# *Experimental data on the mechanical properties of extruded composites from recycled wind turbine blade material*

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**Abstract**

The wind turbine blades (WTB) that face end-of-life was first mechanically milled and classified through a range of varying screen sizes. We then blended this with high density polyethylene (HDPE) thermoplastic resin and extruded it to a profiled composite. We determined the influence of refined particle size, resin content and coupling agents (maleic anhydride polyethylene (MAPE) and methacryloxypropyltriethoxysilane (Silane)) on the mechanical properties of recycled composites [1].

**Keywords:** Recycling, Wind turbine blade, Polymer-matrix composite, Glass fiber

**Value of the Data**

- Based on presented data, researchers could be referred to this dataset to design and analyze different experiments on rWTBs.
- Presented dataset shows consistency among the samples and helps researcher to see the actual trend among these second-generation composites with different formulation.
- Raw dataset presented on mechanical properties of rWTB composites helps other researcher in this field to understand the original condition of these second-generation composites.
- Data on Mechanical properties of second-generation composites manufactured from rWTB materials gives the researchers clear vision about the potential utilization of these second-generation composites.

## 1. Data

*For obtaining mechanical properties of thermoplastic composites fabricated using recycled wind turbine blade materials, flexural tests were performed based on ASTM D790-17. We determined the influence of refined particle size, resin content and coupling agents (maleic anhydride*

*polyethylene (MAPE) and methacryloxypropyltriethoxysilane (Silane)) on the mechanical properties of recycled composites.*

## 2. Experimental Design, Materials, and Methods

### 2.1 Materials

*Recycled wind turbine blade (rWTB) material was supplied by Global Fiberglass Solutions at an incoming moisture content of 1.25% and shipped to the Composites Materials and Engineering Center at Washington State University. A high-density polyethylene (HDPE) (0.3 MFI) was obtained from a commercial vender and used as the matrix for the second-generation extruded composite. The rWTB material was hammer-milled through 3.18, and 1.59 mm screen size (MSS) and particle size distribution of the refined material was performed with Ro-Tap sieve analysis procedures [2]. A commercially available 60-mesh pine (P. stobus) was used for baseline comparison to the rWTB filled extrudate. Methacryloxypropyltrimethoxysilane (Silane) (Gelest Inc.) and maleic anhydride polyethylene (MAPE) were used as the coupling agents [3].*

**Table 1. Extruded rWTB composite formulation**

| Sample # | Pine (40 mesh) (%) | Pine (60 mech) (%) | 3.18 mm MSS rWTB(%) | 1.59 mm MSS rWTB (%) | Talc (%) | MAP (%) | Silane (%) | HDPE(%) |
|---|---|---|---|---|---|---|---|---|
| 1 | 55 | | 0 | | 6 | | | 36 |
| 2 | | | 40 | | 6 | | | 51 |
| 3 | | | 45 | | 6 | | | 46 |
| 4 | | | 50 | | 6 | | | 41 |
| 5 | | | 55 | | 6 | | | 36 |
| 6 | | | 60 | | 6 | | | 31 |
| 7 | | | 50 | | | | | 47 |
| 8 | | | 55 | | | | | 42 |
| 9 | | | 60 | | | | | 37 |
| 10 | | 55 | | | | | | 42 |
| 11 | | 55 | | | 6 | | | 36 |
| 12 | | 55 | | | | 2 | | 40 |
| 13 | | 54.5 | | | | | 0.5 | 42 |
| 14 | | | | 50 | | | | 47 |
| 15 | | | | 55 | | | | 42 |
| 16 | | | | 60 | | | | 37 |
| 17 | | | | 50 | | 2 | | 45 |
| 18 | | | | 55 | | 2 | | 40 |
| 19 | | | | 60 | | 2 | | 35 |
| 20 | | | | 49.5 | | | 0.5 | 47 |
| 21 | | | | 54.5 | | | 0.5 | 42 |

| | | | | |
|---|---|---|---|---|
| 22 | | 59.5 | 0.5 | 37 |
| 23 | 13.75 | 41.25 | | 42 |
| 24 | 27.5 | 27.5 | | 42 |
| 25 | 41.25 | 13.75 | | 42 |
| 26 | | 65 | 2 | 30 |
| 27 | | 70 | 2 | 25 |
| 28 | | 65 | | 32 |
| 29 | | 70 | | 27 |

## 2.2 Extruded rWTB composite preparation

*The various milled size fractions of rWTB material were mixed with high density polyethylene, non-metallic stearate lubricant, MAPE and silane as coupling agents were also added to the formulation. Silane was received in a liquid form and sprayed to rWTB materials. They were then blended for 15 minutes and dried for 10 hours at 60 ℃ in an oven [4]. MAPE was added to the dry blend as a pellet. For comparison purposes, a commercial 60-mesh pine was used as a feedstock source. Mechanical tests were performed based on ASTM D790-17 [5].*

## *2.3* Mechanical properties of extruded rWTB composites

*The mechanical properties of the extruded composites were obtained from flexural tests. To evaluate the influence of MSS on the mechanical properties, milled material from 3.18 and 1.59 mm MSS was chosen. data show that decreasing MSS decreased both modulus of elasticity (MOE) and modulus of rupture (MOR) while the strain at break (SB) remained consistent as shown in Table 1. While MSS had a slightly significant influence on the MOE, it did not have a significant influence on MOR and SB. When the level of rWTB was changed, all of the mechanical properties varied significantly as well. Addition of more rWTB to the mix increased the MOE and lowered the SB, while the MOR remained constant.*

Table2: physical properties of each specimen prepared for Flexural test.

