**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-RF model’s performance with population size of 50.

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

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

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

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

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

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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pop** | **Tr.atio** | **R2** | **Score** | **A10** | **Score** | **RMSE** | **Score** | **MAE** | **Score** | **Total** |
| 50 | 0.55 | 0.953 | 20 | 0.485 | 12 | 135.514 | 21 | 80.562 | 16 | 69 |
|  | 0.60 | 0.96 | 27 | 0.5 | 19 | 121.239 | 30 | 67.995 | 24 | 100 |
|  | 0.65 | 0.96 | 27 | 0.513 | 26 | 117.56 | 34 | 66.582 | 26 | 113 |
|  | 0.70 | 0.976 | 40 | 0.571 | 32 | 89.56 | 43 | 49.562 | 41 | 156 |
|  | 0.75 | 0.976 | 40 | 0.611 | 40 | 93.686 | 40 | 50.805 | 35 | 155 |
|  | 0.80 | 0.949 | 18 | 0.583 | 35 | 142.633 | 16 | 60.124 | 28 | 97 |
|  | 0.85 | 0.903 | 8 | 0.5 | 19 | 192.043 | 7 | 78.807 | 17 | 51 |
|  | 0.90 | 0.874 | 1 | 0.491 | 18 | 214.272 | 1 | 91.302 | 2 | 22 |
| 100 | 0.55 | 0.953 | 20 | 0.485 | 12 | 135.532 | 20 | 80.943 | 13 | 65 |
|  | 0.60 | 0.96 | 27 | 0.5 | 19 | 121.446 | 29 | 68.146 | 23 | 98 |
|  | 0.65 | 0.937 | 11 | 0.385 | 2 | 147.686 | 11 | 86.205 | 5 | 29 |
|  | 0.70 | 0.957 | 24 | 0.476 | 11 | 119.346 | 33 | 68.635 | 22 | 90 |
|  | 0.75 | 0.975 | 38 | 0.6 | 38 | 94.349 | 39 | 50.534 | 37 | 152 |
|  | 0.80 | 0.902 | 5 | 0.49 | 16 | 198.205 | 5 | 82.338 | 10 | 36 |
|  | 0.85 | 0.947 | 16 | 0.578 | 34 | 141.993 | 17 | 58.032 | 30 | 97 |
|  | 0.90 | 0.902 | 5 | 0.417 | 7 | 188.942 | 9 | 88.579 | 3 | 24 |
| 150 | 0.55 | 0.953 | 20 | 0.485 | 12 | 135.273 | 23 | 80.923 | 14 | 69 |
|  | 0.60 | 0.96 | 27 | 0.528 | 28 | 121.228 | 31 | 67.942 | 25 | 111 |
|  | 0.65 | 0.983 | 48 | 0.667 | 44 | 77.316 | 48 | 42.854 | 48 | 188 |
|  | 0.70 | 0.934 | 10 | 0.405 | 5 | 147.743 | 10 | 84.957 | 6 | 31 |
