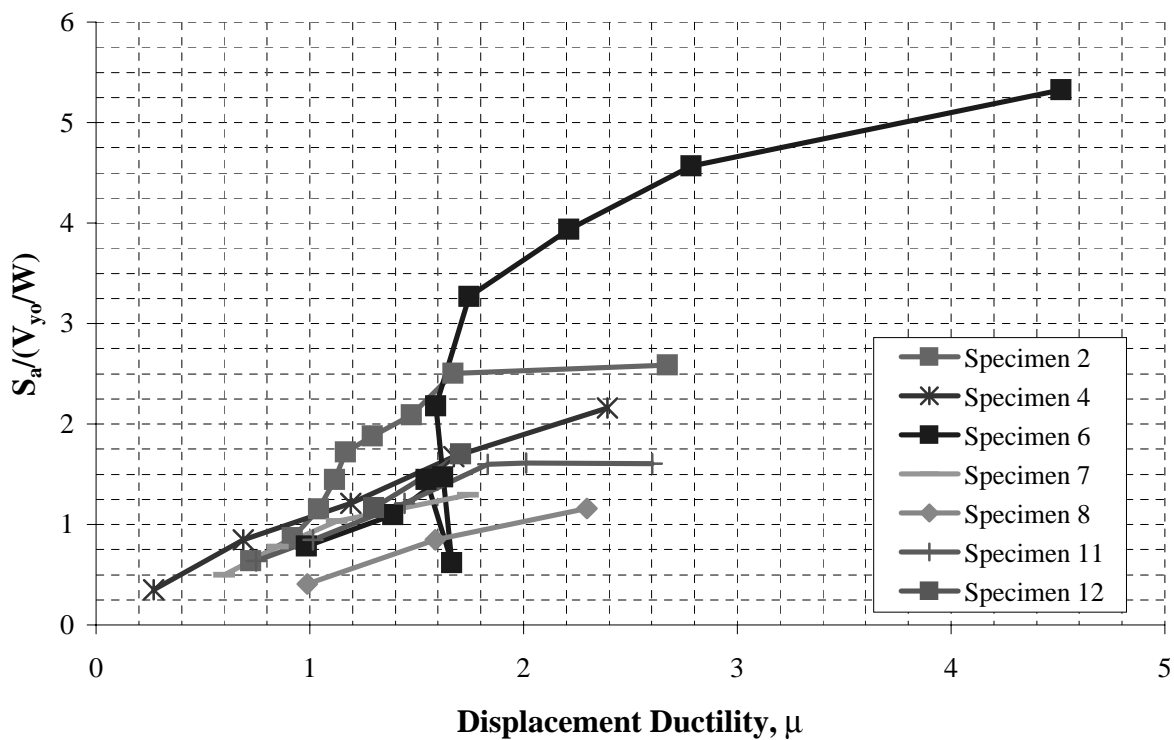
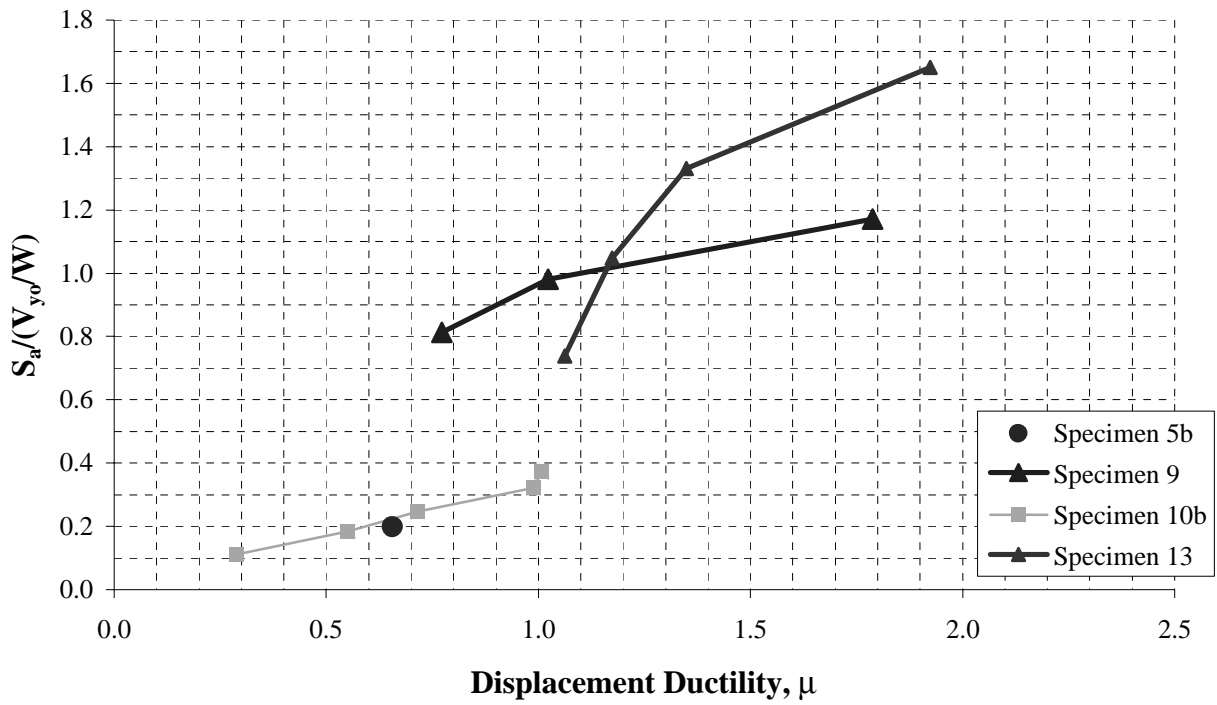


FIGURE C-6 Normalized Spectral Acceleration vs. Displacement Ductility

(c) $S_a/(V_{y0}/W)$ vs μ ($0.3 < \theta \leq 0.5$)



(d) $S_a/(V_{y0}/W)$ vs μ ($\theta \geq 0.5$)

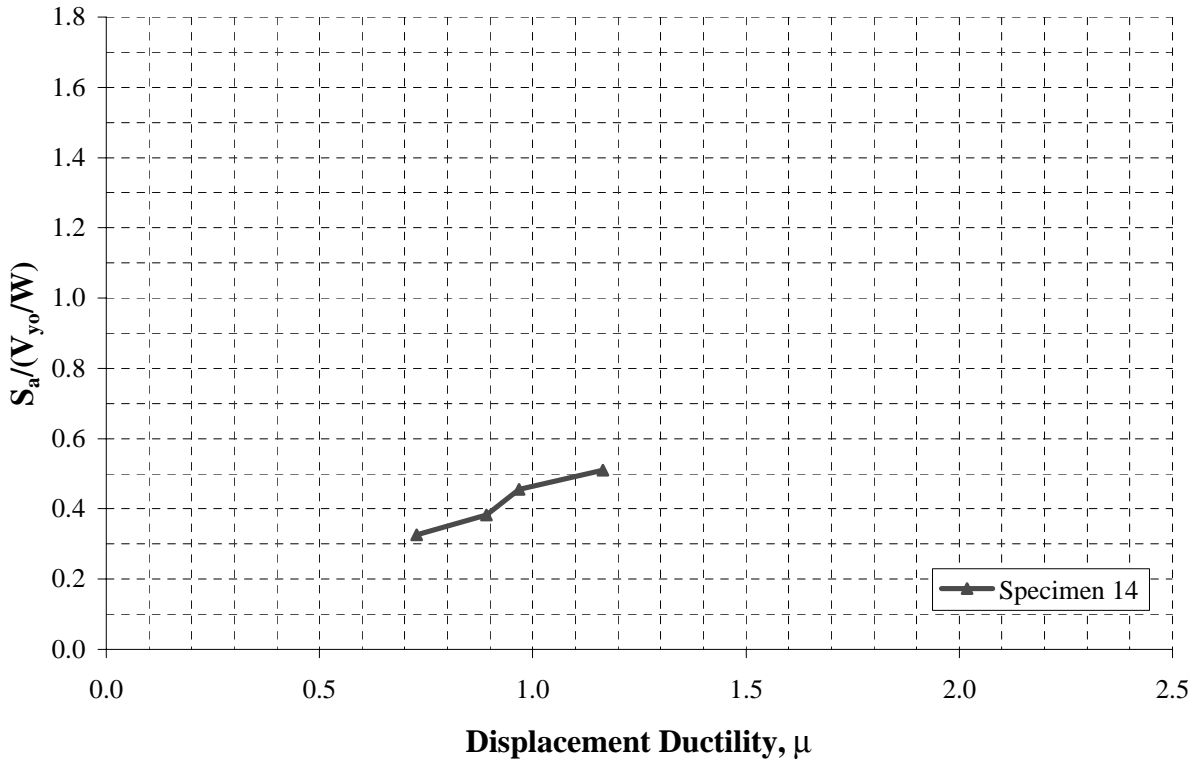


FIGURE C-6 (cont'd) Normalized Spectral Acceleration vs. Displacement Ductility

(e) $S_a/(V_{y0}/W)$ vs. μ - all specimens

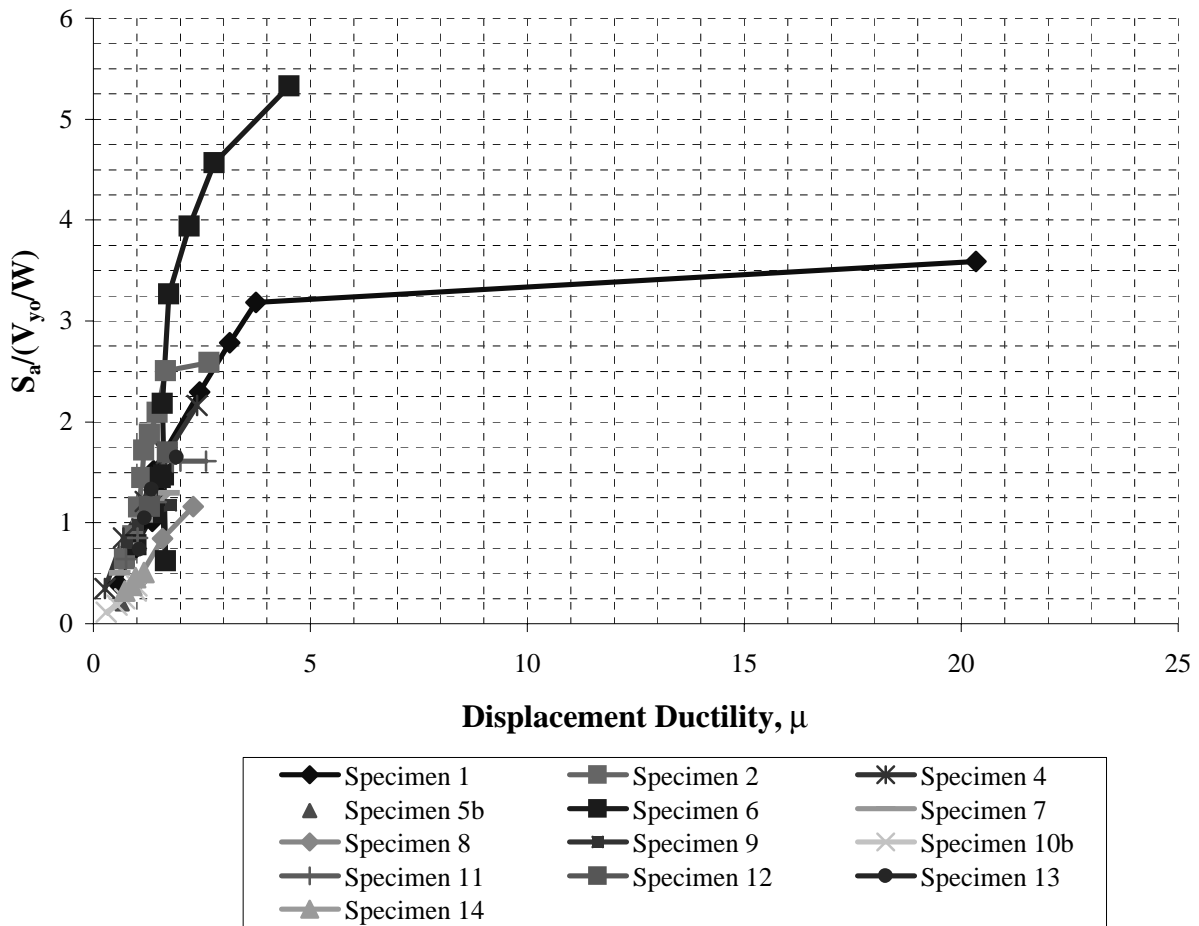
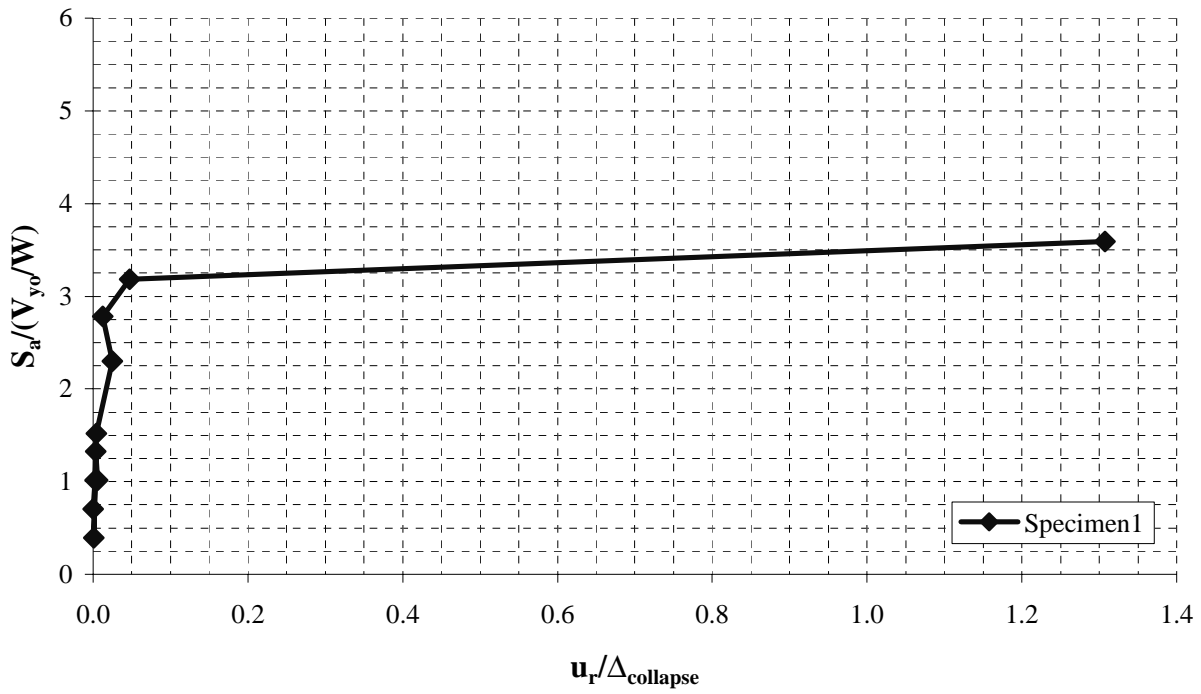


FIGURE C-6 (cont'd) Normalized Spectral Acceleration vs. Displacement Ductility

(a) $S_a/(V_{yo}/W)$ vs $u_r/\Delta_{collapse}$ ($\theta \leq 0.1$)



(b) $S_a/(V_{yo}/W)$ vs $u_r/\Delta_{collapse}$ ($0.1 < \theta \leq 0.3$)

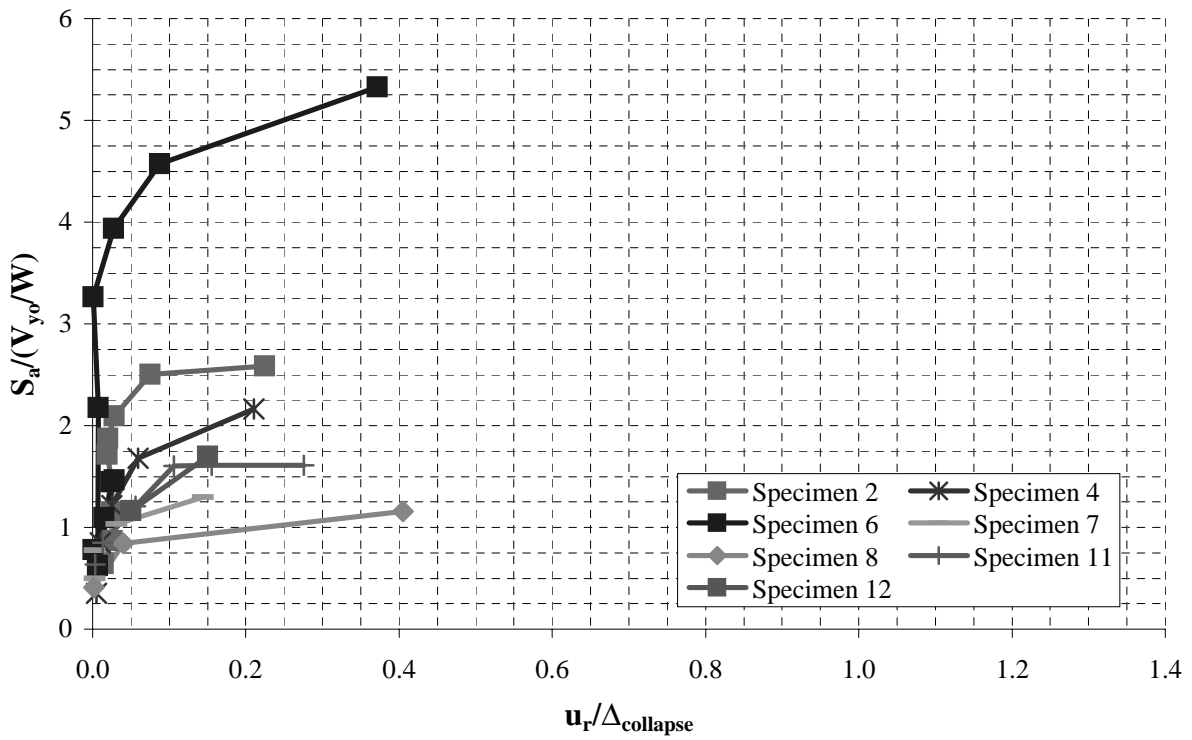
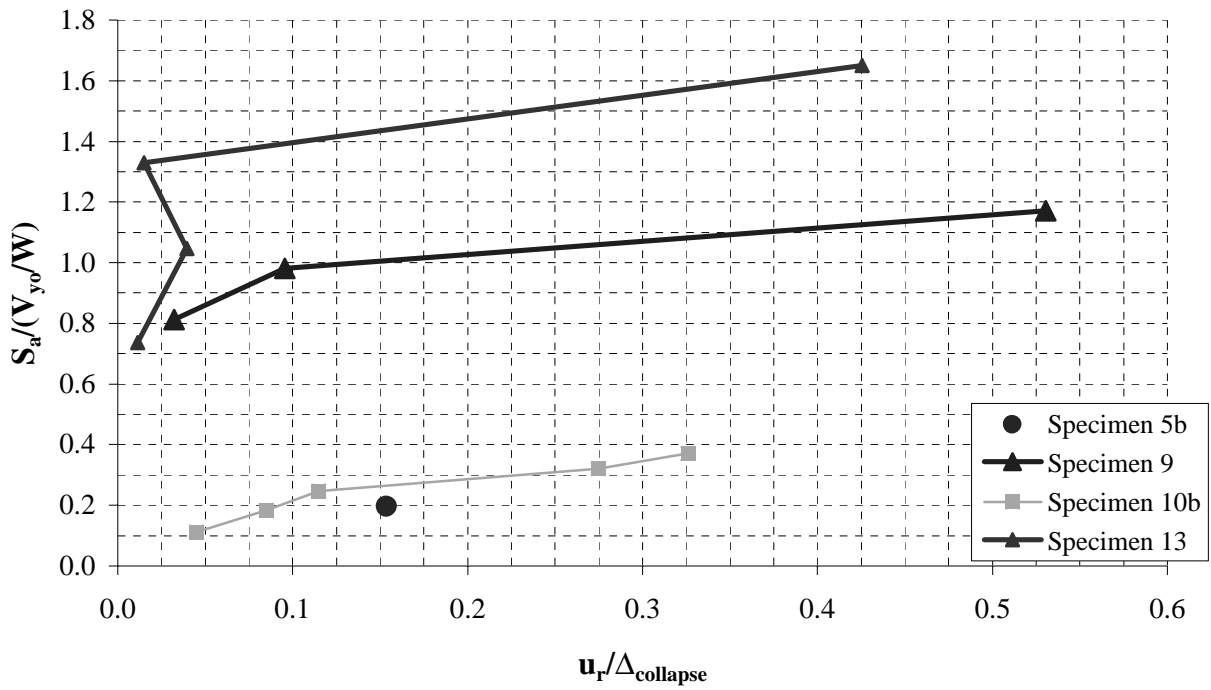


