**Novel hybrid machine learning models for failure mode identification and shear strength prediction of rectangular hollow RC columns subjected to compressive and lateral loads**

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**1. Results of shear strength prediction**

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**Fig. S-1.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 50.

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**Fig. S-2.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 100.

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**Fig. S-3.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 150.

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**Fig. S-4.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 200.

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**Fig. S-5.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 250.

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**Fig. S-6.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 300.

**Table S-1** Performance of MFO-MLP models on the training set

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pop** | **Tr.atio** | **R2** | **Score** | **A10** | **Score** | **RMSE** | **Score** | **MAE** | **Score** | **Total** |
| 50 | 0.55 | 0.812 | 30 | 0.136 | 13 | 271.745 | 30 | 175.227 | 30 | 103 |
|  | 0.60 | 0.783 | 26 | 0.111 | 6 | 282.258 | 26 | 175.537 | 29 | 87 |
|  | 0.65 | 0.755 | 22 | 0.141 | 18 | 291.646 | 23 | 179.162 | 23 | 86 |
|  | 0.70 | 0.73 | 21 | 0.143 | 20 | 298.008 | 21 | 176.812 | 27 | 89 |
|  | 0.75 | 0.77 | 25 | 0.1 | 4 | 287.992 | 25 | 177.552 | 25 | 79 |
|  | 0.80 | 0.652 | 14 | 0.146 | 22 | 373.285 | 11 | 203.353 | 5 | 52 |
|  | 0.85 | 0.668 | 17 | 0.137 | 16 | 354.915 | 16 | 195.825 | 13 | 62 |
|  | 0.90 | 0.63 | 11 | 0.176 | 32 | 366.686 | 14 | 194.049 | 15 | 72 |
| 100 | 0.55 | 0.882 | 43 | 0.136 | 13 | 215.36 | 40 | 142.932 | 39 | 135 |
|  | 0.60 | 0.87 | 40 | 0.181 | 38 | 218.559 | 37 | 144.346 | 38 | 153 |
|  | 0.65 | 0.831 | 33 | 0.115 | 8 | 242.528 | 34 | 159.629 | 34 | 109 |
|  | 0.70 | 0.869 | 39 | 0.155 | 25 | 207.95 | 42 | 138.474 | 42 | 148 |
|  | 0.75 | 0.787 | 27 | 0.133 | 12 | 277.229 | 28 | 176.494 | 28 | 95 |
|  | 0.80 | 0.695 | 19 | 0.188 | 41 | 349.178 | 19 | 192.981 | 17 | 96 |
|  | 0.85 | 0.636 | 12 | 0.196 | 42 | 371.841 | 12 | 196.224 | 12 | 78 |