|  | 0.75 | 0.943 | 13 | 0.4 | 4 | 143.983 | 13 | 82.884 | 9 | 39 |
|  | 0.80 | 0.961 | 32 | 0.677 | 46 | 124.604 | 25 | 50.636 | 36 | 139 |
|  | 0.85 | 0.902 | 5 | 0.51 | 24 | 192.763 | 6 | 78.744 | 19 | 54 |
|  | 0.90 | 0.943 | 13 | 0.676 | 45 | 144.344 | 12 | 50.108 | 39 | 109 |
| 200 | 0.55 | 0.953 | 20 | 0.485 | 12 | 135.42 | 22 | 80.732 | 15 | 69 |
|  | 0.60 | 0.959 | 25 | 0.5 | 19 | 122.785 | 27 | 70.276 | 21 | 92 |
|  | 0.65 | 0.982 | 46 | 0.628 | 41 | 78.885 | 46 | 43.948 | 46 | 179 |
|  | 0.70 | 0.975 | 38 | 0.583 | 35 | 91.041 | 41 | 50.076 | 40 | 154 |
|  | 0.75 | 0.969 | 36 | 0.567 | 31 | 105.321 | 36 | 57.242 | 31 | 134 |
|  | 0.80 | 0.96 | 27 | 0.438 | 9 | 125.974 | 24 | 63.026 | 27 | 87 |
|  | 0.85 | 0.947 | 16 | 0.598 | 37 | 141.417 | 18 | 58.339 | 29 | 100 |
|  | 0.90 | 0.961 | 32 | 0.657 | 43 | 119.665 | 32 | 48.876 | 43 | 150 |
| 250 | 0.55 | 0.951 | 19 | 0.424 | 8 | 139.276 | 19 | 83.008 | 8 | 54 |
|  | 0.60 | 0.973 | 37 | 0.556 | 29 | 99.714 | 37 | 57.06 | 32 | 135 |
|  | 0.65 | 0.941 | 12 | 0.372 | 1 | 142.88 | 15 | 82.262 | 11 | 39 |
|  | 0.70 | 0.982 | 46 | 0.643 | 42 | 77.996 | 47 | 43.574 | 47 | 182 |
|  | 0.75 | 0.943 | 13 | 0.389 | 3 | 143.44 | 14 | 83.153 | 7 | 37 |
|  | 0.80 | 0.962 | 34 | 0.677 | 46 | 123.997 | 26 | 50.529 | 38 | 144 |
|  | 0.85 | 0.903 | 8 | 0.51 | 24 | 191.678 | 8 | 78.768 | 18 | 58 |
|  | **0.90** | 0.885 | 2 | 0.407 | 6 | 204.489 | 3 | 95.804 | 1 | 12 |
| 300 | 0.55 | 0.976 | 40 | 0.606 | 39 | 96.179 | 38 | 54.08 | 33 | 150 |
|  | 0.60 | 0.959 | 25 | 0.5 | 19 | 122.088 | 28 | 70.677 | 20 | 92 |
|  | 0.65 | 0.979 | 45 | 0.564 | 30 | 86.271 | 45 | 48.046 | 44 | 164 |
|  | 0.70 | 0.976 | 40 | 0.571 | 32 | 89.318 | 44 | 49.223 | 42 | 158 |
|  | 0.75 | 0.978 | 44 | 0.522 | 27 | 90.047 | 42 | 52.698 | 34 | 147 |
|  | 0.80 | 0.901 | 4 | 0.49 | 16 | 198.679 | 4 | 82.178 | 12 | 36 |
|  | 0.85 | 0.889 | 3 | 0.451 | 10 | 204.937 | 2 | 87.104 | 4 | 19 |
|  | 0.90 | 0.963 | 35 | 0.713 | 48 | 116.143 | 35 | 46.688 | 45 | 163 |