| | | | | | | | Average (In) | |
|---|---|---|---|---|---|---|---|---|
| Sample # | Depth (In) | | | Width (In) | | | Depth | Width |
| 1-1 | 0.3815 | 0.385 | 0.3885 | 1.498 | 1.486 | 1.489 | 0.385 | 1.491 |
| 1-2 | 0.378 | 0.371 | 0.373 | 1.4905 | 1.4755 | 1.4835 | 0.374 | 1.483 |
| 1-3 | 0.373 | 0.369 | 0.371 | 1.483 | 1.4815 | 1.4815 | 0.371 | 1.482 |
| 1-4 | 0.376 | 0.375 | 0.3735 | 1.484 | 1.487 | 1.485 | 0.374 | 1.485 |
| 1-5 | 0.3735 | 0.374 | 0.3765 | 1.4815 | 1.4815 | 1.4855 | 0.374 | 1.482 |
| 1-6 | 0.374 | 0.369 | 0.3715 | 1.488 | 1.482 | 1.4855 | 0.371 | 1.485 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3--1 | 0.45 | 0.457 | 0.442 | 1.5075 | 1.5185 | 1.523 | 0.449 | 1.516 |
| 3--2 | 0.452 | 0.465 | 0.463 | 1.502 | 1.5415 | 1.531 | 0.460 | 1.524 |
| 3--3 | 0.433 | 0.434 | 0.431 | 1.505 | 1.501 | 1.498 | 0.432 | 1.501 |
| 3--4 | 0.423 | 0.428 | 0.4295 | 1.48 | 1.4885 | 1.503 | 0.426 | 1.490 |
| 3--5 | 0.44 | 0.4555 | 0.4495 | 1.492 | 1.5085 | 1.517 | 0.448 | 1.505 |
| 3--6 | 0.4255 | 0.427 | 0.434 | 1.492 | 1.485 | 1.489 | 0.428 | 1.488 |
| 4-1 | 0.4385 | 0.428 | 0.4235 | 1.5095 | 1.5005 | 1.499 | 0.43 | 1.503 |
| 4-2 | 0.423 | 0.4265 | 0.4255 | 1.49 | 1.498 | 1.5105 | 0.425 | 1.4995 |
| 4-3 | 0.442 | 0.445 | 0.4515 | 1.5145 | 1.5065 | 1.517 | 0.446 | 1.512 |
| 4-4 | 0.4285 | 0.4195 | 0.4225 | 1.5005 | 1.4965 | 1.4915 | 0.423 | 1.496 |
| 4-5 | 0.434 | 0.4365 | 0.4375 | 1.512 | 1.5125 | 1.5105 | 0.436 | 1.511 |
| 4-6 | 0.4375 | 0.437 | 0.4475 | 1.5025 | 1.51 | 1.5125 | 0.440 | 1.508 |
| 5-1 | 0.3965 | 0.395 | 0.3955 | 1.4815 | 1.48 | 1.481 | 0.395 | 1.480 |
| 5-2 | 0.3985 | 0.391 | 0.3935 | 1.4755 | 1.476 | 1.4785 | 0.394 | 1.476 |
| 5-3 | 0.3995 | 0.39 | 0.388 | 1.478 | 1.4795 | 1.4745 | 0.392 | 1.477 |
| 5-4 | 0.4 | 0.4005 | 0.3955 | 1.491 | 1.4815 | 1.4865 | 0.398 | 1.486 |
| 5-5 | 0.401 | 0.398 | 0.3955 | 1.492 | 1.4845 | 1.479 | 0.398 | 1.485 |
| 5-6 | 0.398 | 0.3955 | 0.3935 | 1.482 | 1.4705 | 1.471 | 0.395 | 1.474 |
| 6-1 | 0.3875 | 0.3885 | 0.389 | 1.4855 | 1.4805 | 1.481 | 0.388 | 1.482 |
| 6-2 | 0.389 | 0.3935 | 0.392 | 1.4985 | 1.4865 | 1.479 | 0.391 | 1.488 |
| 6-3 | 0.392 | 0.387 | 0.387 | 1.494 | 1.4805 | 1.4825 | 0.388 | 1.485 |
| 6-4 | 0.391 | 0.389 | 0.387 | 1.477 | 1.4725 | 1.4725 | 0.389 | 1.474 |
| 6-5 | 0.3915 | 0.392 | 0.389 | 1.4755 | 1.4755 | 1.469 | 0.390 | 1.473 |
| 6-6 | 0.391 | 0.3925 | 0.39 | 1.478 | 1.4815 | 1.484 | 0.391 | 1.481 |
| 7-1 | 0.412 | 0.414 | 0.4035 | 1.485 | 1.477 | 1.477 | 0.409 | 1.479 |
| 7-2 | 0.404 | 0.419 | 0.4115 | 1.4765 | 1.464 | 1.475 | 0.411 | 1.471 |
| 7-3 | 0.411 | 0.4085 | 0.4145 | 1.473 | 1.471 | 1.4815 | 0.411 | 1.475 |
| 7-4 | 0.419 | 0.418 | 0.408 | 1.481 | 1.482 | 1.4845 | 0.415 | 1.482 |
| 7-5 | 0.399 | 0.4145 | 0.412 | 1.486 | 1.4705 | 1.4765 | 0.408 | 1.477 |
| 7-6 | 0.414 | 0.415 | 0.418 | 1.4945 | 1.4855 | 1.4955 | 0.415 | 1.491 |
| 8-1 | 0.399 | 0.41 | 0.402 | 1.479 | 1.482 | 1.4825 | 0.401 | 1.481 |
| 8-2 | 0.3995 | 0.4055 | 0.406 | 1.466 | 1.467 | 1.467 | 0.403 | 1.466 |
| 8-3 | 0.4 | 0.4015 | 0.3965 | 1.4995 | 1.481 | 1.483 | 0.399 | 1.487 |
| 8-4 | 0.4035 | 0.406 | 0.399 | 1.483 | 1.469 | 1.4525 | 0.402 | 1.468 |
| 8-5 | 0.399 | 0.398 | 0.3995 | 1.4715 | 1.4685 | 1.473 | 0.398 | 1.471 |
| 8-6 | 0.4015 | 0.396 | 0.403 | 1.493 | 1.4845 | 1.4885 | 0.400 | 1.488 |