FIGURE C-7 Normalized Spectral Acceleration vs. Residual Displacement

(c) $S_a/(V_{yo}/W)$ vs $u_r/\Delta_{collapse}$ ($0.3 < \theta \leq 0.5$)



(d) $S_a/(V_{yo}/W)$ vs $u_r/\Delta_{collapse}$ ($\theta \geq 0.5$)

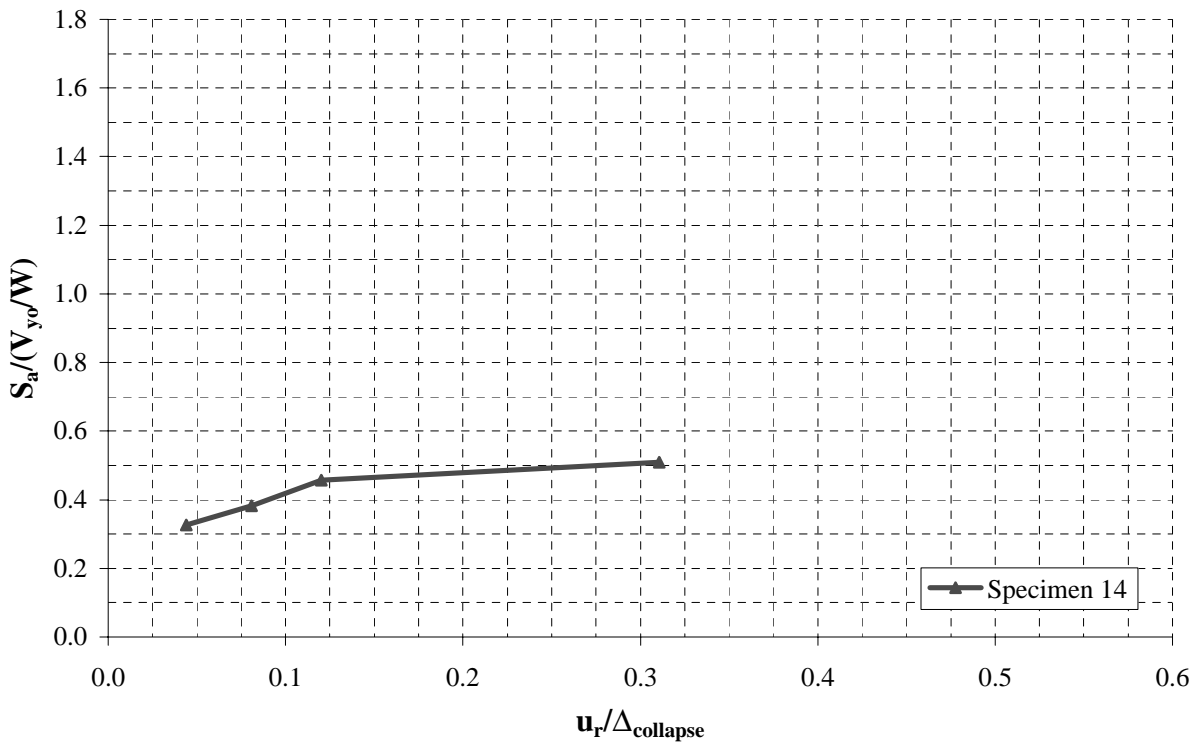


FIGURE C-7 (cont'd) Normalized Spectral Acceleration vs. Residual Displacement

(e) $S_a/(V_{yo}/W)$ vs. $u_r/\Delta_{collapse}$ - all specimens

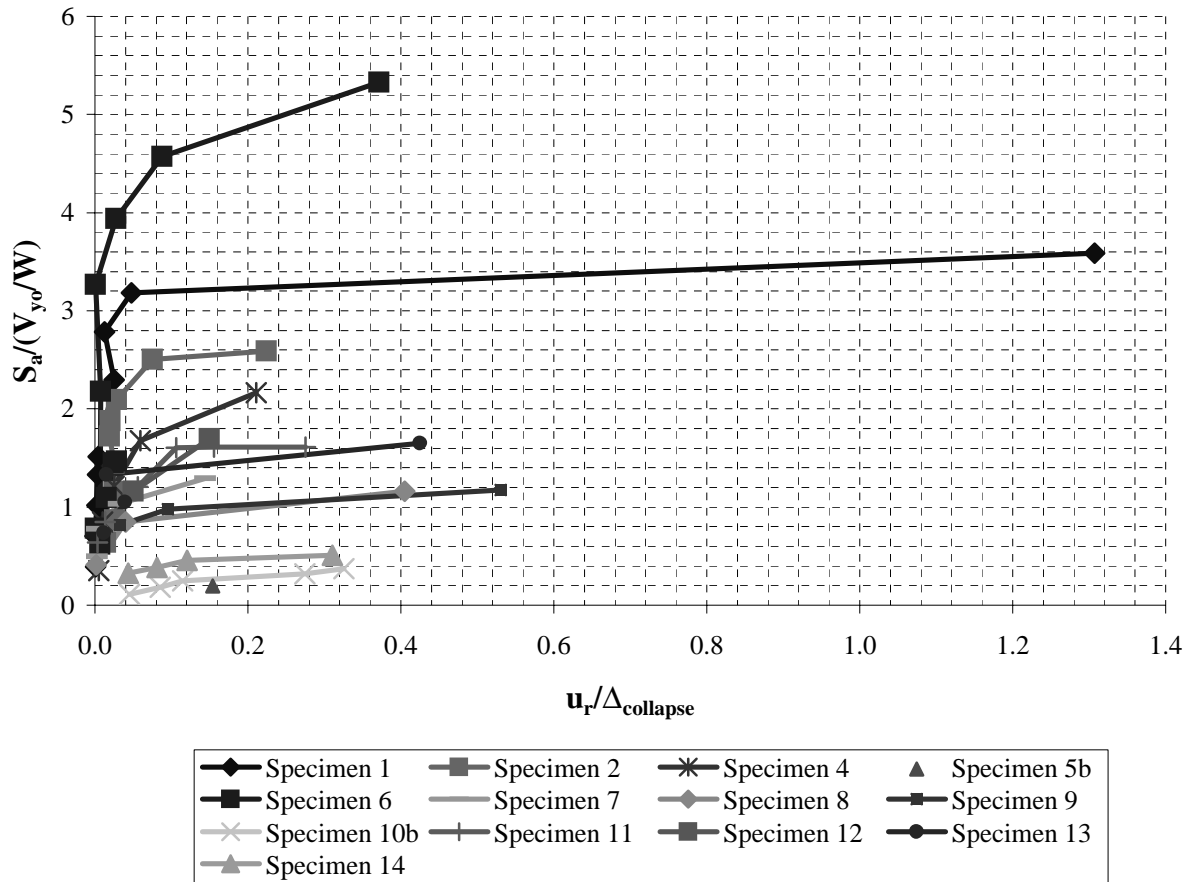
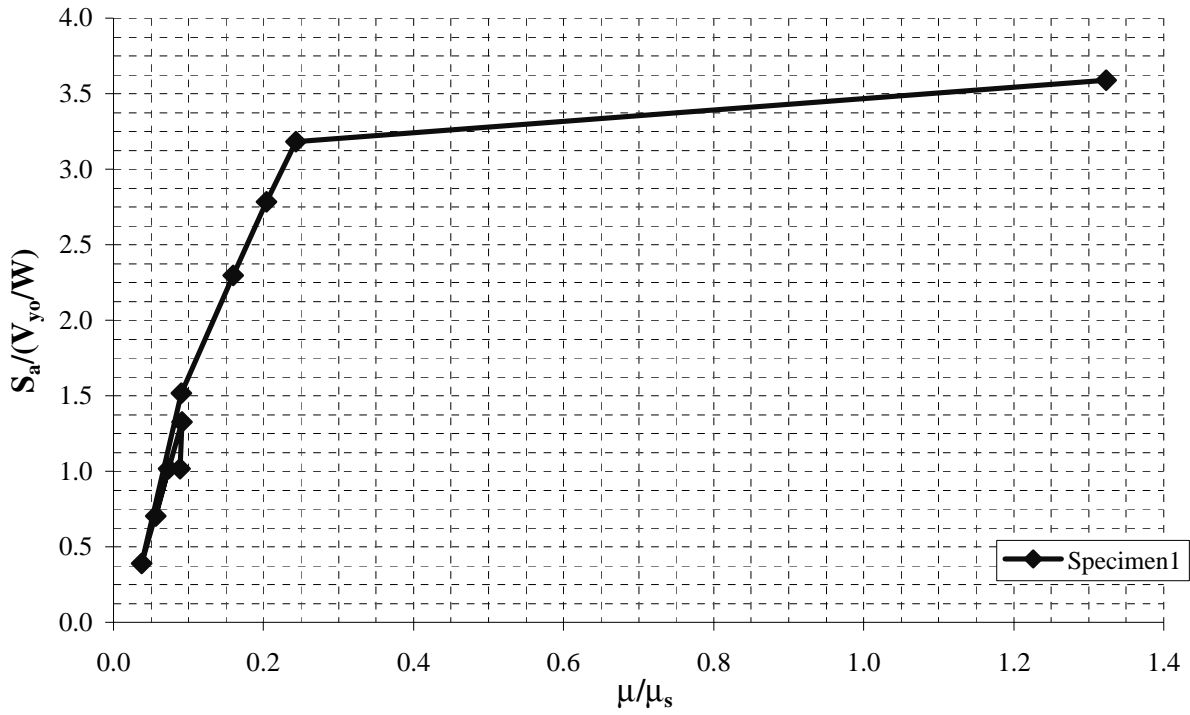


FIGURE C-7 (cont'd) Normalized Spectral Acceleration vs. Residual Displacement

(a) $S_a/(V_{y0}/W)$ vs μ/μ_s ($\theta \leq 0.1$)



(b) $S_a/(V_{y0}/W)$ vs μ/μ_s ($0.1 < \theta \leq 0.3$)

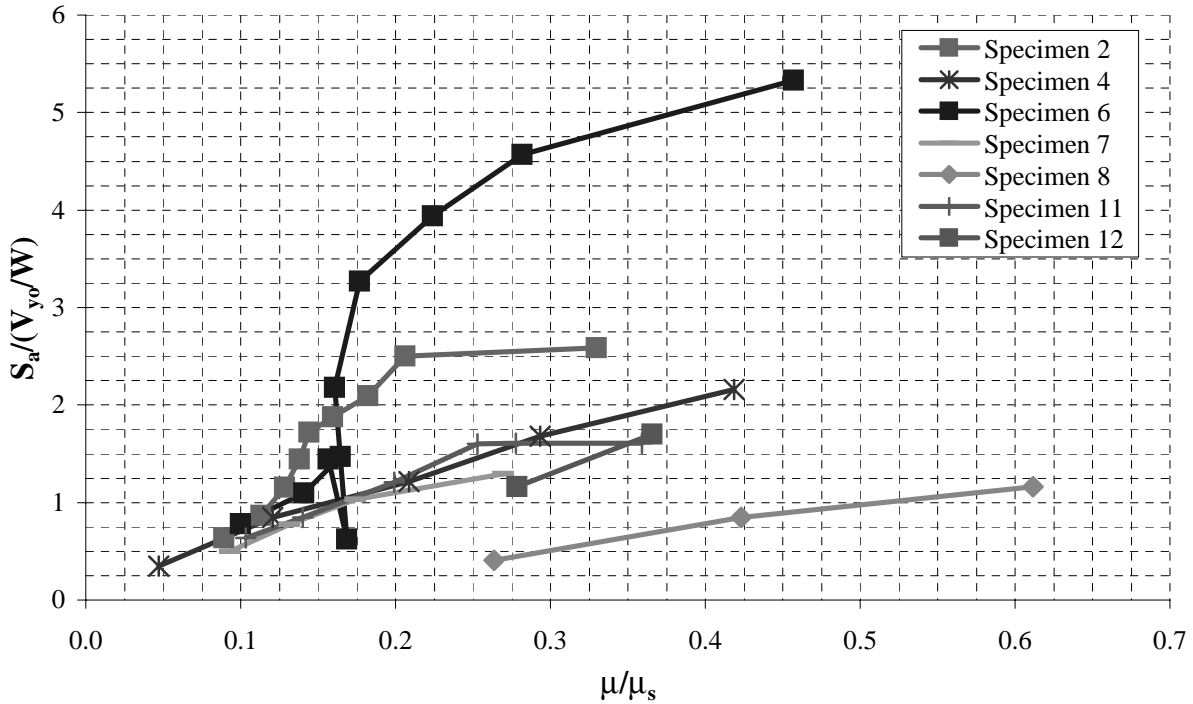


FIGURE C-8 Normalized Spectral Acceleration vs. Normalized Ductility

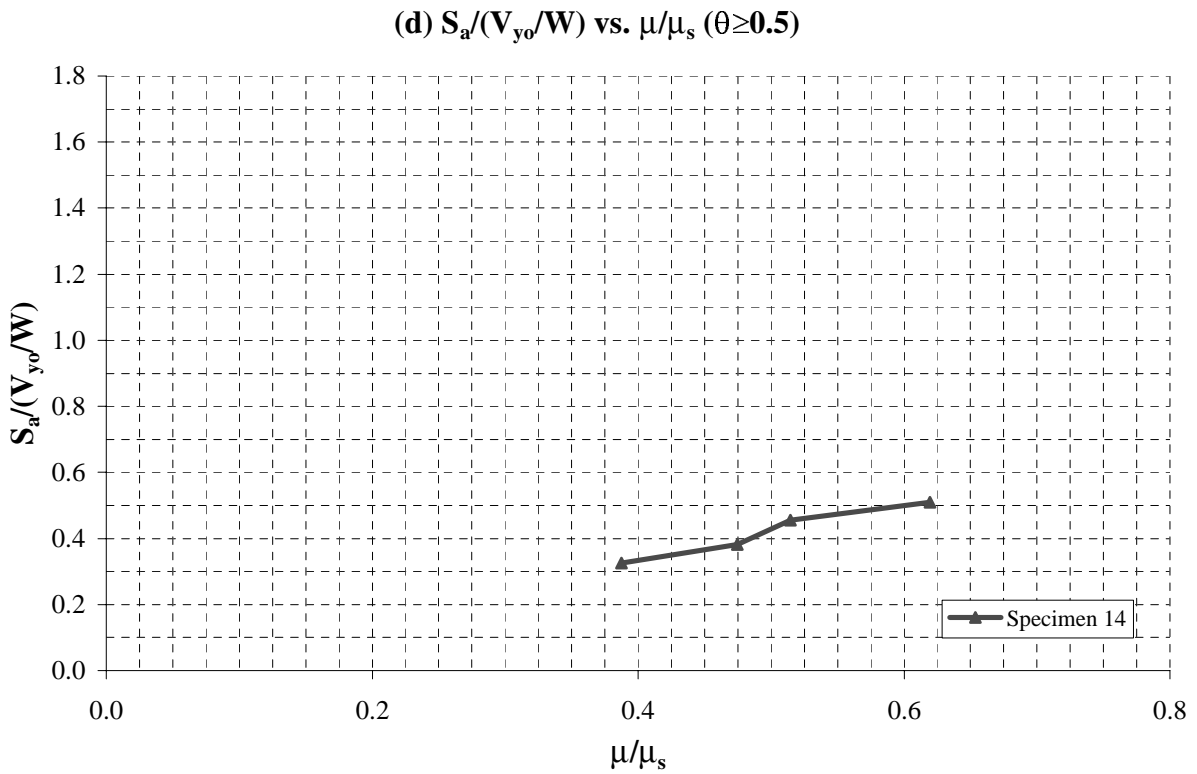
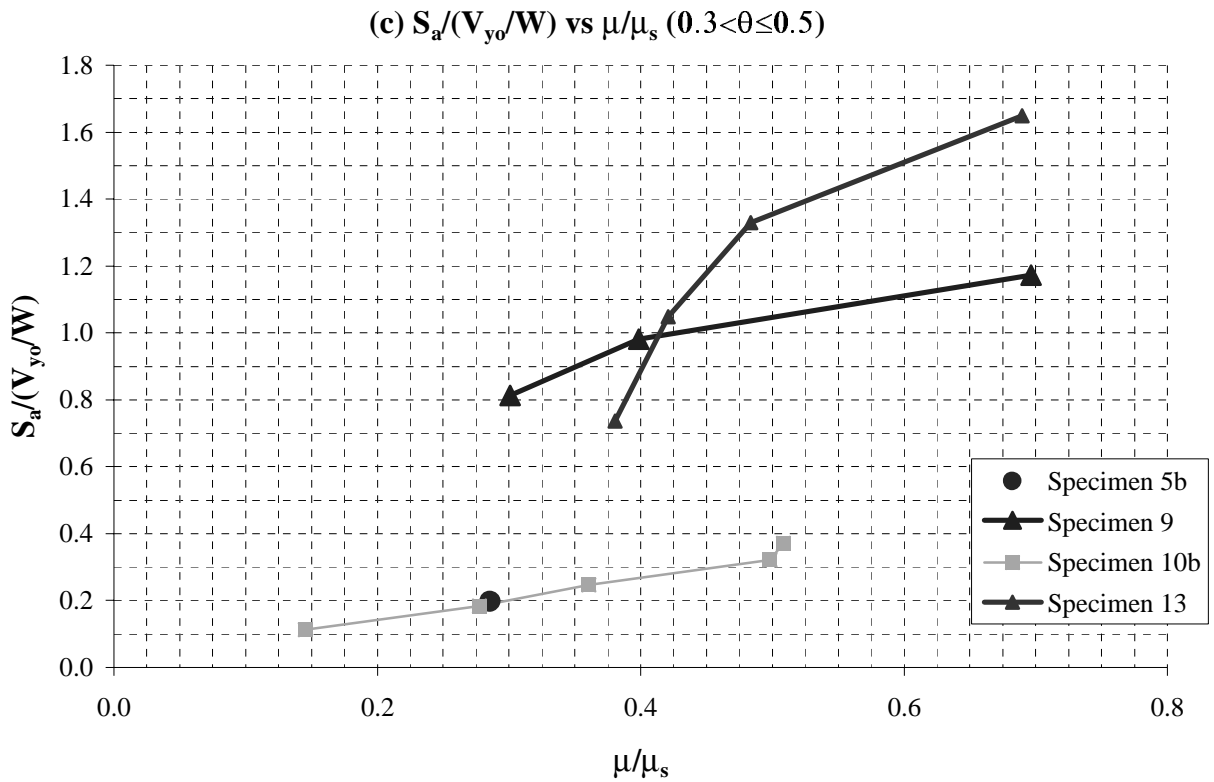