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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pop** | **Tr.atio** | **R2** | **Score** | **A10** | **Score** | **RMSE** | **Score** | **MAE** | **Score** | **Total** |
| 50 | 0.55 | 0.471 | 10 | 0.2 | 6 | 498.634 | 29 | 224.578 | 10 | 55 |
|  | 0.60 | 0.505 | 25 | 0.265 | 18 | 505.431 | 24 | 200.212 | 27 | 94 |
|  | 0.65 | 0.49 | 21 | 0.372 | 44 | 538.891 | 14 | 208.939 | 20 | 99 |
|  | 0.70 | 0.474 | 13 | 0.297 | 23 | 580 | 7 | 231.237 | 3 | 46 |
|  | 0.75 | 0.413 | 1 | 0.355 | 40 | 602.766 | 1 | 211.079 | 17 | 59 |
|  | 0.80 | 0.946 | 43 | 0.4 | 45 | 169.712 | 45 | 92.864 | 46 | 179 |
|  | 0.85 | 0.867 | 33 | 0.316 | 27 | 299.984 | 33 | 139.669 | 36 | 129 |
|  | 0.90 | 0.852 | 31 | 0.154 | 2 | 365.228 | 31 | 183.43 | 31 | 95 |
| 100 | 0.55 | 0.469 | 9 | 0.2 | 6 | 499.797 | 27 | 225.253 | 9 | 51 |
|  | 0.60 | 0.505 | 25 | 0.245 | 14 | 505.515 | 23 | 200.457 | 26 | 88 |
|  | 0.65 | 0.505 | 25 | 0.256 | 16 | 531.001 | 17 | 206.296 | 22 | 80 |
|  | 0.70 | 0.484 | 17 | 0.27 | 19 | 574.605 | 11 | 234.76 | 1 | 48 |
|  | 0.75 | 0.416 | 5 | 0.323 | 33 | 601.314 | 5 | 210.422 | 18 | 61 |
|  | 0.80 | 0.869 | 36 | 0.36 | 43 | 263.867 | 39 | 121.339 | 41 | 159 |
|  | 0.85 | 0.934 | 41 | 0.316 | 27 | 210.63 | 41 | 111.09 | 43 | 152 |
|  | 0.90 | 0.926 | 40 | 0.154 | 2 | 257.974 | 40 | 147.922 | 33 | 115 |
| 150 | 0.55 | 0.468 | 8 | 0.2 | 6 | 500.266 | 26 | 226.203 | 8 | 48 |
|  | 0.60 | 0.505 | 25 | 0.286 | 20 | 505.546 | 22 | 200.882 | 25 | 92 |
|  | 0.65 | 0.484 | 17 | 0.326 | 36 | 542.117 | 13 | 206.58 | 21 | 87 |
|  | 0.70 | 0.491 | 22 | 0.243 | 13 | 570.33 | 12 | 230.44 | 6 | 53 |
|  | 0.75 | 0.414 | 3 | 0.323 | 33 | 602.416 | 3 | 217.524 | 14 | 53 |
|  | 0.80 | 0.949 | 44 | 0.4 | 45 | 164.2 | 46 | 90.83 | 47 | 182 |
|  | 0.85 | 0.867 | 33 | 0.316 | 27 | 299.685 | 34 | 138.886 | 38 | 132 |
|  | 0.90 | 0.919 | 39 | 0.231 | 10 | 269.716 | 37 | 147.23 | 34 | 120 |
| 200 | 0.55 | 0.471 | 10 | 0.182 | 5 | 498.601 | 30 | 224.186 | 11 | 56 |
|  | 0.60 | 0.489 | 19 | 0.286 | 20 | 513.827 | 19 | 198.62 | 30 | 88 |
|  | 0.65 | 0.499 | 23 | 0.349 | 38 | 534.162 | 15 | 199.972 | 28 | 104 |
|  | 0.70 | 0.478 | 16 | 0.297 | 23 | 578.009 | 10 | 230.933 | 5 | 54 |
|  | 0.75 | 0.418 | 6 | 0.355 | 40 | 600.194 | 6 | 209.958 | 19 | 71 |
|  | 0.80 | 0.952 | 45 | 0.32 | 32 | 160.789 | 47 | 94.611 | 45 | 169 |
|  | 0.85 | 0.937 | 42 | 0.316 | 27 | 206.661 | 42 | 110.532 | 44 | 155 |
|  | 0.90 | 0.956 | 48 | 0.231 | 10 | 199.896 | 44 | 121.533 | 40 | 142 |
| 250 | 0.55 | 0.462 | 7 | 0.2 | 6 | 502.864 | 25 | 232.958 | 2 | 40 |
|  | 0.60 | 0.501 | 24 | 0.245 | 14 | 507.505 | 21 | 204.014 | 24 | 83 |
|  | 0.65 | 0.512 | 30 | 0.326 | 36 | 527.242 | 18 | 204.978 | 23 | 107 |
|  | 0.70 | 0.477 | 15 | 0.297 | 23 | 578.447 | 9 | 230.09 | 7 | 54 |
|  | 0.75 | 0.413 | 1 | 0.323 | 33 | 602.703 | 2 | 218.137 | 13 | 49 |
|  | **0.80** | **0.952** | **45** | **0.4** | **45** | **160.101** | **48** | **88.156** | **48** | **186** |
|  | 0.85 | 0.868 | 35 | 0.316 | 27 | 299.127 | 35 | 139.522 | 37 | 134 |
|  | 0.90 | 0.905 | 38 | 0.154 | 2 | 292.529 | 36 | 159.834 | 32 | 108 |
| 300 | 0.55 | 0.471 | 10 | 0.127 | 1 | 498.713 | 28 | 222.127 | 12 | 51 |
|  | 0.60 | 0.489 | 19 | 0.286 | 20 | 513.585 | 20 | 199 | 29 | 88 |
|  | 0.65 | 0.505 | 25 | 0.349 | 38 | 531.228 | 16 | 211.239 | 16 | 95 |
|  | 0.70 | 0.476 | 14 | 0.297 | 23 | 578.823 | 8 | 231.026 | 4 | 49 |
|  | 0.75 | 0.414 | 3 | 0.355 | 40 | 602.243 | 4 | 214.29 | 15 | 62 |
|  | 0.80 | 0.869 | 36 | 0.4 | 45 | 264.767 | 38 | 121.12 | 42 | 161 |
|  | 0.85 | 0.864 | 32 | 0.263 | 17 | 303.264 | 32 | 142.064 | 35 | 116 |
|  | 0.90 | 0.955 | 47 | 0.231 | 10 | 200.447 | 43 | 121.963 | 39 | 139 |