|  | 0.90 | 0.607 | 6 | 0.167 | 28 | 377.766 | 7 | 193.035 | 16 | 57 |
| 150 | 0.55 | 0.198 | 1 | 0.045 | 1 | 561 | 1 | 304.528 | 1 | 4 |
|  | 0.60 | 0.503 | 2 | 0.111 | 6 | 427.311 | 2 | 230.914 | 2 | 12 |
|  | 0.65 | 0.945 | 47 | 0.256 | 46 | 138.124 | 47 | 95.084 | 47 | 187 |
|  | 0.70 | 0.907 | 45 | 0.167 | 28 | 175.337 | 46 | 120.934 | 44 | 163 |
|  | 0.75 | 0.764 | 24 | 0.1 | 4 | 292.004 | 22 | 181.582 | 21 | 71 |
|  | 0.80 | 0.687 | 18 | 0.167 | 28 | 353.596 | 17 | 198.271 | 10 | 73 |
|  | 0.85 | 0.627 | 9 | 0.176 | 32 | 376.293 | 9 | 199.053 | 9 | 59 |
|  | 0.90 | 0.615 | 8 | 0.213 | 43 | 373.969 | 10 | 192.561 | 18 | 79 |
| 200 | 0.55 | 0.809 | 29 | 0.091 | 3 | 274.128 | 29 | 177.278 | 26 | 87 |
|  | 0.60 | 0.962 | 48 | 0.292 | 47 | 118.564 | 48 | 85.349 | 48 | 191 |
|  | 0.65 | 0.839 | 35 | 0.128 | 10 | 236.417 | 36 | 156.272 | 35 | 116 |
|  | 0.70 | 0.906 | 44 | 0.298 | 48 | 176.266 | 45 | 118.507 | 46 | 183 |
|  | 0.75 | 0.815 | 31 | 0.089 | 2 | 258.586 | 31 | 166.467 | 33 | 97 |
|  | 0.80 | 0.629 | 10 | 0.177 | 36 | 385.123 | 6 | 206.033 | 4 | 56 |
|  | 0.85 | 0.588 | 5 | 0.167 | 28 | 395.348 | 4 | 199.87 | 7 | 44 |
|  | 0.90 | 0.575 | 4 | 0.176 | 32 | 392.738 | 5 | 199.483 | 8 | 49 |
| 250 | 0.55 | 0.835 | 34 | 0.182 | 39 | 254.228 | 33 | 169.285 | 31 | 137 |
|  | 0.60 | 0.818 | 32 | 0.139 | 17 | 258.331 | 32 | 167.049 | 32 | 113 |
|  | 0.65 | 0.877 | 42 | 0.154 | 24 | 206.957 | 43 | 137.406 | 43 | 152 |
|  | 0.70 | 0.856 | 37 | 0.131 | 11 | 217.701 | 38 | 146.663 | 37 | 123 |
|  | 0.75 | 0.909 | 46 | 0.222 | 45 | 180.875 | 44 | 119.577 | 45 | 180 |
|  | 0.80 | 0.72 | 20 | 0.177 | 36 | 334.66 | 20 | 184.875 | 20 | 96 |
|  | 0.85 | 0.661 | 16 | 0.176 | 32 | 358.861 | 15 | 197.101 | 11 | 74 |
|  | **0.90** | 0.61 | 7 | 0.213 | 43 | 376.346 | 8 | 195.014 | 14 | 72 |
| 300 | 0.55 | 0.799 | 28 | 0.136 | 13 | 280.863 | 27 | 179.737 | 22 | 90 |
|  | 0.60 | 0.873 | 41 | 0.153 | 23 | 215.613 | 39 | 142.469 | 40 | 143 |
|  | 0.65 | 0.756 | 23 | 0.141 | 18 | 291.172 | 24 | 179.029 | 24 | 89 |
|  | 0.70 | 0.867 | 38 | 0.155 | 25 | 209.007 | 41 | 138.88 | 41 | 145 |
|  | 0.75 | 0.844 | 36 | 0.144 | 21 | 237.537 | 35 | 155.149 | 36 | 128 |
|  | 0.80 | 0.574 | 3 | 0.125 | 9 | 412.795 | 3 | 212.502 | 3 | 18 |
|  | 0.85 | 0.638 | 13 | 0.157 | 27 | 370.432 | 13 | 200.569 | 6 | 59 |
|  | 0.90 | 0.659 | 15 | 0.185 | 40 | 351.93 | 18 | 191.437 | 19 | 92 |