FIGURE C-8 (cont'd) Normalized Spectral Acceleration vs. Normalized Ductility

(e) $S_a/(V_{y0}/W)$ vs. μ/μ_s - all specimens

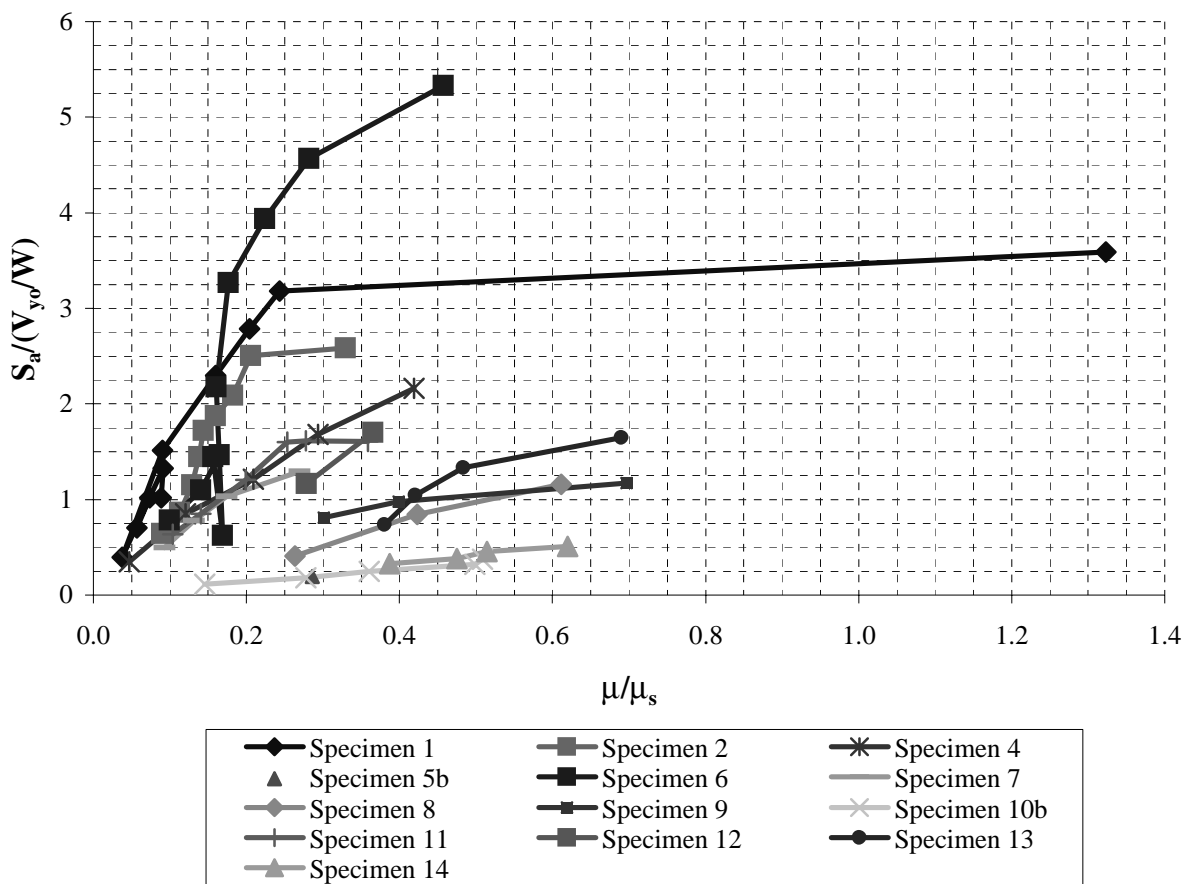


FIGURE C-8 (cont'd) Normalized Spectral Acceleration vs. Normalized Ductility

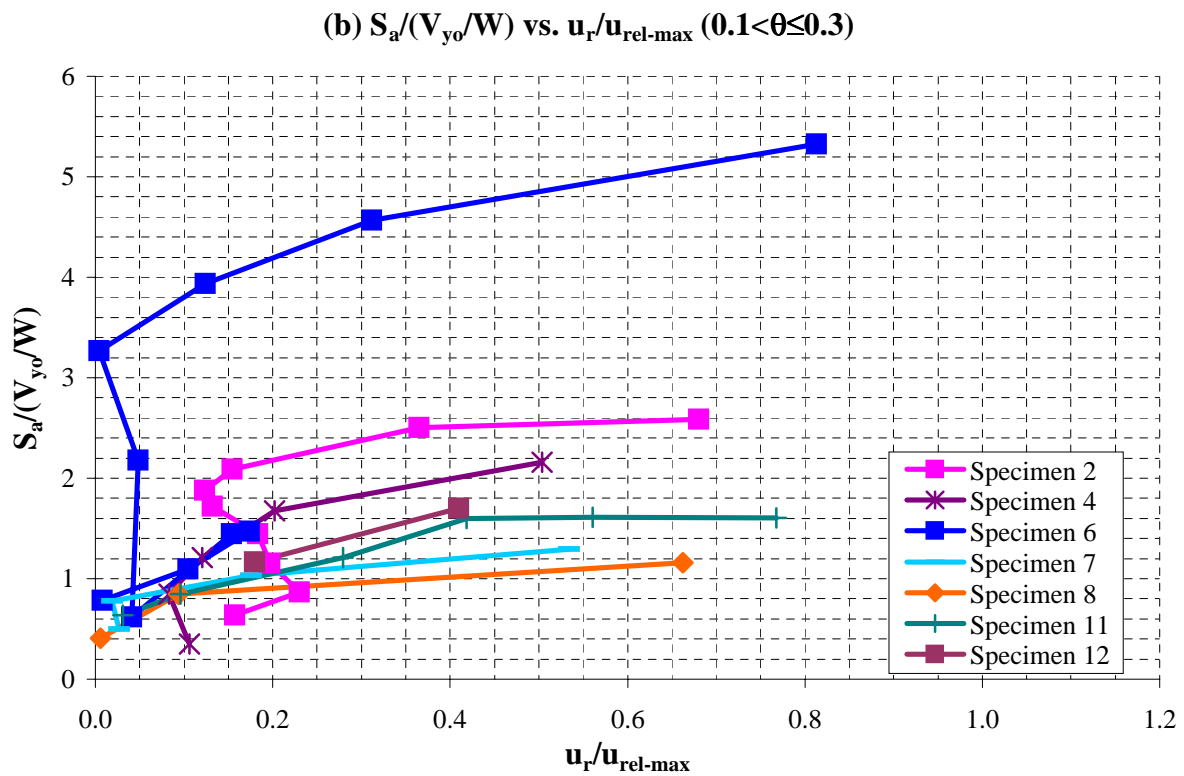
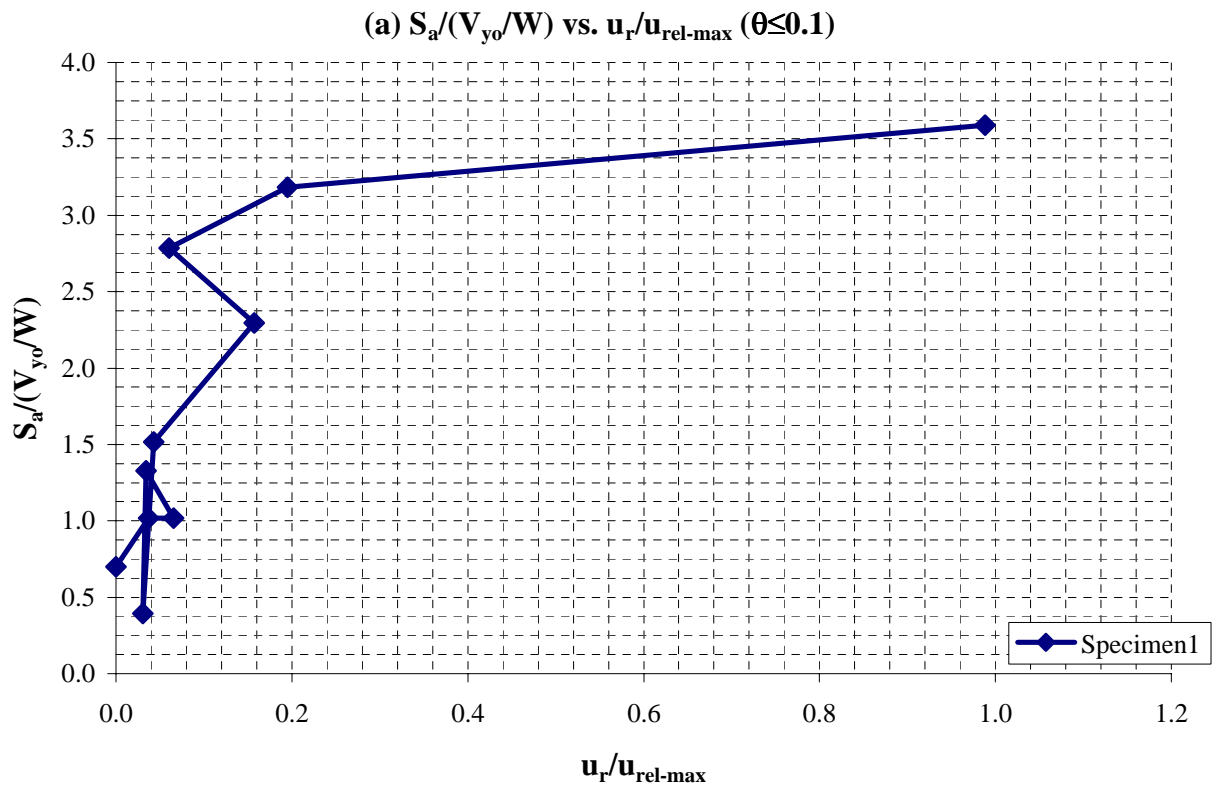
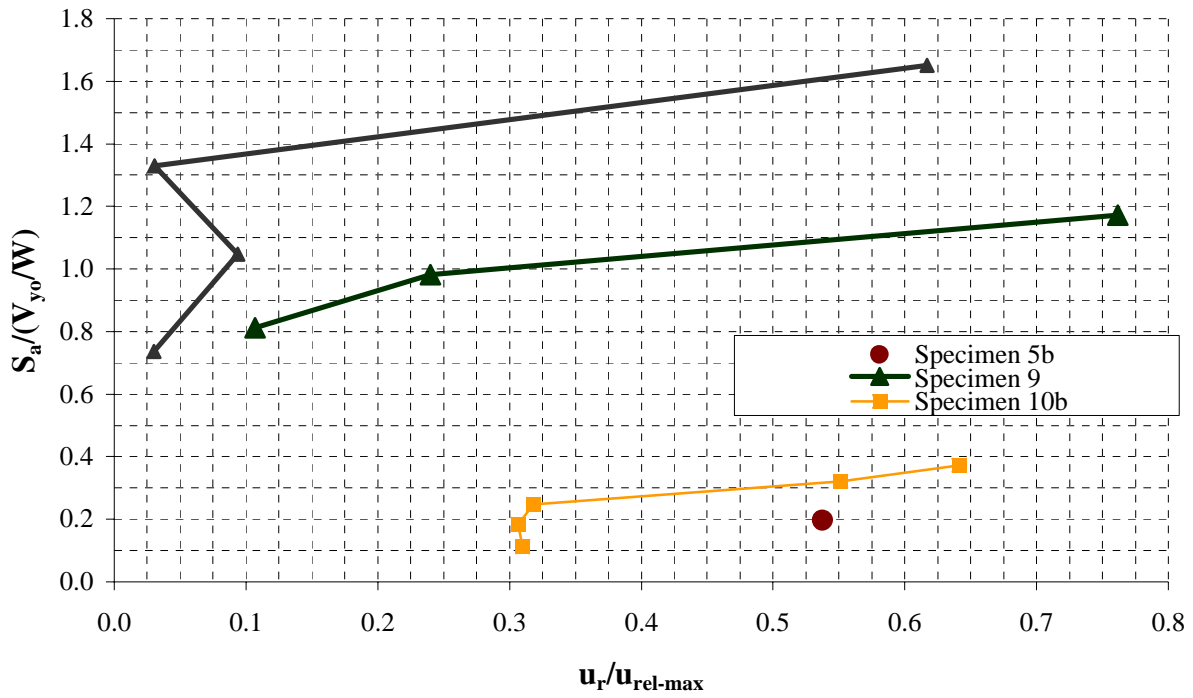


FIGURE C-9 Normalized Spectral Acceleration vs. Displacement Ratio

(c) $S_a/(V_{yo}/W)$ vs. $u_r/u_{rel-max}$ ($0.3 < \theta \leq 0.5$)



(d) V^*/V_{yo} vs. $u_r/u_{rel-max}$ ($\theta \geq 0.5$)