**2. Results of failure modes identification**

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

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

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

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A picture containing screenshot, text, graphics, graphic design

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

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

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

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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pop** | **Tr.atio** | **Acc** | **Score** | **Pre** | **Score** | **Re** | **Score** | **f1** | **Score** | **Total** |
| 50 | 0.55 | 0.69 | 7 | 0.688 | 6 | 0.69 | 7 | 0.685 | 7 | 27 |
|  | 0.60 | 0.844 | 40 | 0.844 | 40 | 0.844 | 40 | 0.842 | 39 | 159 |
|  | 0.65 | 0.805 | 30 | 0.807 | 30 | 0.805 | 30 | 0.804 | 30 | 120 |
|  | 0.70 | 0.703 | 8 | 0.722 | 10 | 0.703 | 8 | 0.697 | 8 | 34 |
|  | 0.75 | 0.883 | 47 | 0.894 | 48 | 0.883 | 47 | 0.881 | 47 | 189 |
|  | 0.80 | 0.836 | 38 | 0.835 | 38 | 0.836 | 38 | 0.835 | 38 | 152 |
|  | 0.85 | 0.819 | 35 | 0.82 | 35 | 0.819 | 35 | 0.819 | 35 | 140 |
|  | 0.90 | 0.744 | 13 | 0.748 | 14 | 0.744 | 13 | 0.743 | 13 | 53 |
| 100 | 0.55 | 0.56 | 1 | 0.638 | 1 | 0.56 | 1 | 0.576 | 1 | 4 |
|  | 0.60 | 0.844 | 40 | 0.857 | 45 | 0.844 | 40 | 0.844 | 41 | 166 |
|  | 0.65 | 0.746 | 14 | 0.751 | 15 | 0.746 | 14 | 0.745 | 15 | 58 |
|  | 0.70 | 0.703 | 8 | 0.707 | 8 | 0.703 | 8 | 0.701 | 9 | 33 |
|  | 0.75 | 0.818 | 33 | 0.817 | 33 | 0.818 | 33 | 0.816 | 33 | 132 |
|  | 0.80 | 0.795 | 25 | 0.794 | 24 | 0.795 | 25 | 0.794 | 25 | 99 |
|  | 0.85 | 0.871 | 46 | 0.874 | 46 | 0.871 | 46 | 0.871 | 46 | 184 |
|  | 0.90 | 0.854 | 43 | 0.854 | 42 | 0.854 | 43 | 0.854 | 43 | 171 |
| 150 | 0.55 | 0.61 | 3 | 0.657 | 4 | 0.61 | 3 | 0.62 | 3 | 13 |
|  | 0.60 | 0.642 | 4 | 0.642 | 3 | 0.642 | 4 | 0.639 | 4 | 15 |
|  | 0.65 | 0.746 | 14 | 0.751 | 15 | 0.746 | 14 | 0.745 | 15 | 58 |