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|---|---|---|---|---|---|---|---|---|
| 9-1 | 0.396 | 0.3985 | 0.398 | 1.4995 | 1.4875 | 1.485 | 0.397 | 1.490 |
| 9-2 | 0.397 | 0.393 | 0.3935 | 1.492 | 1.491 | 1.494 | 0.394 | 1.492 |
| 9-3 | 0.403 | 0.3965 | 0.394 | 1.487 | 1.489 | 1.484 | 0.397 | 1.486 |
| 9-4 | 0.405 | 0.393 | 0.394 | 1.502 | 1.478 | 1.4795 | 0.397 | 1.486 |
| 9-5 | 0.412 | 0.4065 | 0.408 | 1.497 | 1.4905 | 1.502 | 0.408 | 1.496 |
| 9-6 | 0.401 | 0.3895 | 0.4 | 1.4935 | 1.462 | 1.4605 | 0.396 | 1.472 |
| 10-1 | 0.385 | 0.389 | 0.3855 | 1.479 | 1.477 | 1.478 | 0.386 | 1.478 |
| 10-2 | 0.389 | 0.3845 | 0.388 | 1.4835 | 1.478 | 1.473 | 0.387 | 1.478 |
| 10-3 | 0.395 | 0.3865 | 0.386 | 1.479 | 1.4785 | 1.4745 | 0.389 | 1.477 |
| 10-4 | 0.396 | 0.3885 | 0.3845 | 1.4755 | 1.4725 | 1.474 | 0.389 | 1.474 |
| 10-5 | 0.387 | 0.3865 | 0.391 | 1.485 | 1.48 | 1.474 | 0.388 | 1.479 |
| 10-6 | 0.387 | 0.39 | 0.3905 | 1.4745 | 1.4745 | 1.4745 | 0.389 | 1.474 |
| 11-1 | 0.39 | 0.382 | 0.384 | 1.483 | 1.4815 | 1.481 | 0.386 | 1.481 |
| 11-2 | 0.395 | 0.3835 | 0.3845 | 1.4805 | 1.48 | 1.48 | 0.387 | 1.480 |
| 11-3 | 0.392 | 0.381 | 0.385 | 1.49 | 1.481 | 1.483 | 0.386 | 1.484 |
| 11-4 | 0.394 | 0.382 | 0.383 | 1.483 | 1.481 | 1.479 | 0.389 | 1.481 |
| 11-5 | 0.3855 | 0.3825 | 0.3805 | 1.483 | 1.4805 | 1.479 | 0.382 | 1.480 |
| 11-6 | 0.385 | 0.3835 | 0.382 | 1.4825 | 1.485 | 1.431 | 0.383 | 1.466 |
| 12-1 | 0.3885 | 0.381 | 0.384 | 1.454 | 1.461 | 1.458 | 0.384 | 1.457 |
| 12-2 | 0.378 | 0.385 | 0.3895 | 1.4505 | 1.4405 | 1.444 | 0.384 | 1.445 |
| 12-3 | 0.385 | 0.38 | 0.399 | 1.4505 | 1.4505 | 1.444 | 0.388 | 1.448 |
| 12-4 | 0.3835 | 0.3795 | 0.3755 | 1.4745 | 1.473 | 1.47 | 0.379 | 1.472 |
| 12-5 | 0.3815 | 0.38 | 0.38 | 1.457 | 1.4705 | 1.46 | 0.380 | 1.462 |
| 12-6 | 0.376 | 0.38 | 0.378 | 1.464 | 1.4615 | 1.4625 | 0.378 | 1.46 |
| 14-1 | 0.424 | 0.442 | 0.4345 | 1.5105 | 1.502 | 1.4985 | 0.433 | 1.503 |
| 14-2 | 0.4385 | 0.436 | 0.437 | 1.504 | 1.501 | 1.51 | 0.4371 | 1.505 |
| 14-3 | 0.435 | 0.431 | 0.4295 | 1.4915 | 1.484 | 1.4835 | 0.431 | 1.486 |
| 14-4 | 0.438 | 0.443 | 0.438 | 1.4955 | 1.504 | 1.4995 | 0.439 | 1.499 |
| 14-5 | 0.4325 | 0.436 | 0.4395 | 1.5175 | 1.512 | 1.514 | 0.436 | 1.514 |
| 14-6 | 0.448 | 0.448 | 0.433 | 1.513 | 1.5015 | 1.5045 | 0.443 | 1.506 |
| 15-1 | 0.4185 | 0.4245 | 0.4275 | 1.479 | 1.4835 | 1.482 | 0.423 | 1.481 |
| 15-2 | 0.4335 | 0.4285 | 0.4215 | 1.47 | 1.475 | 1.475 | 0.429 | 1.473 |
| 15-3 | 0.437 | 0.445 | 0.446 | 1.5065 | 1.493 | 1.5055 | 0.444 | 1.501 |
| 15-4 | 0.425 | 0.4285 | 0.423 | 1.4925 | 1.4865 | 1.489 | 0.425 | 1.488 |
| 15-5 | 0.4235 | 0.4245 | 0.4315 | 1.4815 | 1.478 | 1.477 | 0.426 | 1.478 |
| 15-6 | 0.441 | 0.429 | 0.4285 | 1.4835 | 1.488 | 1.4735 | 0.4328 | 1.4816 |