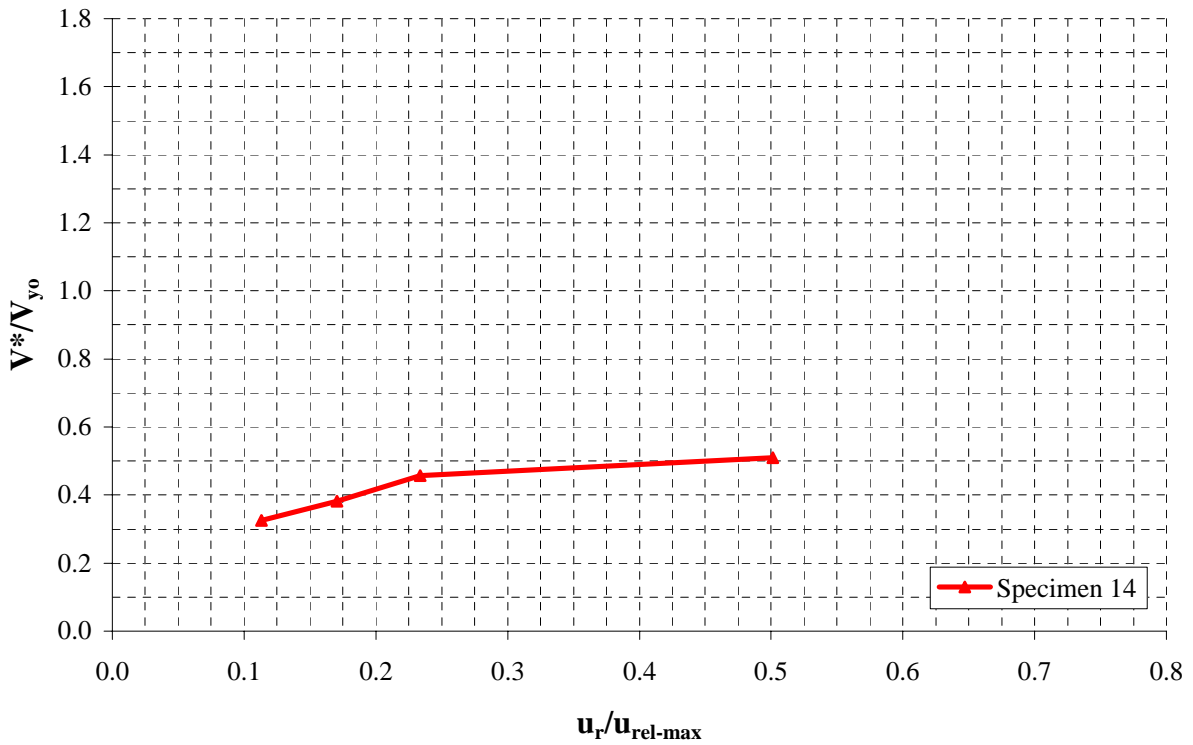


FIGURE C-9 (cont'd) Normalized Spectral Acceleration vs. Displacement Ratio

(e) $S_a/(V_{y0}/W)$ vs. $u_r/u_{rel-max}$ - all specimens

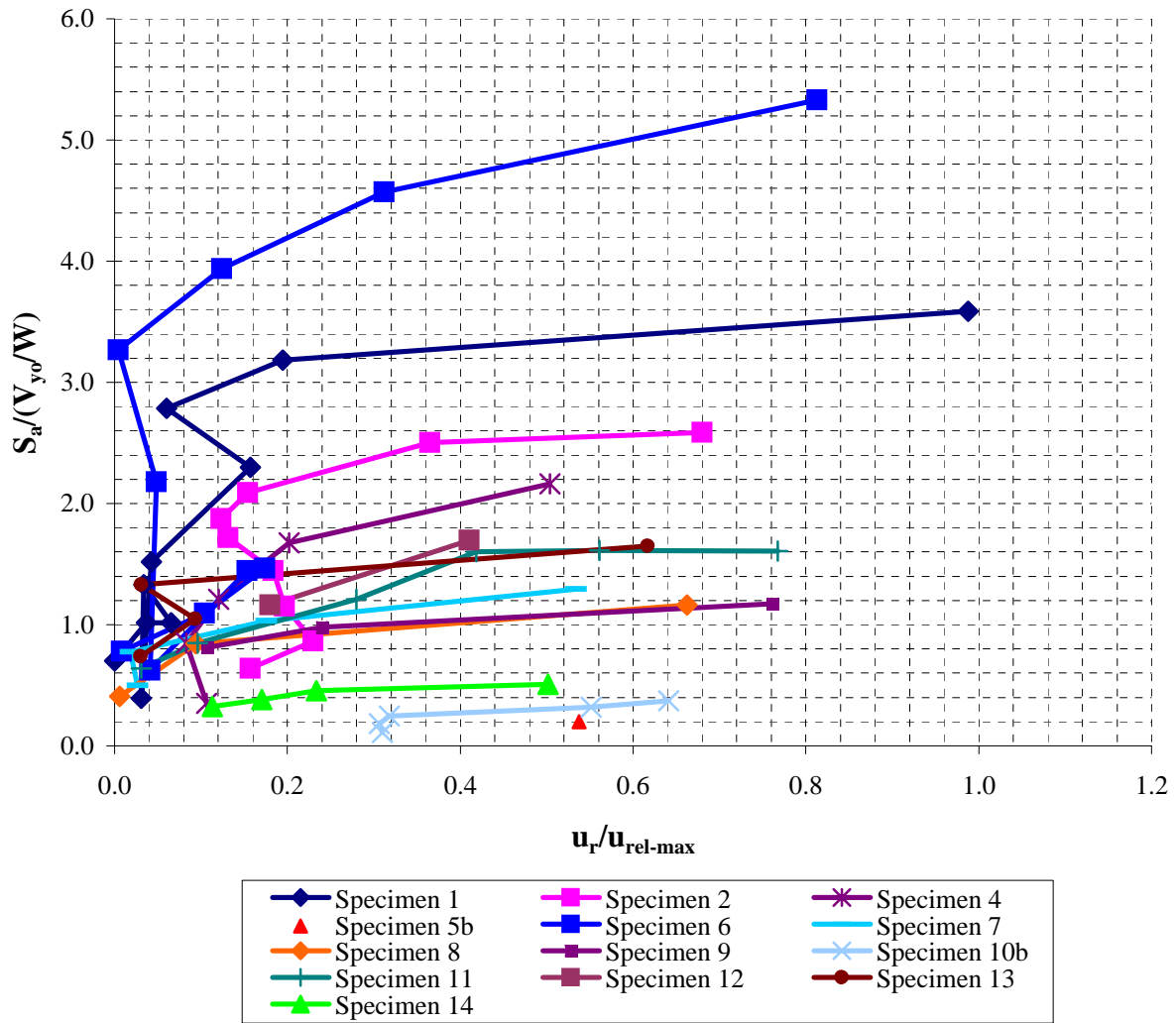
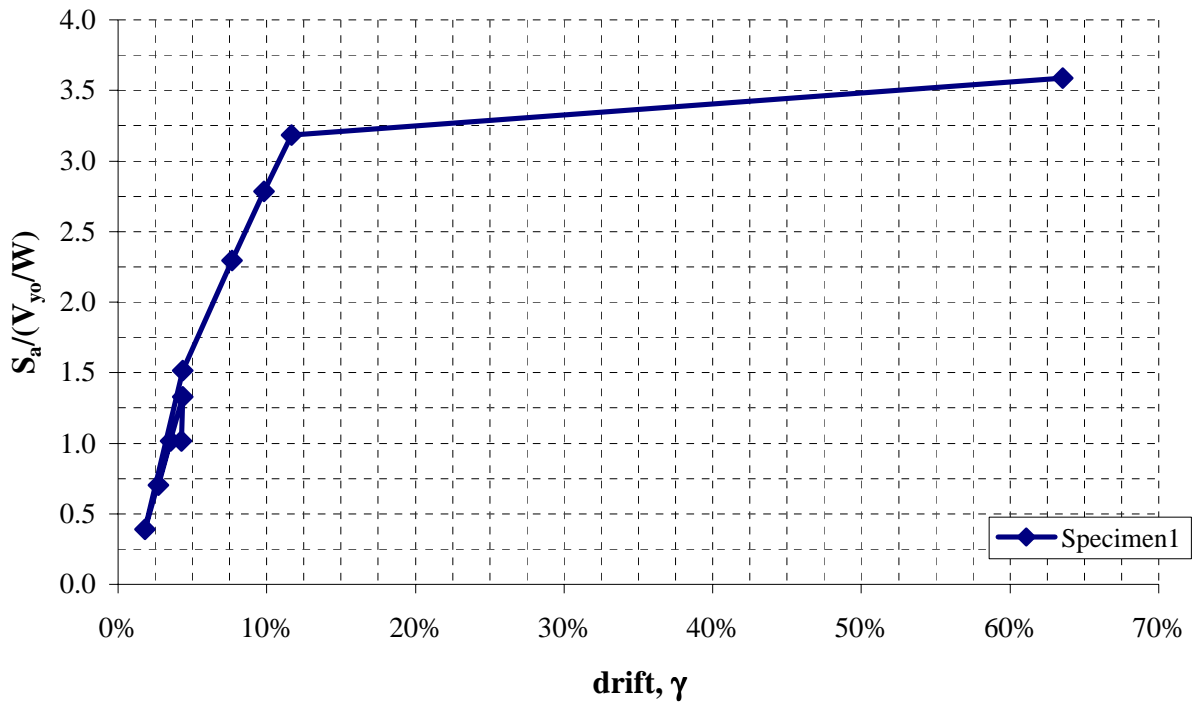


FIGURE C-9 (cont'd) Normalized Spectral Acceleration vs. Displacement Ratio

(a) $S_a/(V_{yo}/W)$ vs. drift ($\theta \leq 0.1$)



(b) $S_a/(V_{yo}/W)$ vs. drift ($0.1 < \theta \leq 0.3$)

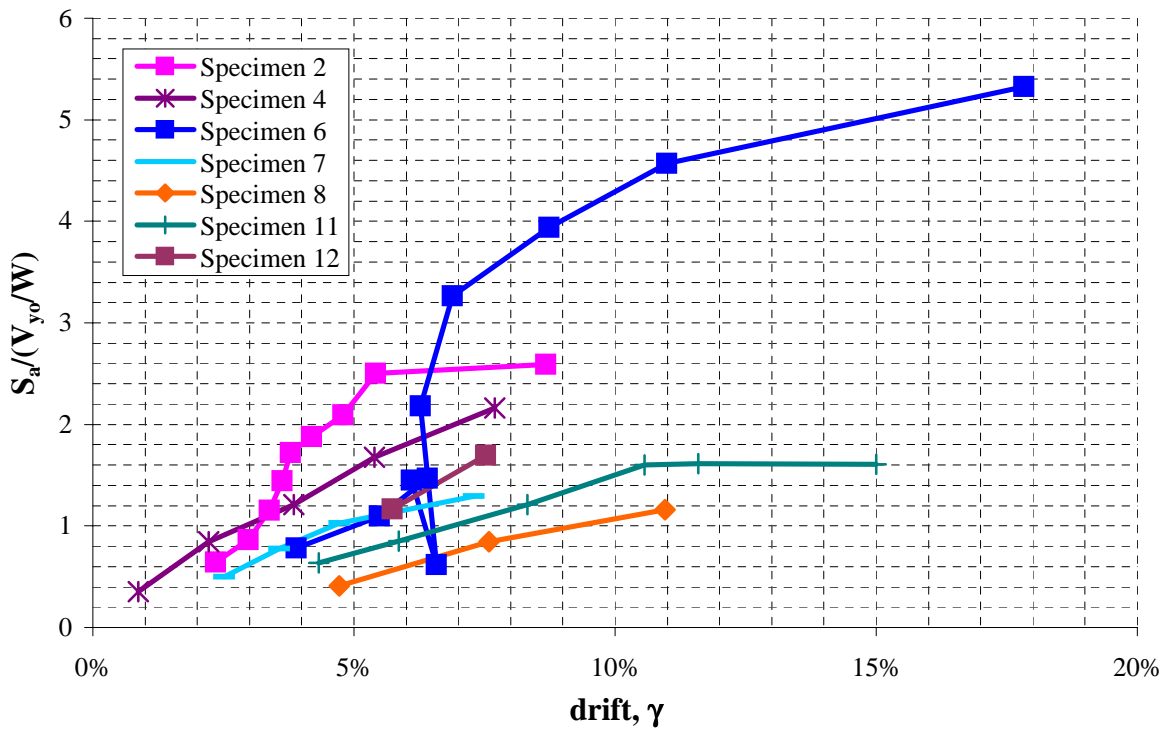
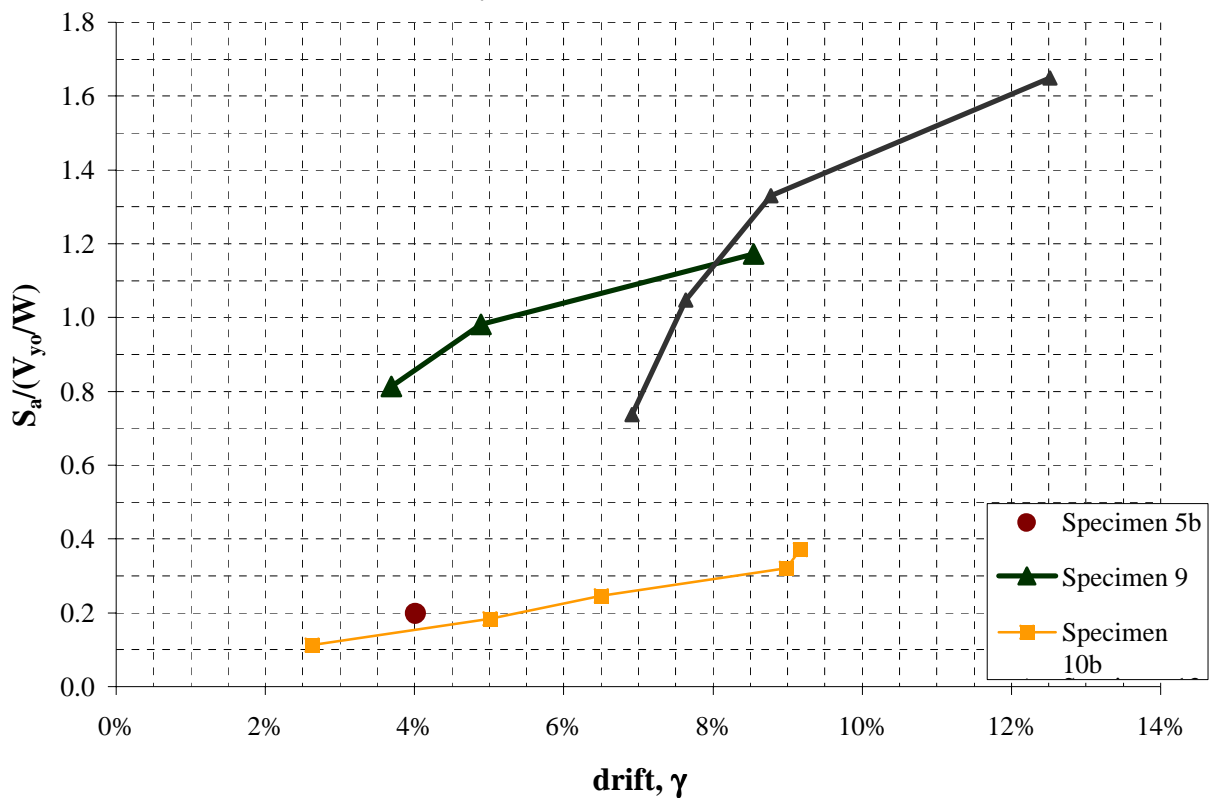


FIGURE C-10 Normalized Spectral Acceleration vs. Drift

(c) $S_a/(V_{yo}/W)$ vs. drift ($0.3 < \theta \leq 0.5$)



(d) $S_a/(V_{yo}/W)$ vs. drift ($\theta \geq 0.5$)

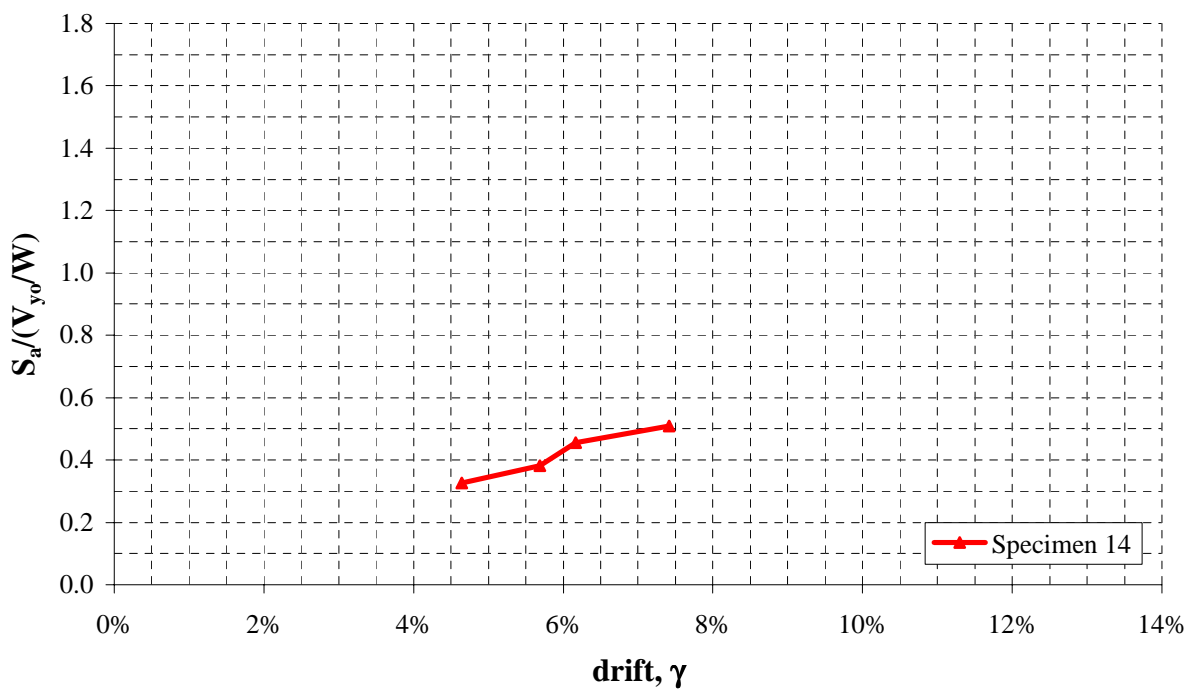
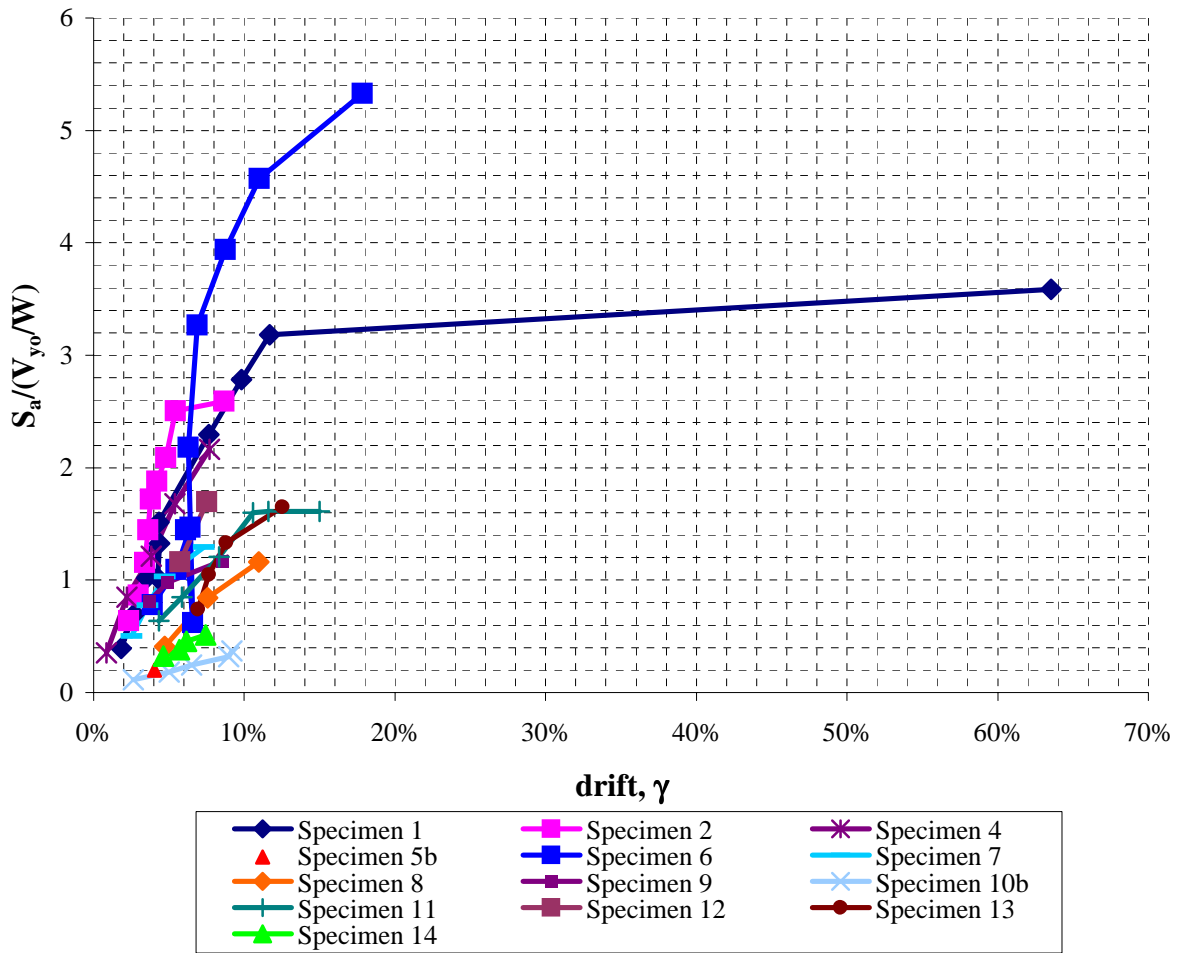
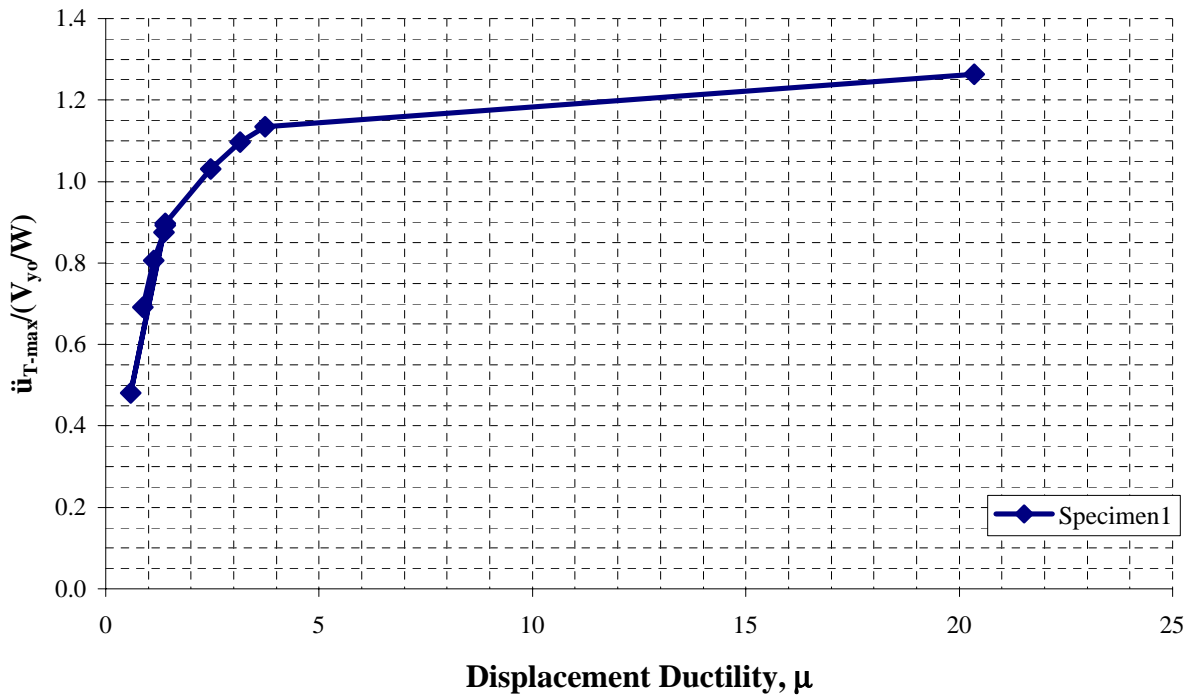