|  | 0.70 | 0.82 | 37 | 0.827 | 37 | 0.82 | 37 | 0.82 | 37 | 148 |
|  | 0.75 | 0.818 | 33 | 0.819 | 34 | 0.818 | 33 | 0.817 | 34 | 134 |
|  | 0.80 | 0.842 | 39 | 0.842 | 39 | 0.842 | 39 | 0.842 | 40 | 157 |
|  | **0.85** | **0.819** | **35** | **0.821** | **36** | **0.819** | **35** | **0.819** | **36** | **142** |
|  | 0.90 | 0.854 | 43 | 0.854 | 42 | 0.854 | 43 | 0.854 | 43 | 171 |
| 200 | 0.55 | 0.75 | 17 | 0.779 | 20 | 0.75 | 17 | 0.748 | 17 | 71 |
|  | 0.60 | 0.752 | 19 | 0.753 | 18 | 0.752 | 19 | 0.752 | 19 | 75 |
|  | 0.65 | 0.678 | 6 | 0.678 | 5 | 0.678 | 6 | 0.672 | 6 | 23 |
|  | 0.70 | 0.797 | 27 | 0.797 | 25 | 0.797 | 27 | 0.797 | 28 | 107 |
|  | 0.75 | 0.723 | 11 | 0.731 | 11 | 0.723 | 11 | 0.719 | 11 | 44 |
|  | 0.80 | 0.856 | 45 | 0.856 | 44 | 0.856 | 45 | 0.856 | 45 | 179 |
|  | 0.85 | 0.794 | 24 | 0.793 | 23 | 0.794 | 24 | 0.793 | 24 | 95 |
|  | 0.90 | 0.805 | 29 | 0.806 | 29 | 0.805 | 29 | 0.803 | 29 | 116 |
| 250 | 0.55 | 0.56 | 1 | 0.638 | 1 | 0.56 | 1 | 0.576 | 1 | 4 |
|  | 0.60 | 0.67 | 5 | 0.696 | 7 | 0.67 | 5 | 0.66 | 5 | 22 |
|  | 0.65 | 0.746 | 14 | 0.746 | 13 | 0.746 | 14 | 0.744 | 14 | 55 |
|  | 0.70 | 0.703 | 8 | 0.707 | 8 | 0.703 | 8 | 0.701 | 9 | 33 |
|  | 0.75 | 0.723 | 11 | 0.731 | 11 | 0.723 | 11 | 0.719 | 11 | 44 |
|  | 0.80 | 0.781 | 21 | 0.781 | 21 | 0.781 | 21 | 0.78 | 21 | 84 |
|  | 0.85 | 0.89 | 48 | 0.893 | 47 | 0.89 | 48 | 0.89 | 48 | 191 |
|  | 0.90 | 0.793 | 23 | 0.798 | 27 | 0.793 | 23 | 0.792 | 23 | 96 |
| 300 | 0.55 | 0.85 | 42 | 0.853 | 41 | 0.85 | 42 | 0.85 | 42 | 167 |
|  | 0.60 | 0.752 | 19 | 0.753 | 18 | 0.752 | 19 | 0.752 | 19 | 75 |
|  | 0.65 | 0.805 | 30 | 0.807 | 30 | 0.805 | 30 | 0.804 | 30 | 120 |
|  | 0.70 | 0.75 | 17 | 0.752 | 17 | 0.75 | 17 | 0.75 | 18 | 69 |
|  | 0.75 | 0.796 | 26 | 0.797 | 26 | 0.796 | 26 | 0.795 | 26 | 104 |
|  | 0.80 | 0.781 | 21 | 0.781 | 21 | 0.781 | 21 | 0.78 | 21 | 84 |
|  | 0.85 | 0.806 | 32 | 0.81 | 32 | 0.806 | 32 | 0.806 | 32 | 128 |
|  | 0.90 | 0.799 | 28 | 0.802 | 28 | 0.799 | 28 | 0.795 | 27 | 111 |