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|---|---|---|---|---|---|---|---|---|
| 16-1 | 0.4085 | 0.4085 | 0.406 | 1.482 | 1.4785 | 1.4805 | 0.407 | 1.488 |
| 16-2 | 0.408 | 0.4155 | 0.408 | 1.477 | 1.483 | 1.481 | 0.410 | 1.480 |
| 16-3 | 0.413 | 0.409 | 0.411 | 1.4845 | 1.4825 | 1.474 | 0.411 | 1.480 |
| 16-4 | 0.4085 | 0.412 | 0.408 | 1.481 | 1.471 | 1.469 | 0.409 | 1.473 |
| 16-5 | 0.409 | 0.4095 | 0.412 | 1.479 | 1.482 | 1.4755 | 0.410 | 1.479 |
| 16-6 | 0.4115 | 0.4085 | 0.417 | 1.483 | 1.483 | 1.4795 | 0.412 | 1.481 |
| 17-1 | 0.409 | 0.419 | 0.42 | 1.4705 | 1.471 | 1.4685 | 0.416 | 1.477 |
| 17-2 | 0.413 | 0.418 | 0.4095 | 1.4705 | 1.463 | 1.446 | 0.413 | 1.459 |
| 17-3 | 0.413 | 0.415 | 0.41 | 1.454 | 1.452 | 1.466 | 0.412 | 1.457 |
| 17-4 | 0.419 | 0.412 | 0.413 | 1.473 | 1.48 | 1.453 | 0.414 | 1.468 |
| 17-5 | 0.404 | 0.4045 | 0.4035 | 1.4705 | 1.463 | 1.472 | 0.404 | 1.468 |
| 17-6 | 0.42 | 0.4125 | 0.424 | 1.461 | 1.461 | 1.4605 | 0.418 | 1.460 |
| 18-1 | 0.404 | 0.404 | 0.406 | 1.454 | 1.464 | 1.451 | 0.404 | 1.45 |
| 18-2 | 0.402 | 0.401 | 0.403 | 1.444 | 1.4485 | 1.4455 | 0.402 | 1.446 |
| 18-3 | 0.4035 | 0.4065 | 0.4045 | 1.4505 | 1.4445 | 1.453 | 0.404 | 1.449 |
| 18-4 | 0.402 | 0.4045 | 0.391 | 1.46 | 1.4645 | 1.4425 | 0.399 | 1.455 |
| 18-5 | 0.397 | 0.3945 | 0.3925 | 1.457 | 1.455 | 1.4535 | 0.394 | 1.455 |
| 18-6 | 0.411 | 0.409 | 0.411 | 1.4695 | 1.462 | 1.4655 | 0.410 | 1.465 |
| 19-1 | 0.389 | 0.385 | 0.3885 | 1.4455 | 1.449 | 1.441 | 0.387 | 1.445 |
| 19-2 | 0.384 | 0.385 | 0.388 | 1.452 | 1.457 | 1.456 | 0.385 | 1.455 |
| 19-3 | 0.394 | 0.39 | 0.392 | 1.46 | 1.463 | 1.461 | 0.392 | 1.461 |
| 19-4 | 0.392 | 0.392 | 0.3865 | 1.46 | 1.468 | 1.468 | 0.390 | 1.465 |
| 19-5 | 0.391 | 0.3885 | 0.3865 | 1.4615 | 1.4505 | 1.448 | 0.388 | 1.453 |
| 19-6 | 0.395 | 0.3935 | 0.391 | 1.4675 | 1.466 | 1.466 | 0.393 | 1.466 |
| 13-1 | 0.3765 | 0.375 | 0.378 | 1.485 | 1.482 | 1.4825 | 0.376 | 1.483 |
| 13-2 | 0.38 | 0.379 | 0.378 | 1.487 | 1.4835 | 1.4805 | 0.379 | 1.483 |
| 13-3 | 0.3805 | 0.379 | 0.3805 | 1.485 | 1.485 | 1.483 | 0.388 | 1.484 |
| 13-4 | 0.387 | 0.387 | 0.383 | 1.491 | 1.488 | 1.4795 | 0.385 | 1.486 |
| 13-5 | 0.3885 | 0.387 | 0.391 | 1.485 | 1.486 | 1.4815 | 0.388 | 1.484 |
| 13-6 | 0.387 | 0.3945 | 0.391 | 1.4815 | 1.488 | 1.483 | 0.390 | 1.489 |
| 20-1 | 0.4565 | 0.4445 | 0.437 | 1.5105 | 1.501 | 1.5005 | 0.446 | 1.504 |
| 20-2 | 0.436 | 0.454 | 0.4395 | 1.4985 | 1.4945 | 1.497 | 0.443 | 1.496 |
| 20-3 | 0.447 | 0.446 | 0.434 | 1.489 | 1.49 | 1.494 | 0.442 | 1.491 |
| 20-4 | 0.4525 | 0.446 | 0.452 | 1.4935 | 1.489 | 1.503 | 0.450 | 1.495 |
| 20-5 | 0.4675 | 0.446 | 0.431 | 1.502 | 1.5015 | 1.506 | 0.448 | 1.506 |
| 20-6 | 0.45 | 0.445 | 0.4515 | 1.499 | 1.5065 | 1.504 | 0.448 | 1.503 |