FIGURE C-10 (cont'd) Normalized Spectral Acceleration vs. Drift

(e) $S_a/(V_{yo}/W)$ vs. drift - all specimens



(a) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs μ ($\theta \leq 0.1$)



(b) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs μ ($0.1 < \theta \leq 0.3$)

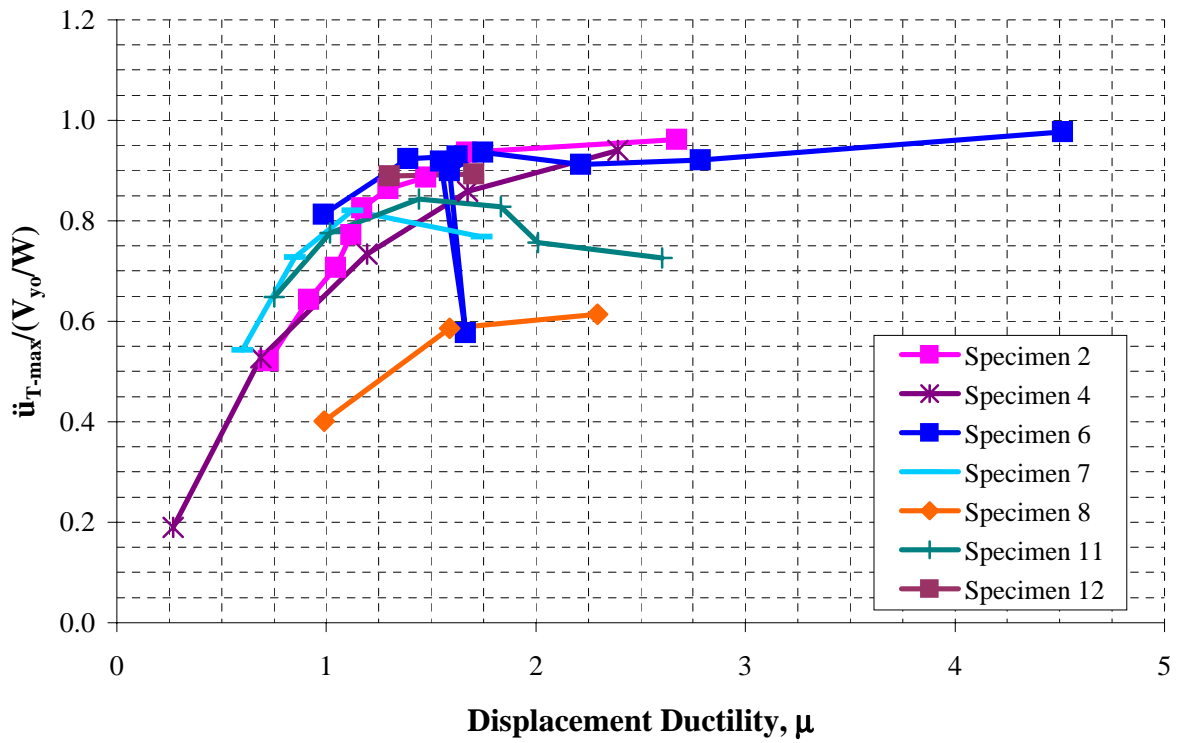
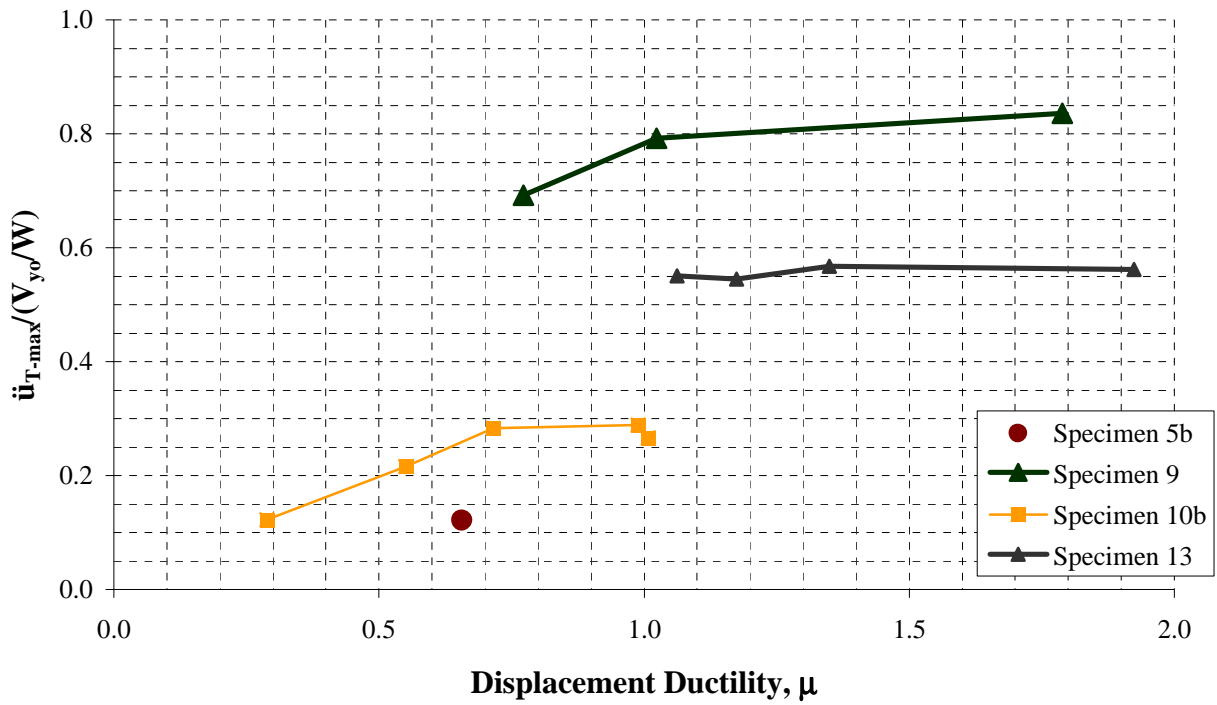


FIGURE C-11 Normalized Absolute Acceleration vs. Displacement Ductility

(c) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs μ ($0.3 < \theta \leq 0.5$)



(d) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs μ ($\theta \geq 0.5$)

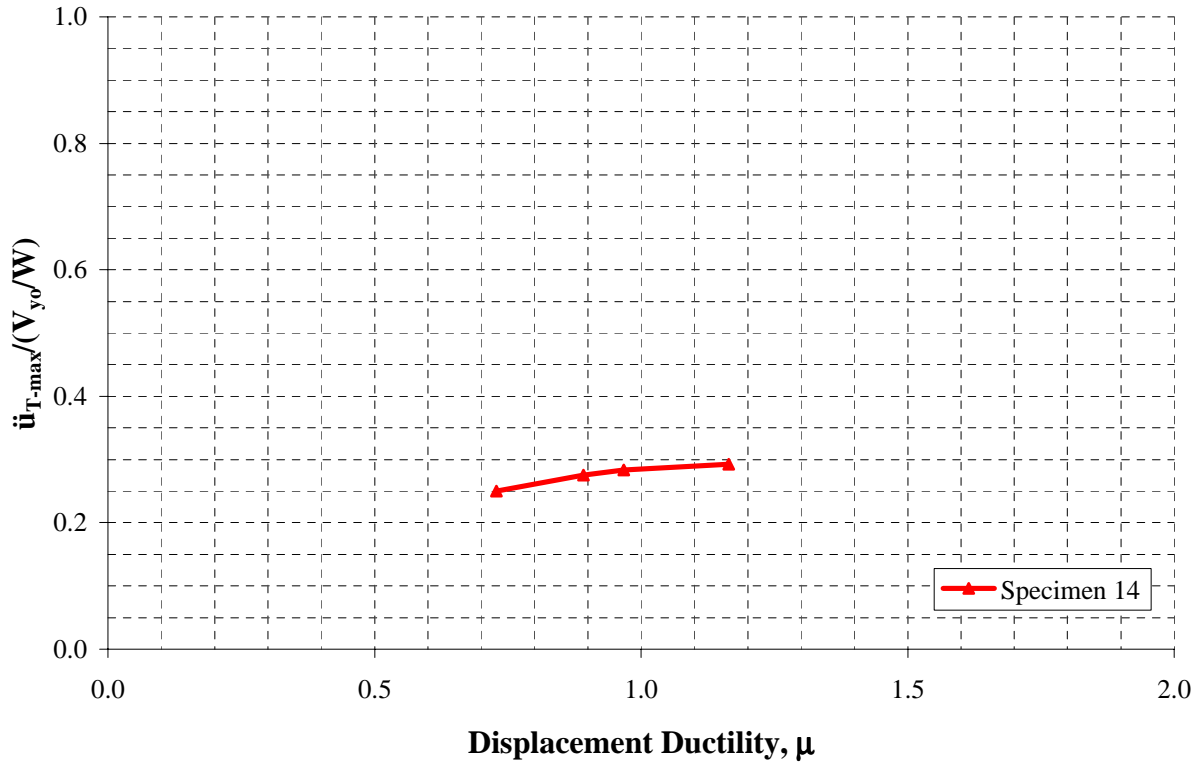


FIGURE C-11 (cont'd) Normalized Absolute Acceleration vs. Displacement Ductility

(e) $\ddot{u}_{r-max}/(V_{yo}/W)$ vs. μ - all specimens

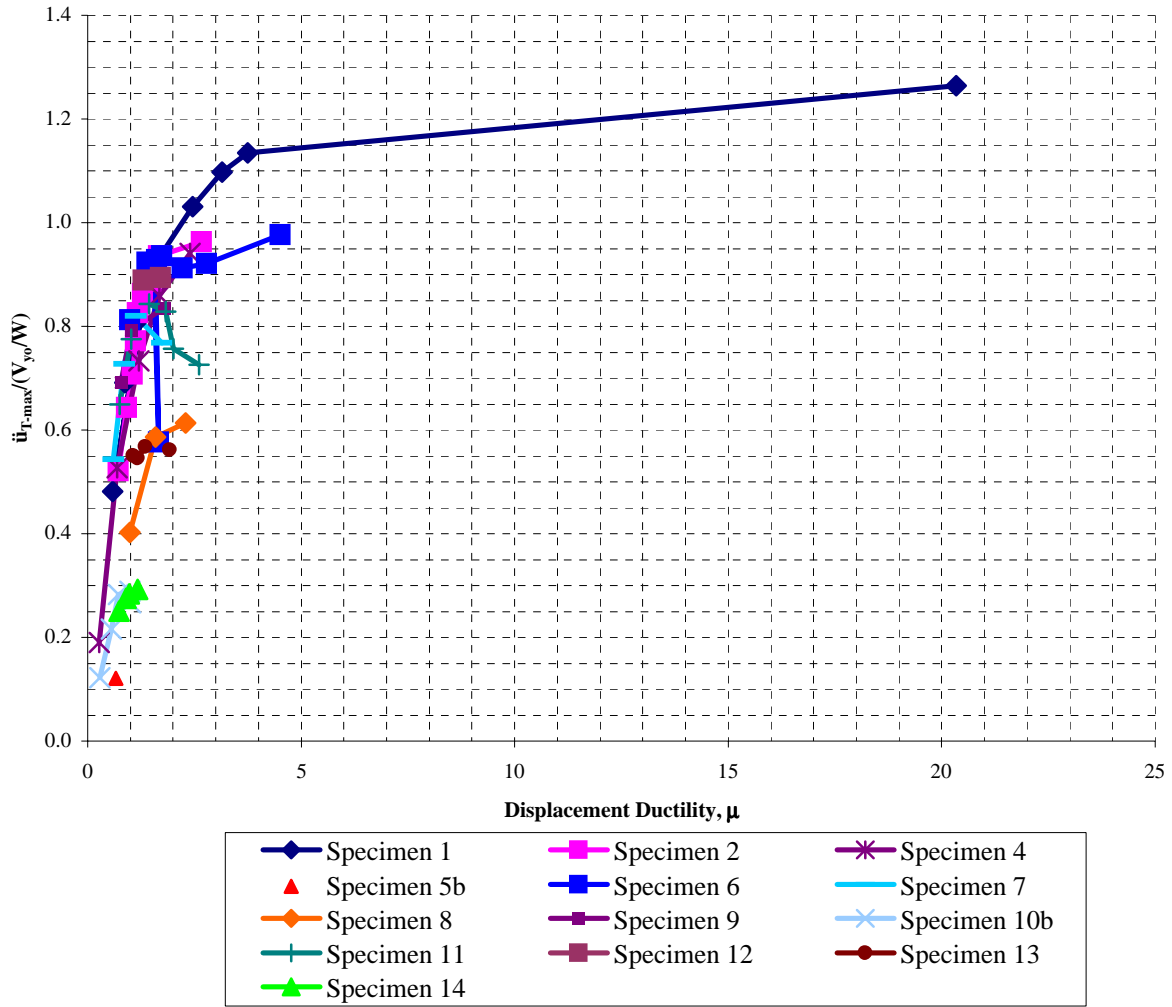
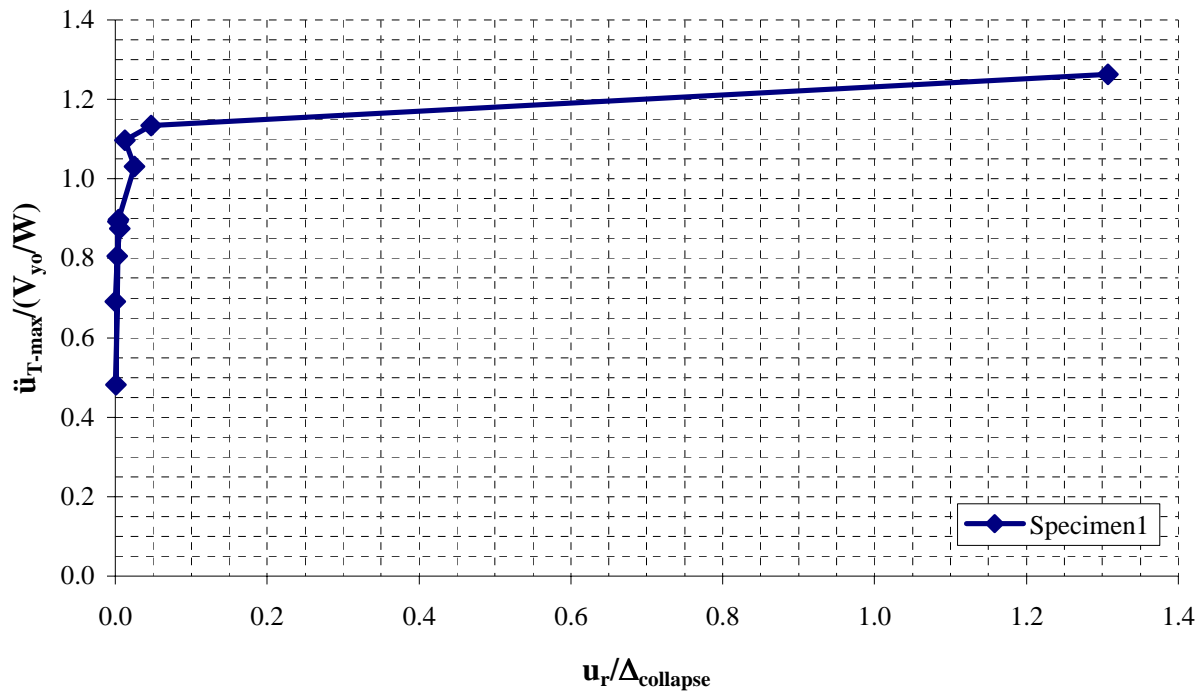


FIGURE C-11 (cont'd) Normalized Absolute Acceleration vs. Displacement Ductility

(a) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs $u_r/\Delta_{collapse}$ ($\theta \leq 0.1$)



(b) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs $u_r/\Delta_{collapse}$ ($0.1 < \theta \leq 0.3$)