**Table S-2** Performance of MFO-MLP models on the test set

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pop** | **Tr.atio** | **R2** | **Score** | **A10** | **Score** | **RMSE** | **Score** | **MAE** | **Score** | **Total** |
| 50 | 0.55 | 0.487 | 27 | 0.091 | 5 | 491.292 | 38 | 233.067 | 41 | 111 |
|  | 0.60 | 0.49 | 29 | 0.102 | 9 | 513.337 | 33 | 231.879 | 42 | 113 |
|  | 0.65 | 0.479 | 25 | 0.14 | 16 | 544.966 | 27 | 236.277 | 36 | 104 |
|  | 0.70 | 0.47 | 22 | 0.162 | 25 | 582.137 | 20 | 250.556 | 24 | 91 |
|  | 0.75 | 0.376 | 8 | 0.097 | 8 | 621.572 | 9 | 268.472 | 10 | 35 |
|  | 0.80 | 0.653 | 43 | 0.24 | 44 | 430.211 | 45 | 213.462 | 45 | 177 |
|  | 0.85 | 0.662 | 44 | 0.211 | 36 | 478.565 | 41 | 235.16 | 40 | 161 |
|  | 0.90 | 0.605 | 37 | 0.154 | 19 | 596.339 | 18 | 322.904 | 6 | 80 |
| 100 | 0.55 | 0.439 | 19 | 0.127 | 13 | 513.896 | 32 | 236.157 | 37 | 101 |
|  | 0.60 | 0.436 | 17 | 0.224 | 39 | 539.457 | 28 | 247.469 | 28 | 112 |
|  | 0.65 | 0.459 | 21 | 0.163 | 28 | 555.394 | 25 | 246.309 | 29 | 103 |
|  | 0.70 | 0.421 | 15 | 0.189 | 34 | 608.517 | 14 | 256.69 | 18 | 81 |
|  | 0.75 | 0.372 | 7 | 0.161 | 23 | 623.733 | 6 | 265.524 | 12 | 48 |
|  | **0.80** | **0.675** | **48** | **0.32** | **48** | **416.404** | **48** | **203.31** | **48** | **192** |
|  | 0.85 | 0.638 | 40 | 0.211 | 36 | 495.078 | 36 | 245.879 | 30 | 142 |
|  | 0.90 | 0.589 | 32 | 0.231 | 40 | 608.816 | 13 | 331.268 | 3 | 88 |
| 150 | 0.55 | 0.104 | 1 | 0.073 | 2 | 649.267 | 2 | 332.299 | 2 | 7 |
|  | 0.60 | 0.376 | 8 | 0.163 | 28 | 567.565 | 23 | 249.061 | 26 | 85 |
|  | 0.65 | 0.347 | 5 | 0.186 | 31 | 610.006 | 11 | 248.949 | 27 | 74 |
|  | 0.70 | 0.393 | 12 | 0.189 | 34 | 623.147 | 8 | 258.333 | 15 | 69 |
|  | 0.75 | 0.384 | 10 | 0.065 | 1 | 617.734 | 10 | 269.803 | 9 | 30 |
|  | 0.80 | 0.667 | 46 | 0.24 | 44 | 421.559 | 46 | 208.254 | 46 | 182 |
|  | 0.85 | 0.635 | 39 | 0.158 | 20 | 497.206 | 35 | 252.43 | 21 | 115 |
|  | 0.90 | 0.598 | 35 | 0.231 | 40 | 601.784 | 16 | 324.642 | 5 | 96 |
| 200 | 0.55 | 0.487 | 27 | 0.091 | 5 | 491.185 | 39 | 235.43 | 39 | 110 |
|  | 0.60 | 0.338 | 3 | 0.163 | 28 | 584.546 | 19 | 251.224 | 23 | 73 |
|  | 0.65 | 0.439 | 19 | 0.186 | 31 | 565.367 | 24 | 252.39 | 22 | 96 |
|  | 0.70 | 0.392 | 11 | 0.216 | 38 | 623.364 | 7 | 254.063 | 19 | 75 |
|  | 0.75 | 0.364 | 6 | 0.161 | 23 | 627.375 | 5 | 266.523 | 11 | 45 |
|  | 0.80 | 0.648 | 42 | 0.16 | 22 | 433.499 | 44 | 216.132 | 44 | 152 |
|  | 0.85 | 0.592 | 33 | 0.105 | 10 | 525.383 | 30 | 272.301 | 8 | 81 |
|  | 0.90 | 0.558 | 31 | 0.077 | 3 | 631.235 | 4 | 353.231 | 1 | 39 |
| 250 | 0.55 | 0.471 | 23 | 0.109 | 11 | 498.696 | 34 | 237.757 | 34 | 102 |
|  | 0.60 | 0.479 | 25 | 0.122 | 12 | 518.637 | 31 | 242.597 | 32 | 100 |
|  | 0.65 | 0.416 | 13 | 0.186 | 31 | 577.152 | 21 | 253.94 | 20 | 85 |
|  | 0.70 | 0.427 | 16 | 0.162 | 25 | 605.55 | 15 | 257.637 | 16 | 72 |
|  | 0.75 | 0.265 | 2 | 0.129 | 14 | 674.56 | 1 | 265.118 | 13 | 30 |
|  | 0.80 | 0.672 | 47 | 0.28 | 46 | 418.028 | 47 | 205.034 | 47 | 187 |
|  | 0.85 | 0.664 | 45 | 0.316 | 47 | 476.911 | 42 | 239.122 | 33 | 167 |
|  | 0.90 | 0.6 | 36 | 0.231 | 40 | 600.307 | 17 | 325.71 | 4 | 97 |
| 300 | 0.55 | 0.493 | 30 | 0.091 | 5 | 488.471 | 40 | 231.109 | 43 | 118 |
|  | 0.60 | 0.437 | 18 | 0.143 | 18 | 539.208 | 29 | 249.207 | 25 | 90 |
|  | 0.65 | 0.478 | 24 | 0.14 | 16 | 545.389 | 26 | 236.658 | 35 | 101 |
|  | 0.70 | 0.419 | 14 | 0.162 | 25 | 609.314 | 12 | 257.184 | 17 | 68 |
|  | 0.75 | 0.343 | 4 | 0.129 | 14 | 637.599 | 3 | 264.314 | 14 | 35 |
|  | 0.80 | 0.594 | 34 | 0.08 | 4 | 465.308 | 43 | 235.7 | 38 | 119 |
|  | 0.85 | 0.643 | 41 | 0.158 | 20 | 491.898 | 37 | 245.425 | 31 | 129 |
|  | 0.90 | 0.632 | 38 | 0.231 | 40 | 576.166 | 22 | 300.571 | 7 | 107 |