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|---|---|---|---|---|---|---|---|---|
| 21-1 | 0.442 | 0.4185 | 0.4205 | 1.4785 | 1.473 | 1.4735 | 0.427 | 1.475 |
| 21-2 | 0.4145 | 0.4245 | 0.4005 | 1.477 | 1.48 | 1.477 | 0.413 | 1.478 |
| 21-3 | 0.405 | 0.4085 | 0.411 | 1.481 | 1.477 | 1.4785 | 0.408 | 1.478 |
| 21-4 | 0.409 | 0.412 | 0.4205 | 1.481 | 1.4785 | 1.4795 | 0.413 | 1.479 |
| 21-5 | 0.4135 | 0.409 | 0.404 | 1.485 | 1.4805 | 1.474 | 0.408 | 1.4798 |
| 21-6 | 0.3955 | 0.431 | 0.41 | 1.478 | 1.481 | 1.48 | 0.412 | 1.4796 |
| 22-1 | 0.3945 | 0.3935 | 0.389 | 1.4775 | 1.476 | 1.4785 | 0.392 | 1.477 |
| 22-2 | 0.392 | 0.389 | 0.3835 | 1.479 | 1.4875 | 1.479 | 0.388 | 1.481 |
| 22-3 | 0.394 | 0.39 | 0.396 | 1.4805 | 1.4755 | 1.477 | 0.393 | 1.477 |
| 22-4 | 0.392 | 0.3825 | 0.381 | 1.4835 | 1.475 | 1.484 | 0.385 | 1.480 |
| 22-5 | 0.3815 | 0.391 | 0.388 | 1.477 | 1.4755 | 1.48 | 0.386 | 1.477 |
| 22-6 | 0.39 | 0.3905 | 0.3985 | 1.4775 | 1.4745 | 1.479 | 0.393 | 1.477 |
| 23-1 | 0.393 | 0.393 | 0.387 | 1.4755 | 1.473 | 1.473 | 0.391 | 1.473 |
| 23-2 | 0.3925 | 0.3895 | 0.3935 | 1.474 | 1.471 | 1.4745 | 0.391 | 1.473 |
| 23-3 | 0.3895 | 0.389 | 0.387 | 1.479 | 1.4765 | 1.4775 | 0.388 | 1.477 |
| 23-4 | 0.391 | 0.388 | 0.388 | 1.4825 | 1.4765 | 1.482 | 0.389 | 1.480 |
| 23-5 | 0.392 | 0.3875 | 0.392 | 1.48 | 1.478 | 1.482 | 0.3905 | 1.48 |
| 23-6 | 0.3865 | 0.392 | 0.3925 | 1.476 | 1.4775 | 1.481 | 0.390 | 1.478 |
| 24-1 | 0.389 | 0.385 | 0.3855 | 1.477 | 1.4755 | 1.4745 | 0.386 | 1.475 |
| 24-2 | 0.385 | 0.386 | 0.3845 | 1.474 | 1.4745 | 1.476 | 0.385 | 1.474 |
| 24-3 | 0.383 | 0.3855 | 0.3845 | 1.481 | 1.4775 | 1.479 | 0.384 | 1.479 |
| 24-4 | 0.386 | 0.386 | 0.386 | 1.4815 | 1.476 | 1.476 | 0.386 | 1.477 |
| 24-5 | 0.38 | 0.387 | 0.387 | 1.472 | 1.472 | 1.474 | 0.384 | 1.472 |
| 24-6 | 0.386 | 0.3845 | 0.385 | 1.477 | 1.4735 | 1.472 | 0.385 | 1.474 |
| 25-1 | 0.386 | 0.386 | 0.3845 | 1.477 | 1.4765 | 1.4775 | 0.385 | 1.477 |
| 25-2 | 0.3835 | 0.3825 | 0.3815 | 1.482 | 1.48 | 1.479 | 0.382 | 1.480 |
| 25-3 | 0.3805 | 0.38 | 0.3825 | 1.4825 | 1.489 | 1.4795 | 0.381 | 1.483 |
| 25-4 | 0.382 | 0.386 | 0.383 | 1.481 | 1.479 | 1.481 | 0.383 | 1.480 |
| 25-5 | 0.386 | 0.3785 | 0.386 | 1.4805 | 1.4725 | 1.4695 | 0.383 | 1.487 |
| 25-6 | 0.39 | 0.391 | 0.3875 | 1.48 | 1.4745 | 1.477 | 0.389 | 1.477 |
| 26-1 | 0.373 | 0.375 | 0.3805 | 1.4515 | 1.4595 | 1.4555 | 0.376 | 1.455 |
| 26-2 | 0.379 | 0.3825 | 0.3805 | 1.4665 | 1.46 | 1.456 | 0.380 | 1.460 |
| 26-3 | 0.3835 | 0.384 | 0.383 | 1.461 | 1.4625 | 1.466 | 0.3835 | 1.463 |
| 26-4 | 0.3765 | 0.3785 | 0.384 | 1.451 | 1.448 | 1.449 | 0.379 | 1.448 |
| 26-5 | 0.3765 | 0.381 | 0.379 | 1.458 | 1.4635 | 1.4545 | 0.378 | 1.458 |
| 26-6 | 0.379 | 0.382 | 0.387 | 1.462 | 1.461 | 1.4605 | 0.382 | 1.461 |