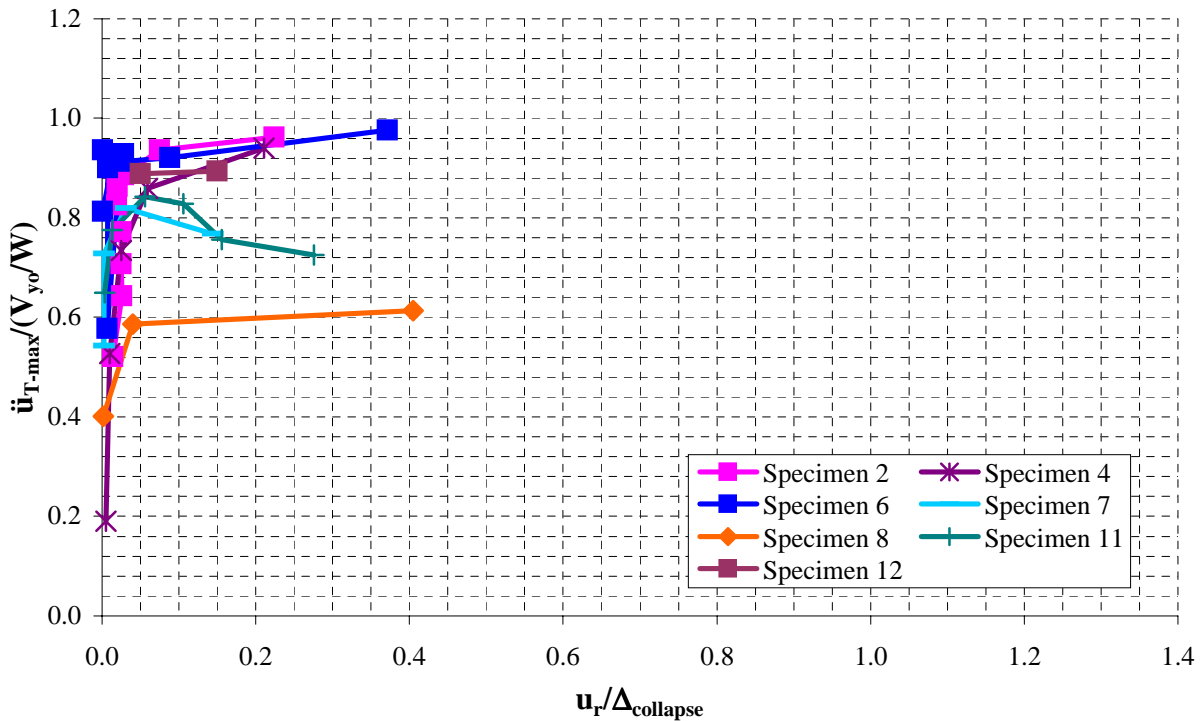
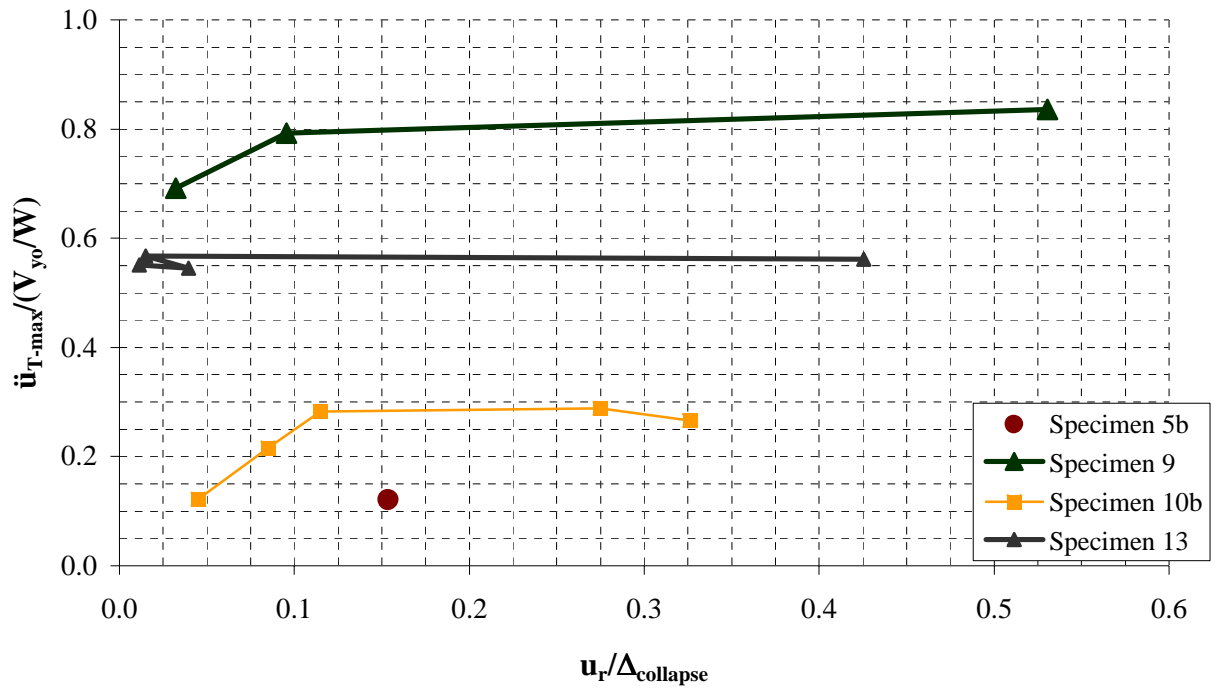


FIGURE C-12 Normalized Absolute Acceleration vs. Normalized Residual Displacement

(c) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs $u_r/\Delta_{collapse}$ ($0.3 < \theta \leq 0.5$)



(d) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs $u_r/\Delta_{collapse}$ ($\theta \geq 0.5$)

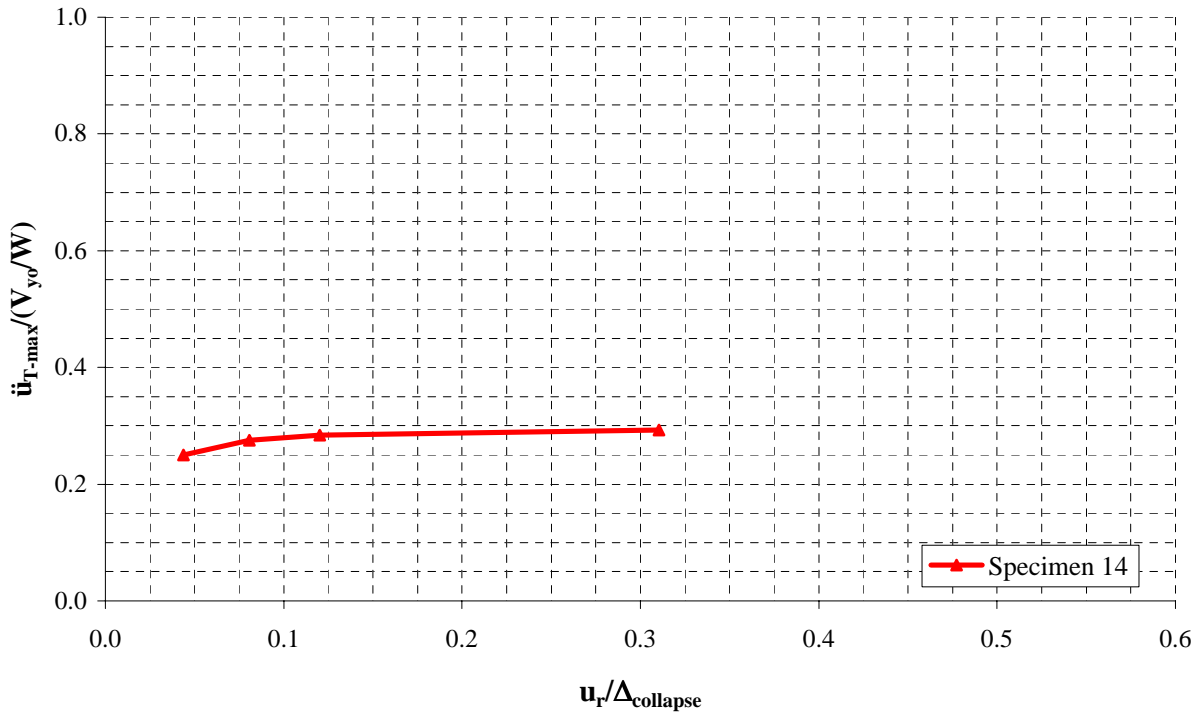


FIGURE C-12 (cont'd) Normalized Absolute Acceleration vs. Normalized Residual Displacement

(e) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs. $u_r/\Delta_{collapse}$ - all specimens

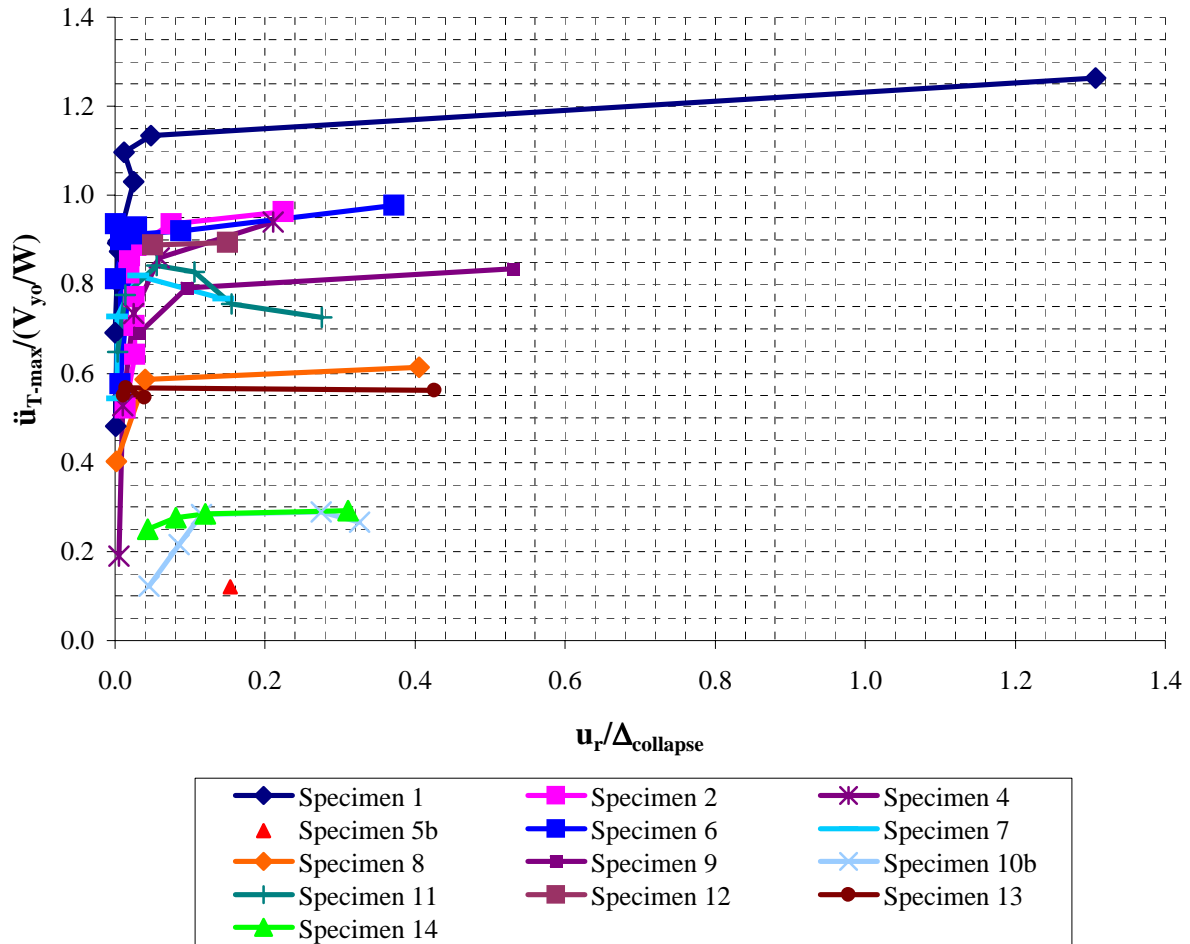
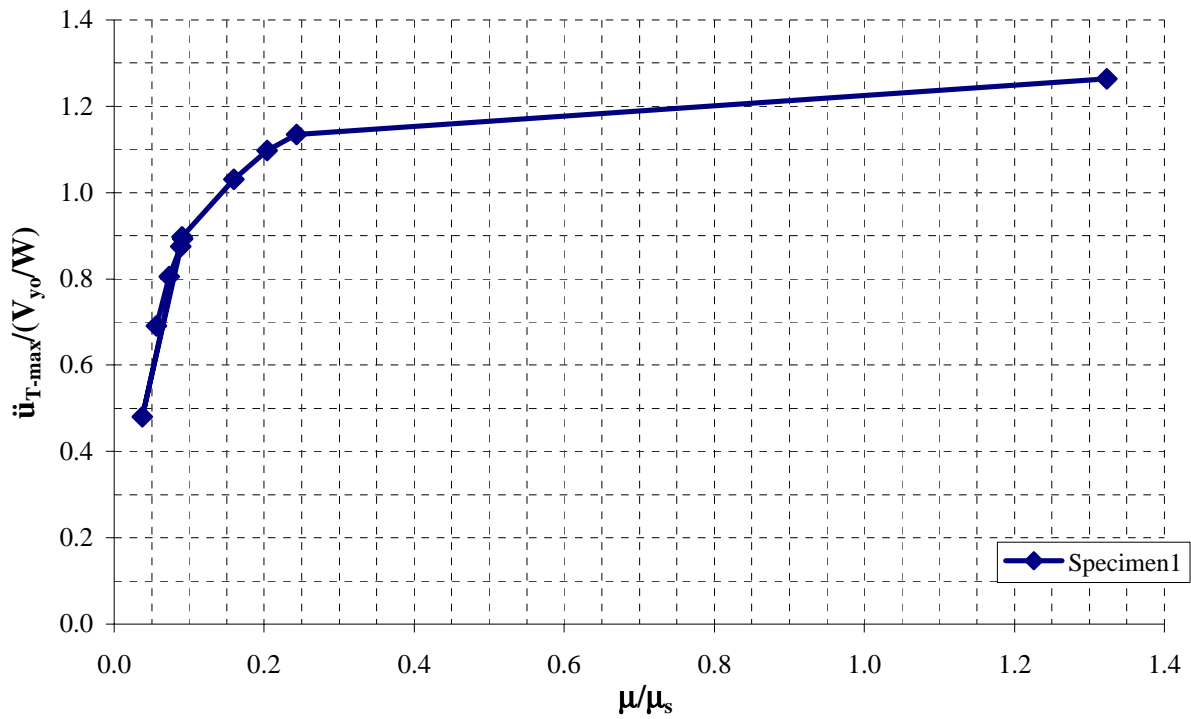


FIGURE C-12 (cont'd) Normalized Absolute Acceleration vs. Normalized Residual Displacement

(a) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs μ/μ_s ($\theta \leq 0.1$)



(b) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs μ/μ_s ($0.1 < \theta \leq 0.3$)