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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pop** | **Tr.atio** | **Acc** | **Score** | **Pre** | **Score** | **Re** | **Score** | **f1** | **Score** | **Total** |
| 50 | 0.55 | 0.687 | 10 | 0.719 | 12 | 0.687 | 10 | 0.69 | 11 | 43 |
|  | 0.60 | 0.757 | 20 | 0.751 | 19 | 0.757 | 20 | 0.752 | 20 | 79 |
|  | 0.65 | 0.769 | 21 | 0.772 | 21 | 0.769 | 21 | 0.77 | 22 | 85 |
|  | 0.70 | 0.691 | 11 | 0.721 | 13 | 0.691 | 11 | 0.686 | 10 | 45 |
|  | 0.75 | 0.739 | 19 | 0.742 | 17 | 0.739 | 19 | 0.73 | 17 | 72 |
|  | **0.80** | 0.784 | 25 | 0.789 | 25 | 0.784 | 25 | 0.783 | 25 | 100 |
|  | 0.85 | 0.786 | 29 | 0.787 | 24 | 0.786 | 29 | 0.785 | 29 | 111 |
|  | 0.90 | 0.632 | 6 | 0.672 | 6 | 0.632 | 6 | 0.631 | 6 | 24 |
| 100 | 0.55 | 0.542 | 1 | 0.571 | 1 | 0.542 | 1 | 0.548 | 1 | 4 |
|  | 0.60 | 0.77 | 23 | 0.8 | 29 | 0.77 | 23 | 0.767 | 21 | 96 |
|  | 0.65 | 0.692 | 12 | 0.707 | 10 | 0.692 | 12 | 0.694 | 12 | 46 |
|  | 0.70 | 0.655 | 7 | 0.673 | 7 | 0.655 | 7 | 0.655 | 7 | 28 |
|  | 0.75 | 0.804 | 33 | 0.814 | 34 | 0.804 | 33 | 0.803 | 35 | 135 |
|  | 0.80 | 0.784 | 25 | 0.786 | 23 | 0.784 | 25 | 0.784 | 28 | 101 |
|  | 0.85 | 0.857 | 47 | 0.859 | 47 | 0.857 | 47 | 0.853 | 47 | 188 |
|  | 0.90 | 0.789 | 31 | 0.801 | 30 | 0.789 | 31 | 0.79 | 31 | 123 |
| 150 | 0.55 | 0.59 | 3 | 0.632 | 5 | 0.59 | 3 | 0.588 | 3 | 14 |
|  | 0.60 | 0.608 | 4 | 0.603 | 3 | 0.608 | 4 | 0.605 | 5 | 16 |
|  | 0.65 | 0.692 | 12 | 0.707 | 10 | 0.692 | 12 | 0.694 | 12 | 46 |
|  | 0.70 | 0.836 | 43 | 0.843 | 44 | 0.836 | 43 | 0.837 | 43 | 173 |
|  | 0.75 | 0.804 | 33 | 0.824 | 39 | 0.804 | 33 | 0.803 | 36 | 141 |
|  | 0.80 | 0.811 | 38 | 0.814 | 33 | 0.811 | 38 | 0.812 | 40 | 149 |
|  | **0.85** | **0.893** | **48** | **0.899** | **48** | **0.893** | **48** | **0.894** | **48** | **192** |
|  | 0.90 | 0.789 | 31 | 0.801 | 30 | 0.789 | 31 | 0.79 | 31 | 123 |