**2. Results of failure modes identification**

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**Fig. S-7.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 50.

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**Fig. S-8.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 100.

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A picture containing text, screenshot, font, graphics

Description automatically generated

**Fig. S-9.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 150.

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A picture containing text, screenshot, font, graphics

Description automatically generated

**Fig. S-10.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 200.

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**Fig. S-11.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 250.

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**Fig. S-12.** Effect of training-test ratios on the MFO-MLP model’s performance with population size of 300.

**Table S-3** Performance of MFO-MLP models on the training set

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pop** | **Tr.atio** | **Acc** | **Score** | **Pre** | **Score** | **Re** | **Score** | **f1** | **Score** | **Total** |
| 50 | 0.55 | 0.78 | 48 | 0.789 | 48 | 0.78 | 48 | 0.78 | 48 | 192 |
|  | 0.60 | 0.55 | 36 | 0.375 | 30 | 0.55 | 36 | 0.443 | 32 | 134 |
|  | 0.65 | 0.39 | 12 | 0.152 | 11 | 0.39 | 12 | 0.219 | 12 | 47 |
|  | 0.70 | 0.375 | 8 | 0.141 | 7 | 0.375 | 8 | 0.205 | 7 | 30 |
|  | 0.75 | 0.365 | 5 | 0.133 | 4 | 0.365 | 5 | 0.195 | 4 | 18 |
|  | 0.80 | 0.658 | 46 | 0.657 | 43 | 0.658 | 46 | 0.657 | 46 | 181 |
|  | 0.85 | 0.484 | 22 | 0.326 | 19 | 0.484 | 22 | 0.388 | 21 | 84 |
|  | 0.90 | 0.348 | 1 | 0.164 | 12 | 0.348 | 1 | 0.209 | 10 | 24 |
| 100 | 0.55 | 0.41 | 14 | 0.168 | 13 | 0.41 | 14 | 0.238 | 13 | 54 |
|  | 0.60 | 0.404 | 13 | 0.482 | 33 | 0.404 | 13 | 0.252 | 16 | 75 |
|  | 0.65 | 0.686 | 47 | 0.682 | 45 | 0.686 | 47 | 0.68 | 47 | 186 |
|  | 0.70 | 0.461 | 18 | 0.337 | 21 | 0.461 | 18 | 0.361 | 17 | 74 |
|  | 0.75 | 0.365 | 5 | 0.133 | 4 | 0.365 | 5 | 0.195 | 4 | 18 |
|  | 0.80 | 0.349 | 4 | 0.122 | 3 | 0.349 | 4 | 0.181 | 3 | 14 |
|  | 0.85 | 0.516 | 28 | 0.351 | 24 | 0.516 | 28 | 0.418 | 27 | 107 |