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|---|---|---|---|---|---|---|---|---|
| 27-1 | 0.3695 | 0.3735 | 0.3675 | 1.4515 | 1.452 | 1.446 | 0.370 | 1.447 |
| 27-2 | 0.379 | 0.3655 | 0.37 | 1.4555 | 1.4525 | 1.4515 | 0.371 | 1.453 |
| 27-3 | 0.3735 | 0.37 | 0.3675 | 1.454 | 1.4565 | 1.453 | 0.370 | 1.454 |
| 27-4 | 0.3665 | 0.377 | 0.3715 | 1.4535 | 1.453 | 1.454 | 0.371 | 1.453 |
| 27-5 | 0.37 | 0.3675 | 0.3665 | 1.464 | 1.457 | 1.458 | 0.368 | 1.457 |
| 27-6 | 0.3695 | 0.3735 | 0.3745 | 1.465 | 1.463 | 1.4625 | 0.372 | 1.463 |
| 28-1 | 0.3845 | 0.3875 | 0.3805 | 1.481 | 1.478 | 1.476 | 0.384 | 1.478 |
| 28-2 | 0.3905 | 0.383 | 0.3865 | 1.4815 | 1.483 | 1.488 | 0.386 | 1.484 |
| 28-3 | 0.383 | 0.3815 | 0.3765 | 1.4695 | 1.4745 | 1.4795 | 0.380 | 1.474 |
| 28-4 | 0.3835 | 0.3845 | 0.382 | 1.477 | 1.476 | 1.4755 | 0.383 | 1.47 |
| 28-5 | 0.3775 | 0.3815 | 0.379 | 1.477 | 1.481 | 1.473 | 0.379 | 1.477 |
| 28-6 | 0.376 | 0.377 | 0.373 | 1.476 | 1.4755 | 1.479 | 0.375 | 1.476 |
| 29-1 | 0.38 | 0.3775 | 0.376 | 1.4795 | 1.4795 | 1.4885 | 0.377 | 1.482 |
| 29-2 | 0.3855 | 0.383 | 0.382 | 1.4875 | 1.4885 | 1.482 | 0.383 | 1.486 |
| 29-3 | 0.375 | 0.377 | 0.38 | 1.4845 | 1.483 | 1.488 | 0.377 | 1.485 |
| 29-4 | 0.381 | 0.388 | 0.3875 | 1.486 | 1.4835 | 1.492 | 0.385 | 1.487 |
| 29-5 | 0.377 | 0.379 | 0.377 | 1.483 | 1.4815 | 1.48 | 0.379 | 1.481 |
| 29-6 | 0.39 | 0.3905 | 0.3985 | 1.4775 | 1.4745 | 1.479 | 0.393 | 1.477 |

*MAPE and silane are two common coupling agents that are used in the production of reinforced thermoplastic composites. Table 3 presents the mechanical properties of composites modified with MAPE and silane. As expected, the results indicate that MAPE had a significantly positive influence on MOE and MOR of the composite. When the rWTB content increased, the MAPE had a slightly stronger influence on the MOE and MOR of the composite. The silane-based coupling agent showed limited improvement, and in some cases a reduction in the mechanical properties of composites at the lower rWTB levels. When the rWTB content increased, the influence of silane on MOE and MOR decreased. However, this effect was not significant. In addition, both the MAPE and silane reduced the SB of the composite. Because silane lacked performance, it was not used at higher level of rWTB content. As the rWTB level was increased to over 65%, there was a separation in behavior for the MAPE based composites. Results show that for the non-MAPE composites, increasing the rWTB content more than 65% decreased the MOE and MOR. However, MAPE had a significant influence on the MOE and MOR of composites with a higher rWTB content. By increasing rWTB content to more than 65%, the difference in MOE and MOR between untreated composite and modified with MAPE composite was significant. For a 70% rWTB content, the MOE and MOR of the composite modified with MAPE was almost twice that of the untreated composite. The decreasing trend of SB with increasing rWTB showed a leveling-off or plateau after 65%.*

Table 3: flexural properties of rWTB composites.

| Sample | Specimen | Density (lb/ft$^3$) | MOE (Psi) | MOR (Psi) | Strain at break |
|---|---|---|---|---|---|
| **1** | 1 | 66.5 | 304567.7 | 3231.804 | 0.0233567 |
| | 2 | 69.7 | 343208.1 | 3505.698 | 0.0236243 |
| | 3 | 70.3 | 330044.9 | 3380.67 | 0.0163448 |
| | 4 | 68.8 | 286116.8 | 3586.546 | 0.0215225 |
| | 5 | 69.5 | 281497.5 | 3327.194 | 0.0175193 |
| | 6 | 69.6 | 313466.8 | 3668.125 | 0.0194976 |
| Average for Sample 1 | | 69.07165 | 309817 | 3450.006 | 0.0203109 |
| Standard Dev for Sample 1 | | 1.349893 | 24202.09 | 165.4225 | 0.0030301 |
| Coefficient of Variation for Sample 1 | | 1.95% | 7.81% | 4.79% | 14.92% |
| **3** | 1 | 69.0 | 308541.1 | 3401.682 | 0.0276958 |
| | 2 | 68.5 | 306065.7 | 3452.762 | 0.0308106 |
| | 3 | 70.2 | 321223.7 | 3704.978 | 0.0319467 |
| | 4 | 70.2 | 305611.9 | 3647.846 | 0.0401398 |
| | 5 | 69.0 | 299410.5 | 3496.801 | 0.028492 |
| | 6 | 69.3 | 276882 | 3360.609 | 0.0408529 |
| Average for Sample 3 | | 69.39051 | 302955.8 | 3510.78 | 0.033323 |
| Standard Dev for Sample 3 | | 0.713198 | 14656.38 | 137.4883 | 0.0057685 |
| Coefficient of Variation for Sample 3 | | 1.03% | 4.84% | 3.92% | 17.31% |
| **4** | 1 | 72.8 | 362097 | 3800.943 | 0.0264318 |
| | 2 | 72.0 | 355692.3 | 3611.169 | 0.0226378 |
| | 3 | 71.0 | 349597.7 | 3825.238 | 0.0254042 |
| | 4 | 72.9 | 374619.8 | 3916.847 | 0.0231283 |
| | 5 | 72.3 | 350088.8 | 3741.625 | 0.0233838 |
| | 6 | 71.1 | 335608.3 | 3660.137 | 0.02385 |
| Average for Sample 4 | | 72.02719 | 354617.3 | 3759.326 | 0.0241393 |
| Standard Dev for Sample 4 | | 0.821483 | 13147.22 | 112.2421 | 0.0014688 |
| Coefficient of Variation for Sample 4 | | 1.14% | 3.71% | 2.99% | 6.08% |
| **5** | 1 | 77.1 | 407256.3 | 3920.144 | 0.0161263 |
| | 2 | 75.1 | 375962.4 | 3709.435 | 0.021672 |
| | 3 | 75.7 | 384892.7 | 3629.383 | 0.0159973 |
| | 4 | 76.3 | 375091.1 | 3749.674 | 0.0198154 |
| | 5 | 74.9 | 342725.6 | 3497.443 | 0.0200733 |
| | 6 | 75.1 | 357807.5 | 3544.593 | 0.0175873 |
| Average for Sample 5 | | 75.1 | 373955.9 | 3675.112 | 0.0185453 |
| Standard Dev for Sample 5 | | 0.847762 | 22225.86 | 153.278 | 0.0023232 |
| Coefficient of Variation for Sample 5 | | 1.13% | 5.94% | 4.17% | 12.53% |