| 200 | 0.55 | 0.783 | 24 | 0.79 | 28 | 0.783 | 24 | 0.781 | 24 | 100 |
|  | 0.60 | 0.784 | 25 | 0.789 | 26 | 0.784 | 25 | 0.784 | 26 | 102 |
|  | 0.65 | 0.723 | 15 | 0.727 | 15 | 0.723 | 15 | 0.724 | 15 | 60 |
|  | 0.70 | 0.727 | 17 | 0.75 | 18 | 0.727 | 17 | 0.733 | 19 | 71 |
|  | 0.75 | 0.804 | 33 | 0.82 | 37 | 0.804 | 33 | 0.803 | 33 | 136 |
|  | 0.80 | 0.838 | 44 | 0.839 | 43 | 0.838 | 44 | 0.837 | 44 | 175 |
|  | 0.85 | 0.714 | 14 | 0.722 | 14 | 0.714 | 14 | 0.713 | 14 | 56 |
|  | 0.90 | 0.842 | 45 | 0.855 | 46 | 0.842 | 45 | 0.844 | 46 | 182 |
| 250 | 0.55 | 0.542 | 1 | 0.571 | 1 | 0.542 | 1 | 0.548 | 1 | 4 |
|  | 0.60 | 0.608 | 4 | 0.605 | 4 | 0.608 | 4 | 0.599 | 4 | 16 |
|  | 0.65 | 0.723 | 15 | 0.729 | 16 | 0.723 | 15 | 0.725 | 16 | 62 |
|  | 0.70 | 0.655 | 7 | 0.673 | 7 | 0.655 | 7 | 0.655 | 7 | 28 |
|  | 0.75 | 0.804 | 33 | 0.82 | 37 | 0.804 | 33 | 0.803 | 33 | 136 |
|  | 0.80 | 0.811 | 38 | 0.815 | 35 | 0.811 | 38 | 0.81 | 38 | 149 |
|  | 0.85 | 0.821 | 42 | 0.829 | 41 | 0.821 | 42 | 0.819 | 42 | 167 |
|  | 0.90 | 0.737 | 18 | 0.754 | 20 | 0.737 | 18 | 0.732 | 18 | 74 |
| 300 | 0.55 | 0.819 | 41 | 0.825 | 40 | 0.819 | 41 | 0.818 | 41 | 163 |
|  | 0.60 | 0.784 | 25 | 0.789 | 26 | 0.784 | 25 | 0.784 | 26 | 102 |
|  | 0.65 | 0.769 | 21 | 0.772 | 21 | 0.769 | 21 | 0.77 | 22 | 85 |
|  | 0.70 | 0.655 | 7 | 0.681 | 9 | 0.655 | 7 | 0.662 | 9 | 32 |
|  | 0.75 | 0.804 | 33 | 0.829 | 42 | 0.804 | 33 | 0.804 | 37 | 145 |
|  | 0.80 | 0.811 | 38 | 0.815 | 35 | 0.811 | 38 | 0.81 | 38 | 149 |
|  | 0.85 | 0.786 | 29 | 0.802 | 32 | 0.786 | 29 | 0.788 | 30 | 120 |
|  | 0.90 | 0.842 | 45 | 0.844 | 45 | 0.842 | 45 | 0.839 | 45 | 180 |

A screenshot of a computer

Description automatically generated with low confidenceA picture containing screenshot, rectangle, square, design

Description automatically generated

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