|  | 0.90 | 0.53 | 34 | 0.566 | 35 | 0.53 | 34 | 0.51 | 36 | 139 |
| 150 | 0.55 | 0.41 | 14 | 0.168 | 13 | 0.41 | 14 | 0.238 | 13 | 54 |
|  | 0.60 | 0.514 | 27 | 0.646 | 41 | 0.514 | 27 | 0.438 | 31 | 126 |
|  | 0.65 | 0.517 | 29 | 0.36 | 28 | 0.517 | 29 | 0.419 | 28 | 114 |
|  | 0.70 | 0.555 | 37 | 0.656 | 42 | 0.555 | 37 | 0.529 | 37 | 153 |
|  | 0.75 | 0.511 | 26 | 0.35 | 23 | 0.511 | 26 | 0.415 | 26 | 101 |
|  | 0.80 | 0.527 | 31 | 0.365 | 29 | 0.527 | 31 | 0.431 | 30 | 121 |
|  | 0.85 | 0.523 | 30 | 0.354 | 26 | 0.523 | 30 | 0.422 | 29 | 115 |
|  | 0.90 | 0.591 | 41 | 0.641 | 40 | 0.591 | 41 | 0.544 | 39 | 161 |
| 200 | 0.55 | 0.53 | 32 | 0.386 | 31 | 0.53 | 32 | 0.445 | 33 | 128 |
|  | 0.60 | 0.606 | 44 | 0.657 | 44 | 0.606 | 44 | 0.566 | 41 | 173 |
|  | 0.65 | 0.492 | 23 | 0.338 | 22 | 0.492 | 23 | 0.397 | 23 | 91 |
|  | 0.70 | 0.375 | 8 | 0.141 | 7 | 0.375 | 8 | 0.205 | 7 | 30 |
|  | 0.75 | 0.555 | 38 | 0.544 | 34 | 0.555 | 38 | 0.529 | 38 | 148 |
|  | 0.80 | 0.582 | 40 | 0.623 | 38 | 0.582 | 40 | 0.589 | 43 | 161 |
|  | 0.85 | 0.348 | 3 | 0.121 | 2 | 0.348 | 3 | 0.18 | 2 | 10 |
|  | 0.90 | 0.476 | 20 | 0.32 | 18 | 0.476 | 20 | 0.379 | 20 | 78 |
| 250 | 0.55 | 0.41 | 14 | 0.168 | 13 | 0.41 | 14 | 0.238 | 13 | 54 |
|  | 0.60 | 0.505 | 24 | 0.354 | 27 | 0.505 | 24 | 0.414 | 25 | 100 |
|  | 0.65 | 0.508 | 25 | 0.353 | 25 | 0.508 | 25 | 0.414 | 24 | 99 |
|  | 0.70 | 0.477 | 21 | 0.335 | 20 | 0.477 | 21 | 0.393 | 22 | 84 |
|  | 0.75 | 0.46 | 17 | 0.311 | 17 | 0.46 | 17 | 0.367 | 18 | 69 |
|  | 0.80 | 0.644 | 45 | 0.71 | 47 | 0.644 | 45 | 0.596 | 45 | 182 |
|  | 0.85 | 0.594 | 42 | 0.636 | 39 | 0.594 | 42 | 0.565 | 40 | 163 |
|  | 0.90 | 0.348 | 1 | 0.121 | 1 | 0.348 | 1 | 0.179 | 1 | 4 |
| 300 | 0.55 | 0.53 | 32 | 0.388 | 32 | 0.53 | 32 | 0.448 | 34 | 130 |
|  | 0.60 | 0.385 | 11 | 0.148 | 10 | 0.385 | 11 | 0.214 | 11 | 43 |
|  | 0.65 | 0.602 | 43 | 0.605 | 36 | 0.602 | 43 | 0.591 | 44 | 166 |
|  | 0.70 | 0.375 | 8 | 0.141 | 7 | 0.375 | 8 | 0.205 | 7 | 30 |
|  | 0.75 | 0.365 | 5 | 0.133 | 4 | 0.365 | 5 | 0.195 | 4 | 18 |
|  | 0.80 | 0.575 | 39 | 0.618 | 37 | 0.575 | 39 | 0.581 | 42 | 157 |
|  | 0.85 | 0.542 | 35 | 0.683 | 46 | 0.542 | 35 | 0.463 | 35 | 151 |
|  | 0.90 | 0.463 | 19 | 0.311 | 16 | 0.463 | 19 | 0.372 | 19 | 73 |