| | | | | | |
|---|---|---|---|---|---|
| **6** | 1 | 80.2 | 429714.7 | 3863.973 | 0.0147796 |
| | 2 | 79.1 | 409733.6 | 3656.425 | 0.0141218 |
| | 3 | 79.2 | 382948.5 | 3559.357 | 0.0158962 |
| | 4 | 77.8 | 386033.9 | 3469.042 | 0.012982 |
| | 5 | 77.8 | 353509.5 | 3247.073 | 0.0133762 |
| | 6 | 78.5 | 377348 | 3531.565 | 0.0156096 |
| Average for Sample 6 | | 78.76046 | 389881.4 | 3554.573 | 0.0144609 |
| Standard Dev for Sample 6 | | 0.943874 | 26546.84 | 204.2186 | 0.0011798 |
| Coefficient of Variation for Sample 6 | | 1.20% | 6.81% | 5.75% | 8.16% |
| **7** | 1 | 70.6 | 291661.8 | 3519.779 | 0.0323017 |
| | 2 | 69.9 | 255131.4 | 3236.844 | 0.0362315 |
| | 3 | 70.3 | 282118.8 | 3609.505 | 0.0342891 |
| | 4 | 70.2 | 304974.3 | 3868.327 | 0.0386613 |
| | 5 | 69.8 | 318574.4 | 3746.874 | 0.0339369 |
| | 6 | 69.2 | 314786.3 | 3801.544 | 0.031994 |
| Average For Sample 7 | | 69.98004 | 294541.2 | 3630.479 | 0.0345691 |
| Standard Dev For Sample 7 | | 0.505225 | 23715.18 | 231.0952 | 0.0025203 |
| Coefficient of Variation for Sample 7 | | 0.72% | 8.05% | 6.37% | 7.29% |
| **8** | 1 | 71.1 | 324213.5 | 3483.48 | 0.024306 |
| | 2 | 70.7 | 311916.9 | 3375.537 | 0.0312424 |
| | 3 | 71.7 | 348652.7 | 3761.752 | 0.0264836 |
| | 4 | 70.8 | 300857.7 | 3348.814 | 0.0267157 |
| | 5 | 71.6 | 289232.5 | 3326.822 | 0.0253743 |
| | 6 | 71.2 | 342701.5 | 3669.565 | 0.0225609 |
| Average for Sample 8 | | 71.18565 | 319595.8 | 3494.328 | 0.0261138 |
| Standard Dev for Sample 8 | | 0.410923 | 23373.11 | 182.0357 | 0.0029407 |
| Coefficient of Variation for Sample 8 | | 0.58% | 7.31% | 5.21% | 11.26% |
| **9** | 1 | 73.0 | 362227.3 | 3569.507 | 0.0208864 |
| | 2 | 73.7 | 346902.1 | 3448.675 | 0.0205047 |
| | 3 | 72.9 | 332385.5 | 3397.423 | 0.0202824 |
| | 4 | 72.8 | 333415.3 | 3167.471 | 0.0203698 |
| | 5 | 73.1 | 336302.5 | 3367.432 | 0.0201465 |
| | 6 | 73.6 | 324021.2 | 3450.692 | 0.0211331 |
| Average for Sample 9 | | 73.1768 | 339209 | 3400.2 | 0.0205538 |
| Standard Dev for Sample 9 | | 0.40733 | 13477.89 | 133.273 | 0.00038 |
| Coefficient of Variation for Sample 9 | | 0.56% | 3.97% | 3.92% | 1.85% |
| **10** | 1 | 66.3 | 247309 | 3255 | 0.043 |
| | 2 | 66.6 | 227202 | 2759 | 0.034 |
| | 3 | 66.4 | 230768 | 2775 | 0.039 |
| | 4 | 66.1 | 232621 | 2971 | 0.041 |
| | 5 | 66.2 | 242181 | 3053 | 0.042 |