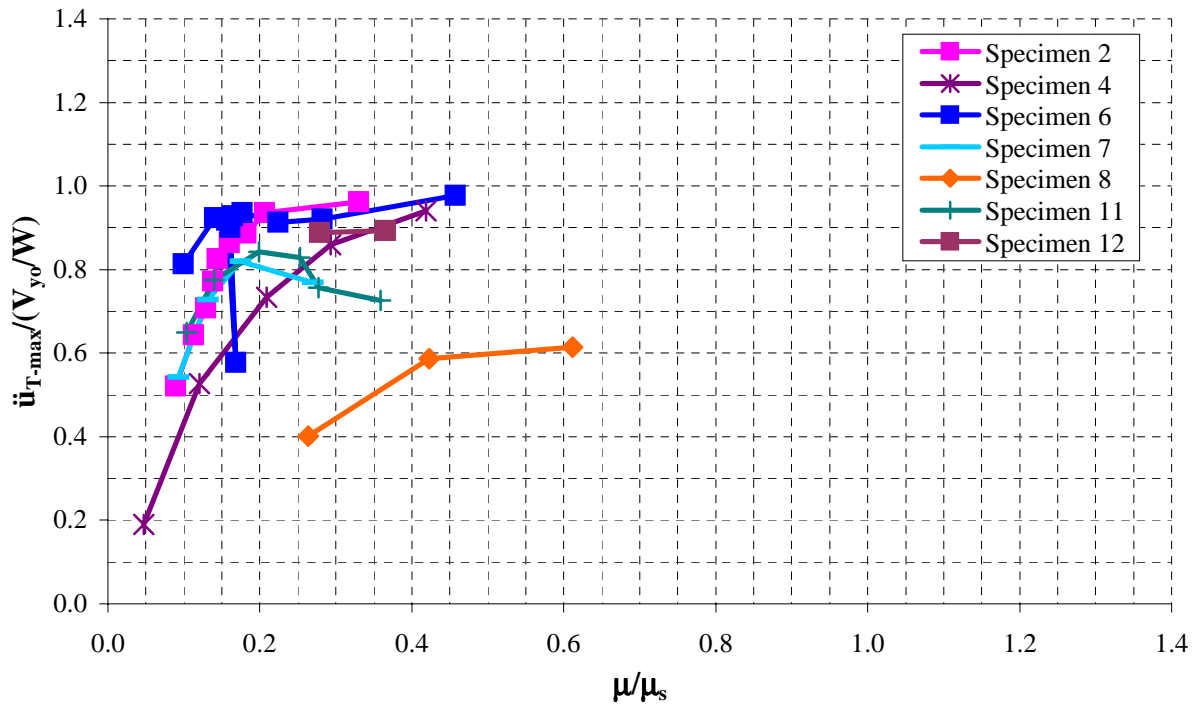


FIGURE C-13 Normalized Absolute Acceleration vs. Normalized Ductility

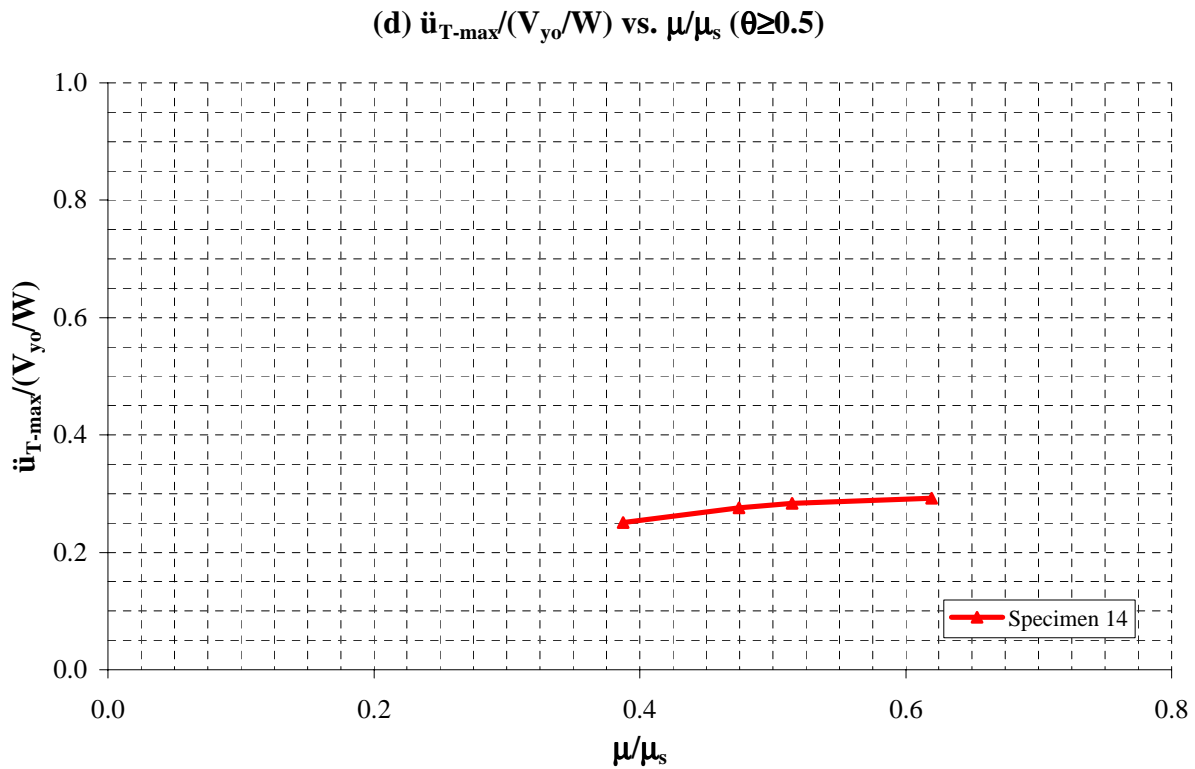
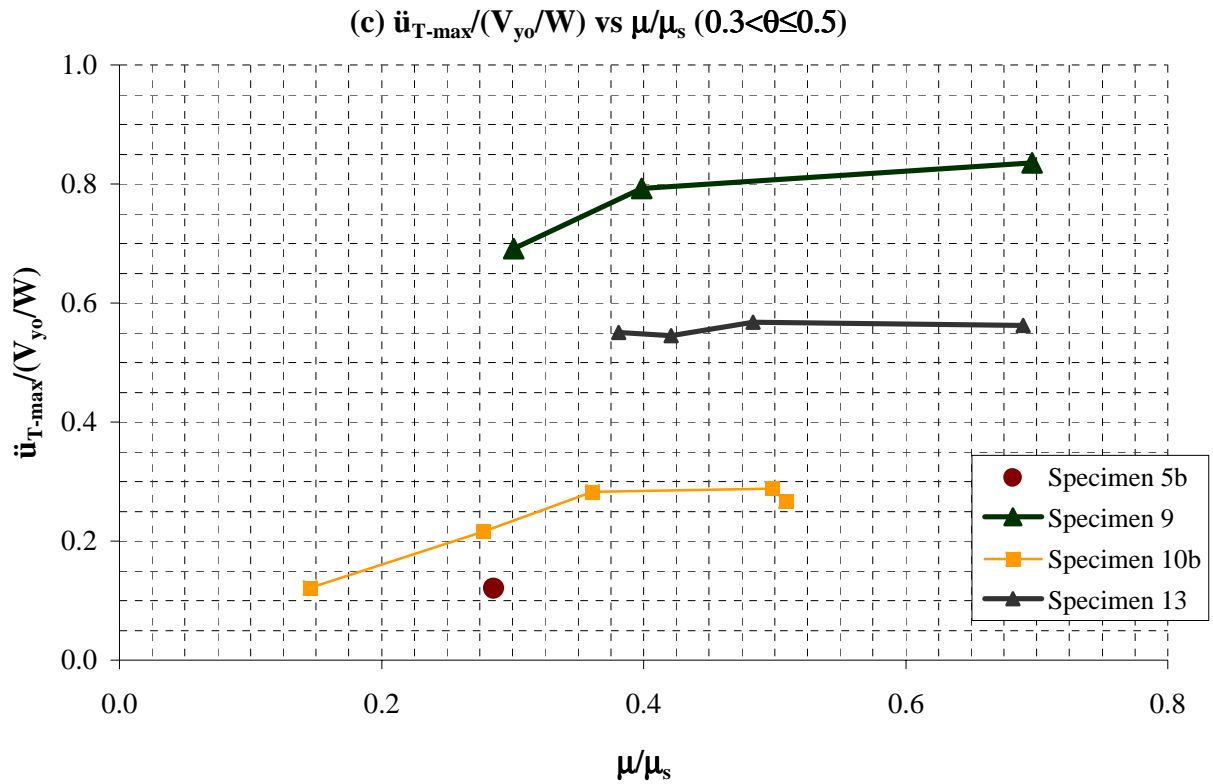
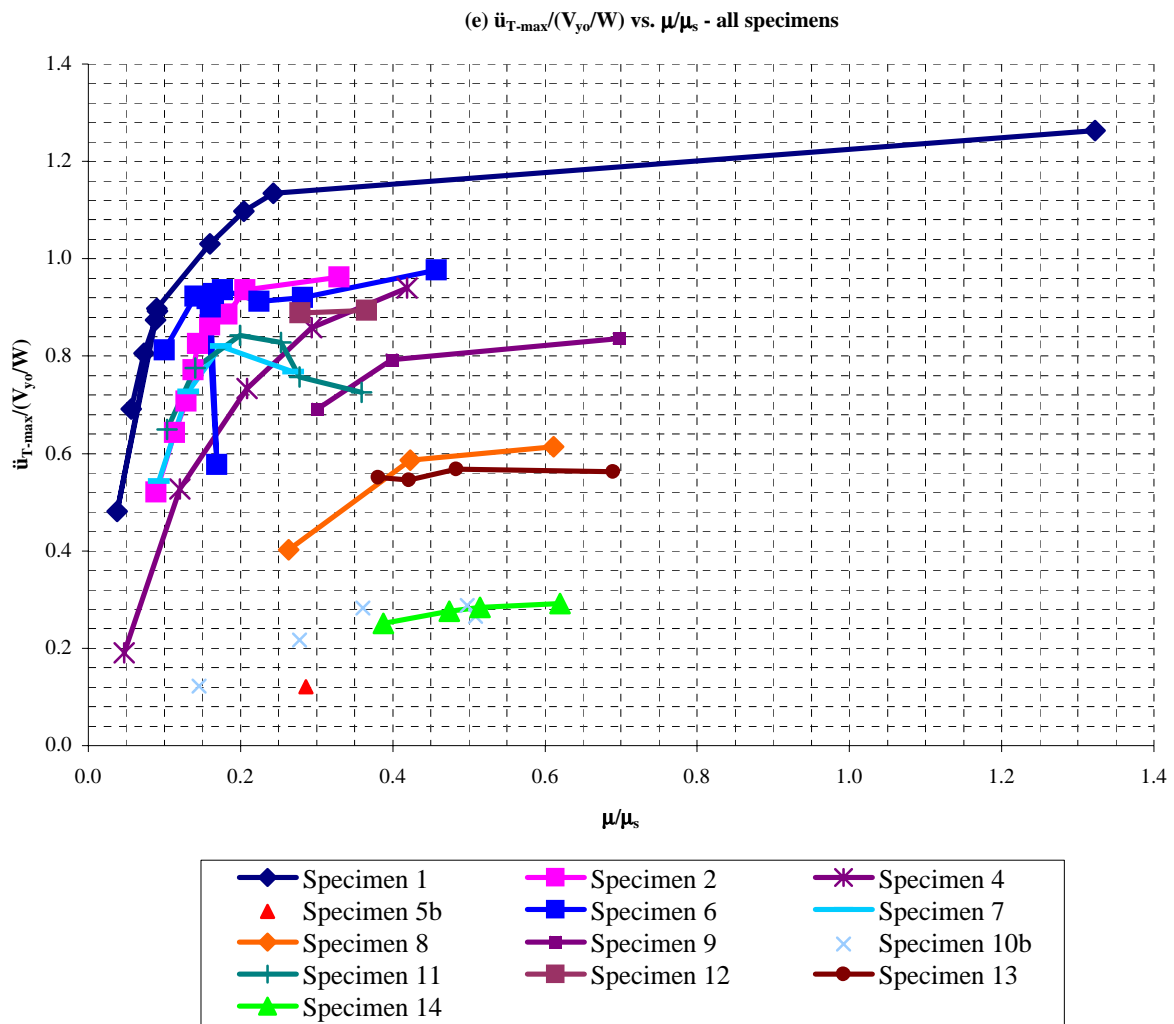


FIGURE C-13 (cont'd) Normalized Absolute Acceleration vs. Normalized Ductility



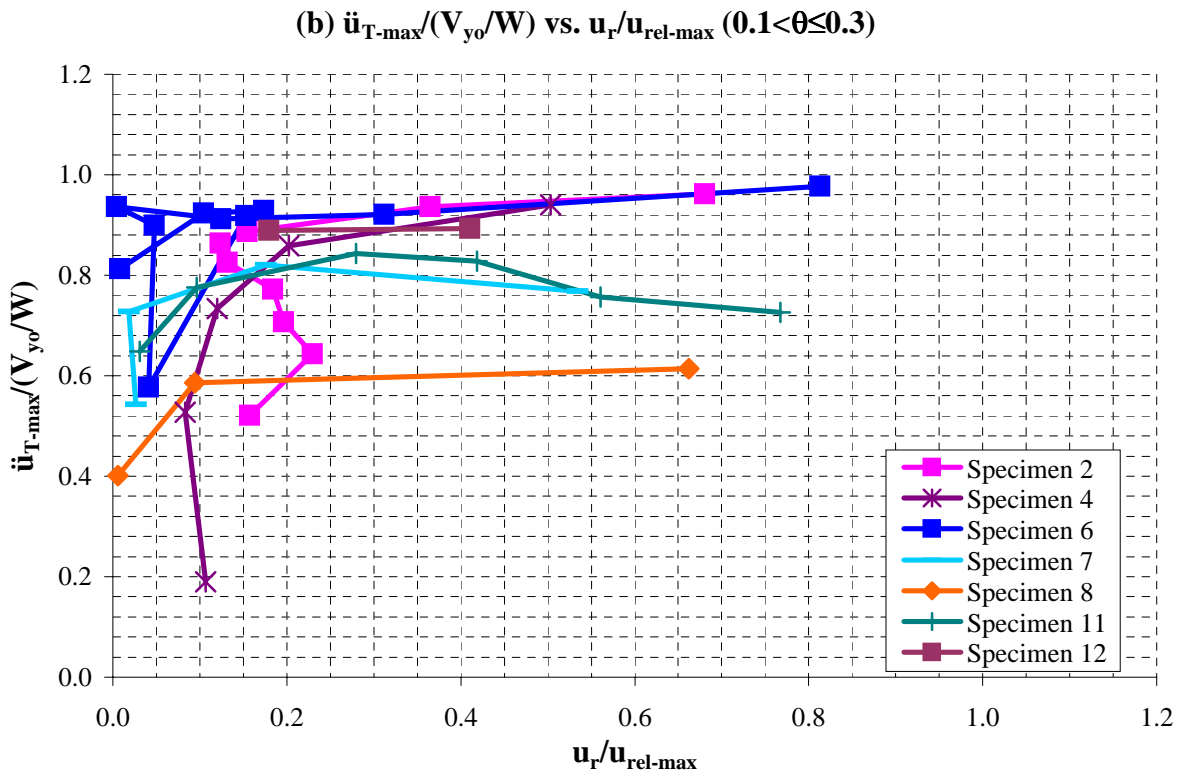
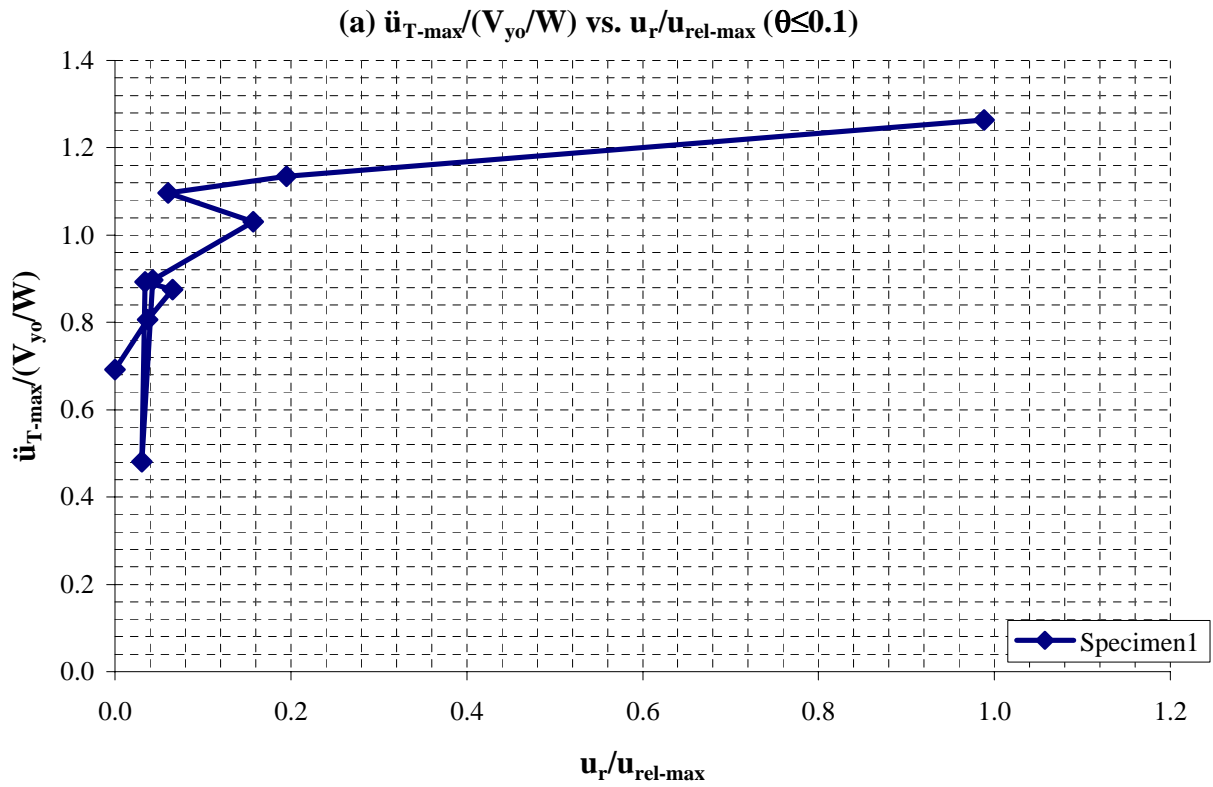
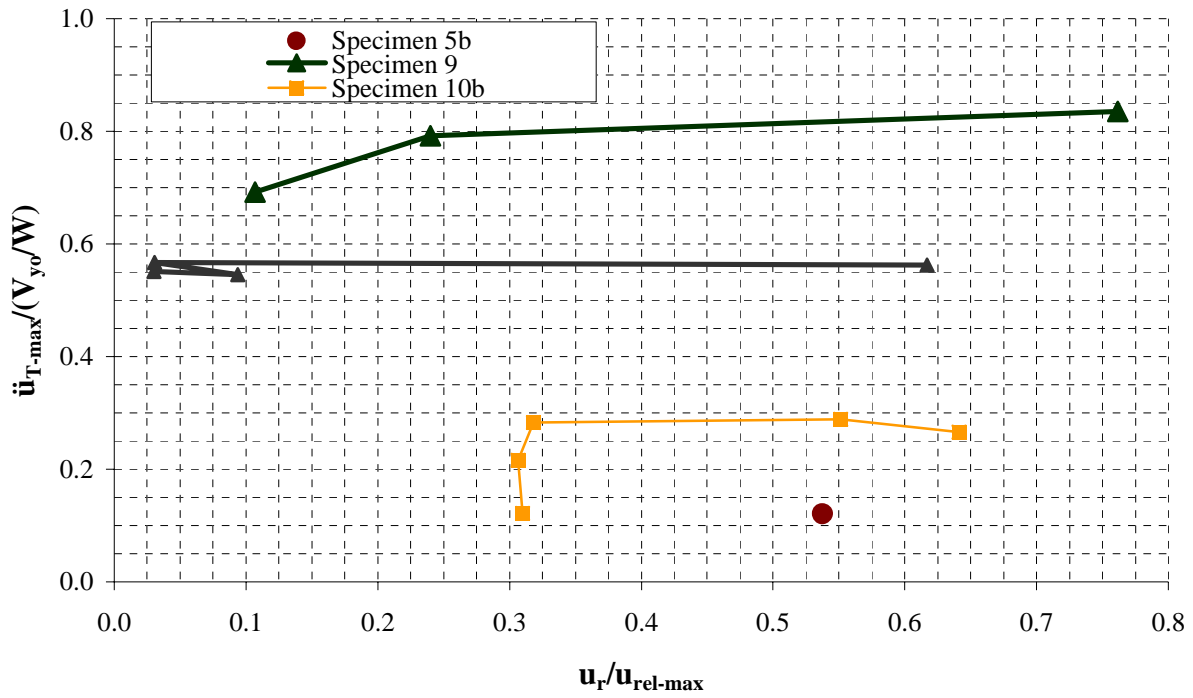


FIGURE C-14 Normalized Absolute Acceleration vs. Displacement Ratio

(c) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs. $u_r/u_{rel-max}$ ($0.3 < \theta \leq 0.5$)



(d) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs. $u_r/u_{rel-max}$ ($\theta \geq 0.5$)