**Table S-4** Performance of MFO-MLP models on the test set

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pop** | **Tr.atio** | **Acc** | **Score** | **Pre** | **Score** | **Re** | **Score** | **f1** | **Score** | **Total** |
| **50** | **0.55** | **0.807** | **48** | **0.807** | **48** | **0.807** | **48** | **0.806** | **48** | **192** |
|  | 0.60 | 0.486 | 32 | 0.34 | 33 | 0.486 | 32 | 0.39 | 33 | 130 |
|  | 0.65 | 0.231 | 2 | 0.053 | 2 | 0.231 | 2 | 0.087 | 2 | 8 |
|  | 0.70 | 0.236 | 3 | 0.056 | 3 | 0.236 | 3 | 0.09 | 3 | 12 |
|  | 0.75 | 0.239 | 6 | 0.057 | 6 | 0.239 | 6 | 0.092 | 6 | 24 |
|  | 0.80 | 0.649 | 44 | 0.658 | 41 | 0.649 | 44 | 0.649 | 44 | 173 |
|  | 0.85 | 0.429 | 22 | 0.261 | 24 | 0.429 | 22 | 0.324 | 22 | 90 |
|  | 0.90 | 0.316 | 16 | 0.205 | 15 | 0.316 | 16 | 0.219 | 16 | 63 |
| 100 | 0.55 | 0.241 | 9 | 0.058 | 9 | 0.241 | 9 | 0.094 | 9 | 36 |
|  | 0.60 | 0.284 | 15 | 0.406 | 34 | 0.284 | 15 | 0.157 | 15 | 79 |
|  | 0.65 | 0.692 | 47 | 0.718 | 44 | 0.692 | 47 | 0.694 | 47 | 185 |
|  | 0.70 | 0.436 | 23 | 0.246 | 18 | 0.436 | 23 | 0.31 | 20 | 84 |
|  | 0.75 | 0.239 | 6 | 0.057 | 6 | 0.239 | 6 | 0.092 | 6 | 24 |
|  | 0.80 | 0.27 | 14 | 0.073 | 14 | 0.27 | 14 | 0.115 | 14 | 56 |
|  | 0.85 | 0.464 | 29 | 0.284 | 28 | 0.464 | 29 | 0.351 | 30 | 116 |
|  | 0.90 | 0.684 | 46 | 0.768 | 48 | 0.684 | 46 | 0.681 | 46 | 186 |
| 150 | 0.55 | 0.241 | 9 | 0.058 | 9 | 0.241 | 9 | 0.094 | 9 | 36 |
|  | 0.60 | 0.405 | 18 | 0.248 | 19 | 0.405 | 18 | 0.307 | 19 | 74 |
|  | 0.65 | 0.446 | 24 | 0.259 | 23 | 0.446 | 24 | 0.327 | 23 | 94 |
|  | 0.70 | 0.655 | 45 | 0.726 | 45 | 0.655 | 45 | 0.653 | 45 | 180 |
|  | 0.75 | 0.522 | 35 | 0.322 | 32 | 0.522 | 35 | 0.397 | 34 | 136 |
|  | 0.80 | 0.459 | 28 | 0.271 | 26 | 0.459 | 28 | 0.338 | 27 | 109 |
|  | 0.85 | 0.464 | 29 | 0.284 | 28 | 0.464 | 29 | 0.351 | 30 | 116 |
|  | 0.90 | 0.579 | 42 | 0.693 | 43 | 0.579 | 42 | 0.584 | 43 | 170 |
| 200 | 0.55 | 0.398 | 17 | 0.23 | 16 | 0.398 | 17 | 0.292 | 17 | 67 |
|  | 0.60 | 0.541 | 38 | 0.629 | 40 | 0.541 | 38 | 0.505 | 37 | 153 |
|  | 0.65 | 0.446 | 24 | 0.259 | 21 | 0.446 | 24 | 0.327 | 24 | 93 |
|  | 0.70 | 0.236 | 3 | 0.056 | 3 | 0.236 | 3 | 0.09 | 3 | 12 |
|  | 0.75 | 0.522 | 35 | 0.506 | 35 | 0.522 | 35 | 0.5 | 36 | 141 |
|  | 0.80 | 0.541 | 38 | 0.55 | 36 | 0.541 | 38 | 0.527 | 39 | 151 |
|  | 0.85 | 0.25 | 12 | 0.062 | 12 | 0.25 | 12 | 0.1 | 12 | 48 |
|  | 0.90 | 0.474 | 31 | 0.274 | 27 | 0.474 | 31 | 0.348 | 29 | 118 |
| 250 | 0.55 | 0.241 | 9 | 0.058 | 9 | 0.241 | 9 | 0.094 | 9 | 36 |
|  | 0.60 | 0.419 | 20 | 0.25 | 20 | 0.419 | 20 | 0.313 | 21 | 81 |
|  | 0.65 | 0.446 | 24 | 0.259 | 21 | 0.446 | 24 | 0.327 | 24 | 93 |
|  | 0.70 | 0.455 | 27 | 0.261 | 25 | 0.455 | 27 | 0.33 | 26 | 105 |
|  | **0.75** | 0.5 | 33 | 0.304 | 31 | 0.5 | 33 | 0.378 | 32 | 129 |
|  | 0.80 | 0.622 | 43 | 0.763 | 47 | 0.622 | 43 | 0.574 | 42 | 175 |
|  | 0.85 | 0.536 | 37 | 0.598 | 39 | 0.536 | 37 | 0.51 | 38 | 151 |
|  | 0.90 | 0.211 | 1 | 0.044 | 1 | 0.211 | 1 | 0.073 | 1 | 4 |
| 300 | 0.55 | 0.41 | 19 | 0.238 | 17 | 0.41 | 19 | 0.301 | 18 | 73 |
|  | 0.60 | 0.257 | 13 | 0.066 | 13 | 0.257 | 13 | 0.105 | 13 | 52 |
|  | 0.65 | 0.569 | 41 | 0.573 | 38 | 0.569 | 41 | 0.558 | 41 | 161 |
|  | 0.70 | 0.236 | 3 | 0.056 | 3 | 0.236 | 3 | 0.09 | 3 | 12 |
|  | 0.75 | 0.239 | 6 | 0.057 | 6 | 0.239 | 6 | 0.092 | 6 | 24 |
|  | 0.80 | 0.541 | 38 | 0.55 | 36 | 0.541 | 38 | 0.527 | 39 | 151 |
|  | 0.85 | 0.5 | 33 | 0.686 | 42 | 0.5 | 33 | 0.424 | 35 | 143 |
|  | 0.90 | 0.421 | 21 | 0.297 | 30 | 0.421 | 21 | 0.338 | 28 | 100 |

A screenshot of a computer

Description automatically generated with low confidenceA screenshot of a computer

Description automatically generated with low confidence

**Fig. S-13.** Performance of MFO-MLP models.