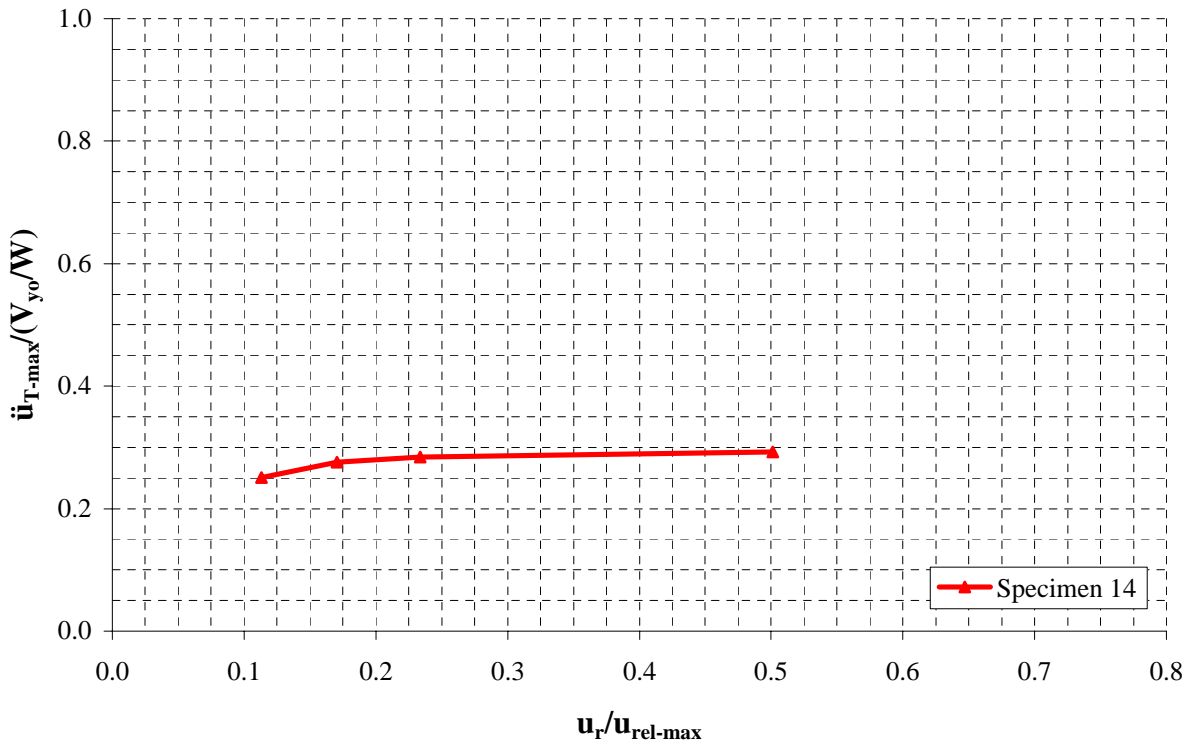


FIGURE C-14 (cont'd) Normalized Absolute Acceleration vs. Displacement Ratio

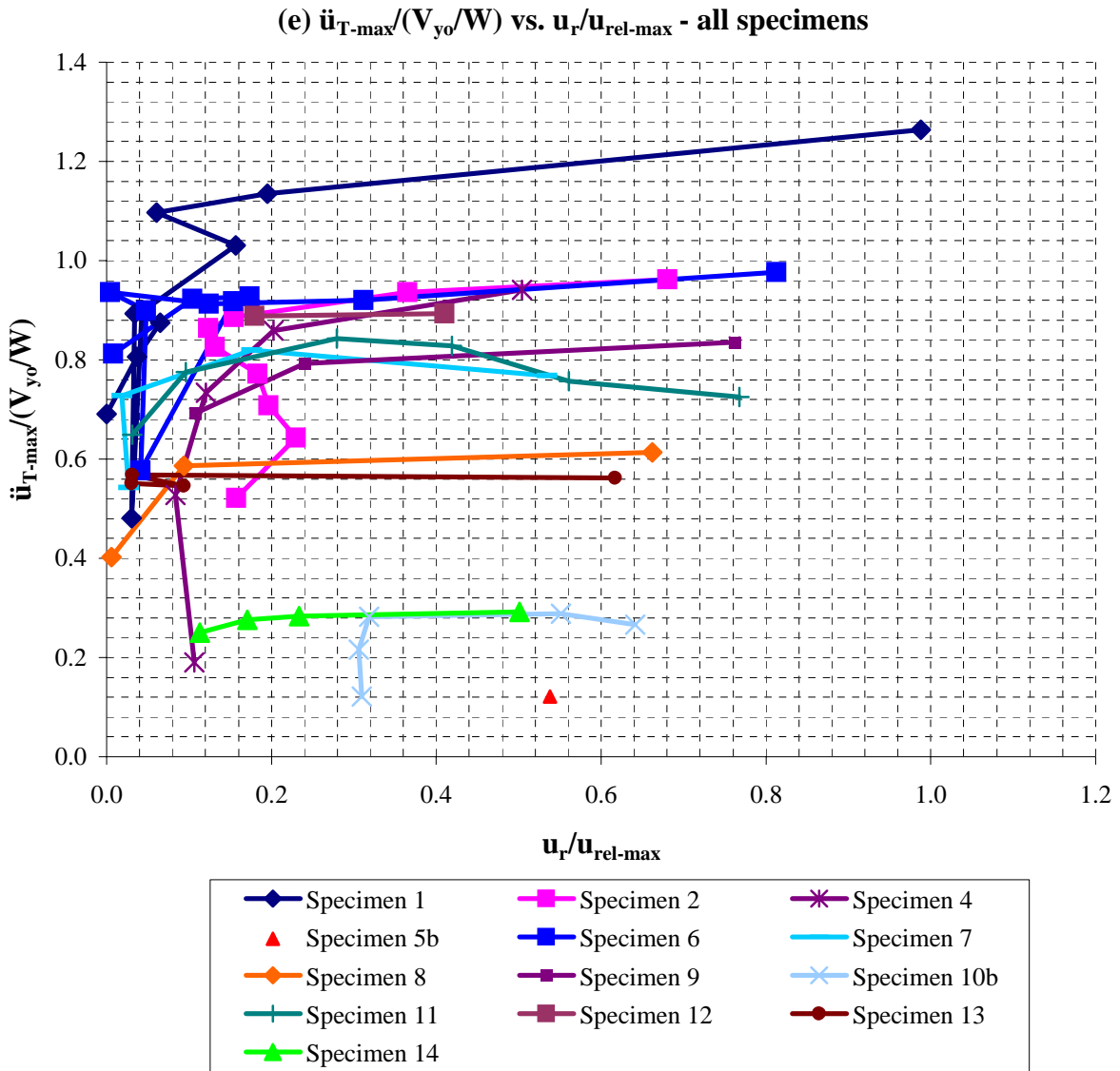
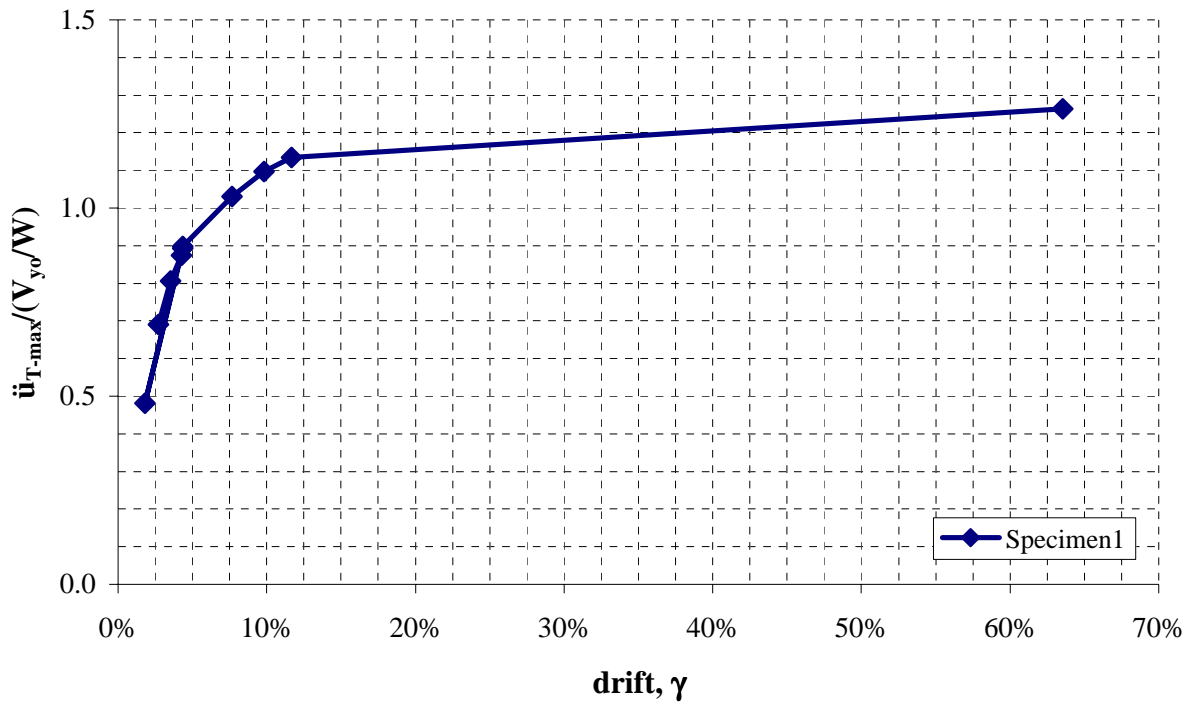


FIGURE C-14 (cont'd) Normalized Absolute Acceleration vs. Displacement Ratio

(a) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs. drift ($\theta \leq 0.1$)



(b) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs. drift ($0.1 < \theta \leq 0.3$)

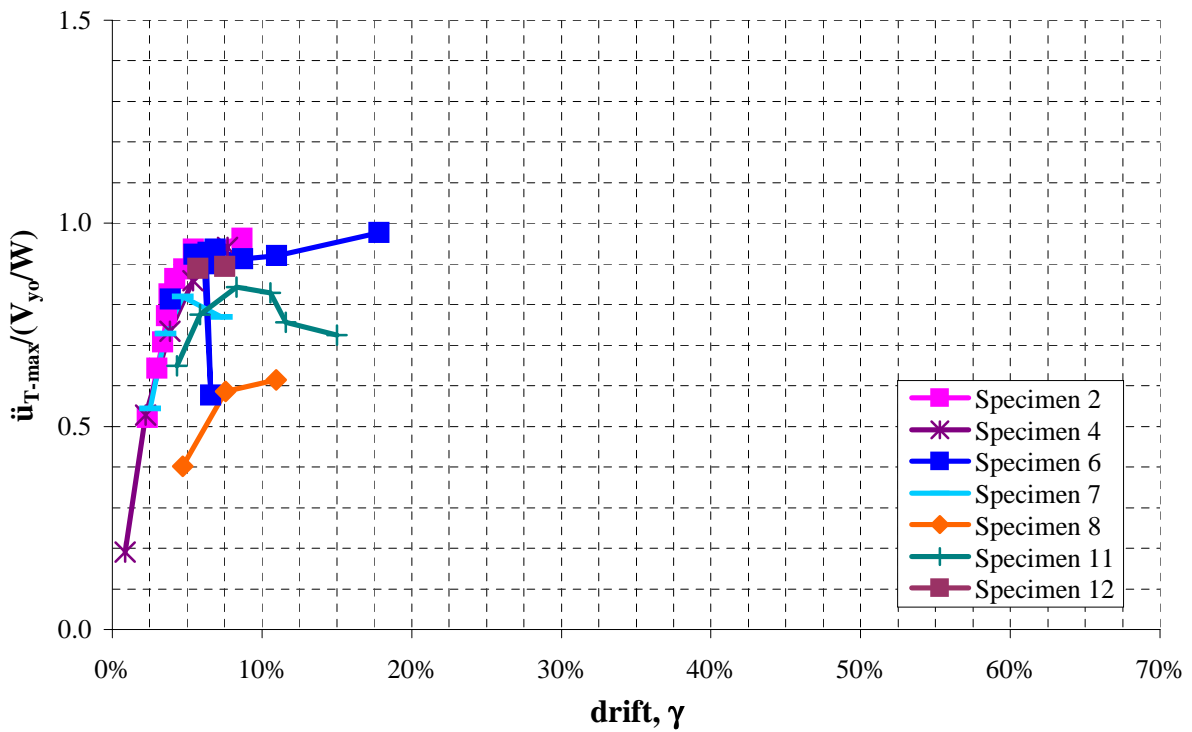


FIGURE C-15 Normalized Absolute Acceleration vs. Drift

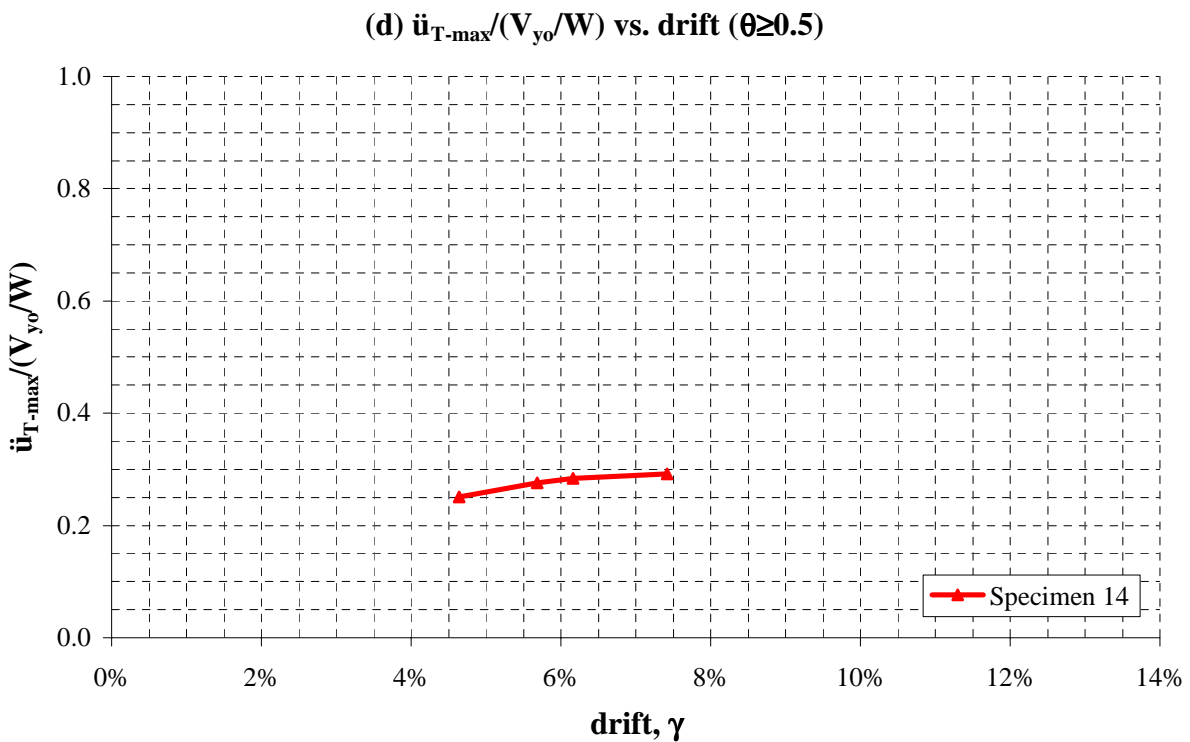
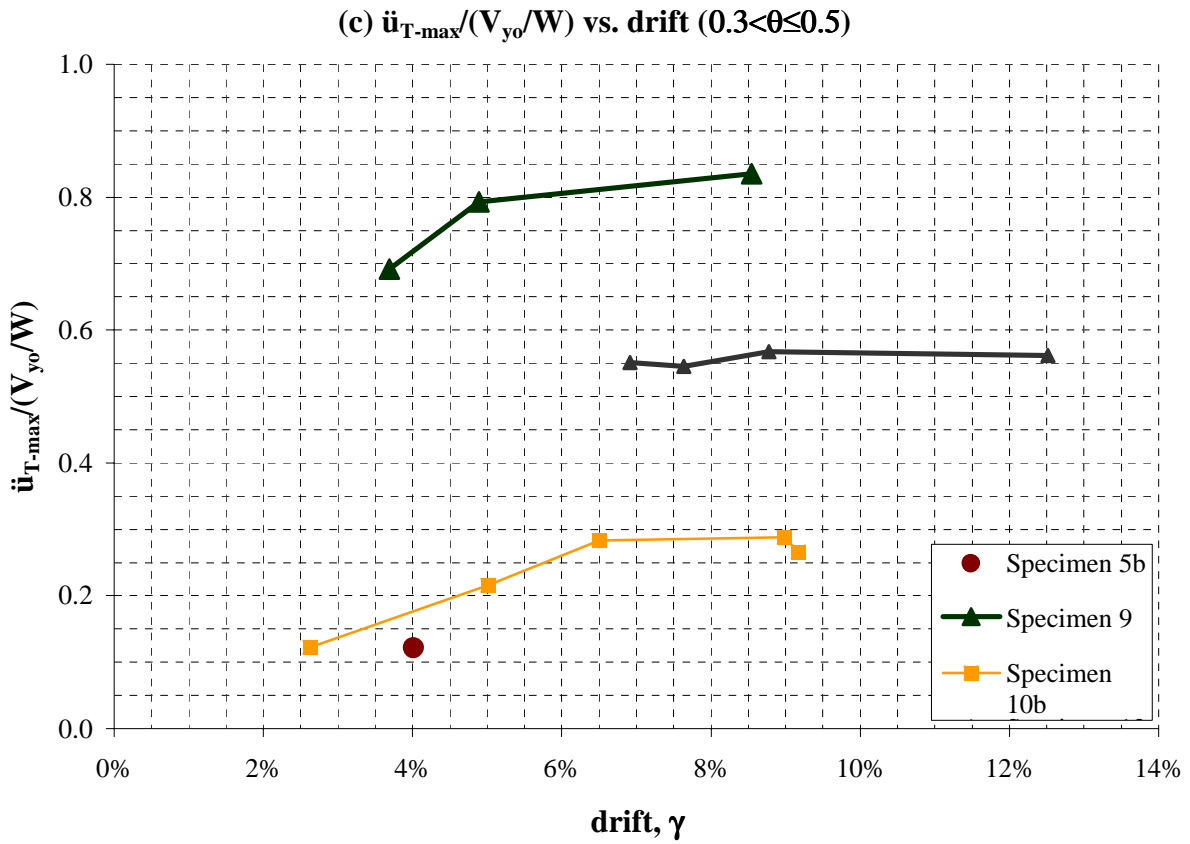


FIGURE C-15 (cont'd) Normalized Absolute Acceleration vs. Drift

(e) $\ddot{u}_{T-max}/(V_{yo}/W)$ vs. drift - all specimens

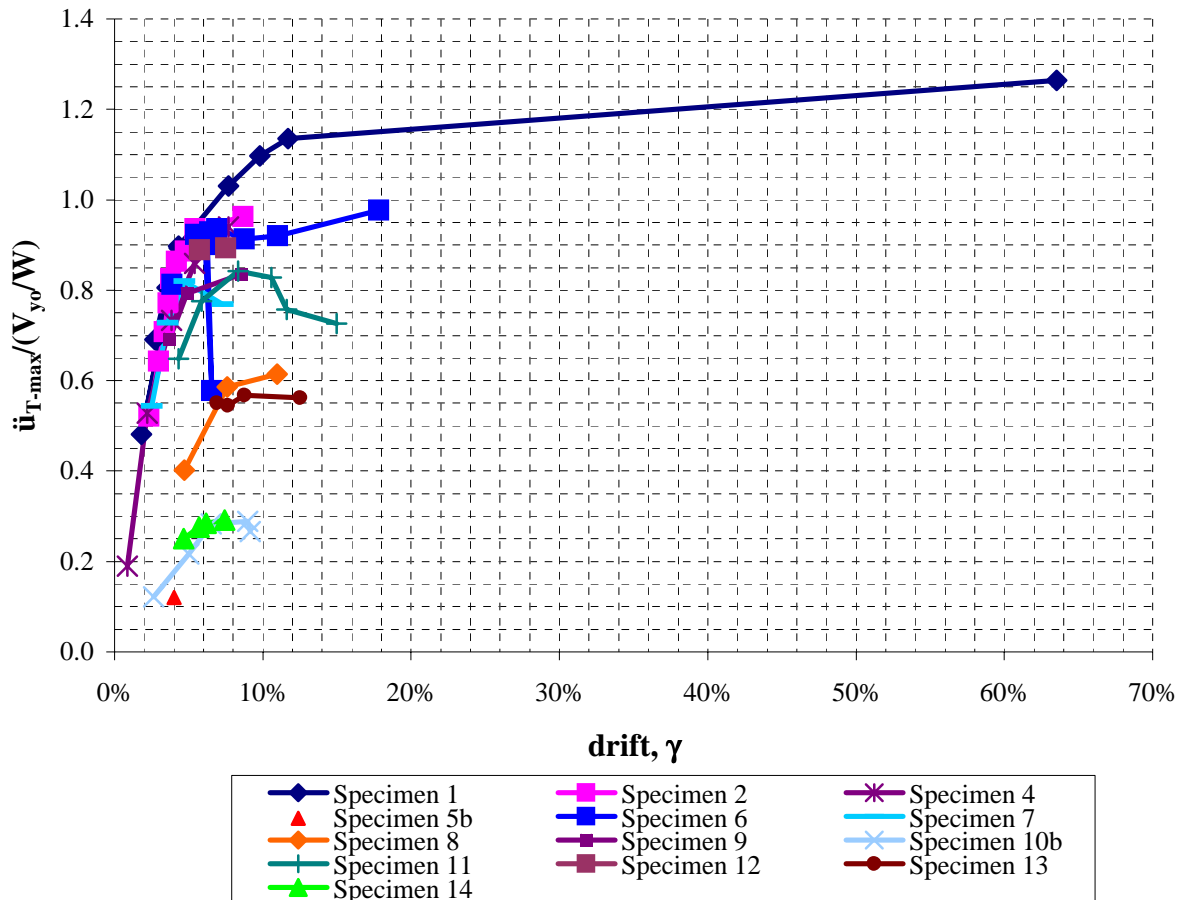


FIGURE C-15 (cont'd) Normalized Absolute Acceleration vs. Drift