| | | | | | |
|---|---|---|---|---|---|
| | 6 | 66.4 | 247159 | 3036 | 0.038 |
| Average for Sample 9 | | 66.33112 | 237873.3 | 2974.788 | 0.0395191 |
| Standard Dev for Sample 9 | | 0.154142 | 8783.503 | 187.0119 | 0.0033784 |
| Coefficient of Variation for Sample 9 | | 0.23% | 3.69% | 6.29% | 8.55% |
| | 1 | 69.7 | 268850 | 3083 | 0.033 |
| | 2 | 69.4 | 283206 | 2977 | 0.028 |
| **11** | 3 | 69.5 | 252420 | 2937 | 0.033 |
| | 4 | 69.4 | 259069 | 2944 | 0.028 |
| | 5 | 68.8 | 291998 | 3358 | 0.029 |
| | 6 | 70.9 | 289147 | 3161 | 0.032 |
| Average for Sample 9 | | 69.59452 | 274114.9 | 3076.59 | 0.0302723 |
| Standard Dev for Sample 9 | | 0.687315 | 16451 | 163.2519 | 0.0024745 |
| Coefficient of Variation for Sample 9 | | 0.99% | 6.00% | 5.31% | 8.17% |
| | 1 | 66.6 | 373882 | 4864 | 0.027 |
| | 2 | 67.3 | 350489 | 4618 | 0.030 |
| **12** | 3 | 66.5 | 337832 | 4503 | 0.033 |
| | 4 | 68.2 | 353776 | 4135 | 0.025 |
| | 5 | 67.9 | 364422 | 4366 | 0.027 |
| | 6 | 68.2 | 377435 | 4386 | 0.027 |
| Average for Sample 9 | | 67.42186 | 359639.4 | 4478.469 | 0.0283046 |
| Standard Dev for Sample 9 | | 0.781465 | 15073.72 | 248.1113 | 0.0029043 |
| Coefficient of Variation for Sample 9 | | 1.16% | 4.19% | 5.54% | 10.26% |
| | 1 | 68.0 | 253234 | 3117 | 0.031 |
| | 2 | 67.3 | 228548 | 3068 | 0.031 |
| **13** | 3 | 66.8 | 222482 | 2967 | 0.031 |
| | 4 | 65.9 | 217166 | 2911 | 0.032 |
| | 5 | 65.9 | 223025 | 3000 | 0.032 |
| | 6 | 65.9 | 224845 | 2912 | 0.030 |
| Average for Sample 9 | | 66.60299 | 228216.7 | 2995.842 | 0.0312339 |
| Standard Dev for Sample 9 | | 0.89421 | 12800.89 | 83.85731 | 0.000677 |
| Coefficient of Variation for Sample 9 | | 1.34% | 5.61% | 2.80% | 2.17% |
| | 1 | 68.7 | 281885 | 3516 | 0.032 |
| | 2 | 68.3 | 284365 | 3617 | 0.036 |
| **14** | 3 | 69.5 | 287167 | 3630 | 0.040 |
| | 4 | 68.4 | 276612 | 3525 | 0.037 |
| | 5 | 69.0 | 283960 | 3630 | 0.040 |
| | 6 | 67.8 | 254077 | 3062 | 0.029 |
| Average for Sample 9 | | 68.61325 | 278011 | 3496.669 | 0.035601 |
| Standard Dev for Sample 9 | | 0.586232 | 12242.43 | 219.3349 | 0.0044951 |
| Coefficient of Variation for Sample 9 | | 0.85% | 4.40% | 6.27% | 12.63% |
| **15** | 1 | 71.3 | 320421 | 3605 | 0.029 |

| | | | | | |
|---|---|---|---|---|---|
| | 2 | 70.8 | 301256 | 3362 | 0.028 |
| | 3 | 69.1 | 271862 | 3213 | 0.025 |
| | 4 | 70.8 | 285917 | 3429 | 0.030 |
| | 5 | 71.7 | 284026 | 3197 | 0.024 |
| | 6 | 71.1 | 276940 | 3261 | 0.028 |
| Average for Sample 9 | | 70.79461 | 290070.3 | 3344.423 | 0.0272626 |
| Standard Dev for Sample 9 | | 0.916791 | 17910.97 | 155.7952 | 0.0022778 |
| Coefficient of Variation for Sample 9 | | 1.30% | 6.17% | 4.66% | 8.35% |
| | 1 | 74.7 | 315250 | 3217 | 0.020 |
| | 2 | 74.3 | 318137 | 3200 | 0.018 |
| **16** | 3 | 73.8 | 318249 | 3193 | 0.021 |
| | 4 | 73.8 | 333512 | 3362 | 0.020 |
| | 5 | 74.3 | 325278 | 3312 | 0.020 |
| | 6 | 73.9 | 351404 | 3509 | 0.020 |
| Average for Sample 9 | | 74.12573 | 326971.8 | 3298.872 | 0.0195533 |
| Standard Dev for Sample 9 | | 0.342014 | 13668.4 | 123.3658 | 0.0009529 |
| Coefficient of Variation for Sample 9 | | 0.46% | 4.18% | 3.74% | 4.87% |
| | 1 | 68.3 | 313737 | 4687 | 0.029 |
| | 2 | 68.7 | 315917 | 4699 | 0.029 |
| **17** | 3 | 68.6 | 318432 | 4675 | 0.030 |
| | 4 | 67.9 | 308634 | 4544 | 0.032 |
| | 5 | 69.8 | 337378 | 4865 | 0.028 |
| | 6 | 68.2 | 342063 | 4638 | 0.024 |
| Average for Sample 9 | | 68.57234 | 322693.4 | 4684.823 | 0.0286881 |
| Standard Dev for Sample 9 | | 0.661847 | 13658.72 | 104.6904 | 0.002599 |
| Coefficient of Variation for Sample 9 | | 0.97% | 4.23% | 2.23% | 9.06% |
| | 1 | 71.5 | 370286 | 4853 | 0.023 |
| | 2 | 72.3 | 369850 | 4740 | 0.021 |
| **18** | 3 | 71.8 | 356905 | 4819 | 0.024 |
| | 4 | 71.7 | 370702 | 4935 | 0.024 |
| | 5 | 72.6 | 395546 | 5080 | 0.023 |
| | 6 | 71.3 | 362564 | 4816 | 0.024 |
| Average for Sample 9 | | 71.8598 | 370975.6 | 4873.862 | 0.0229549 |
| Standard Dev for Sample 9 | | 0.507577 | 13223.09 | 119.2369 | 0.0010593 |
| Coefficient of Variation for Sample 9 | | 0.71% | 3.56% | 2.45% | 4.61% |
| | 1 | 75.2 | 442821 | 5050 | 0.017 |
| | 2 | 75.3 | 452187 | 5361 | 0.019 |
| **19** | 3 | 74.3 | 452300 | 5362 | 0.018 |
| | 4 | 74.7 | 449912 | 5472 | 0.019 |
| | 5 | 74.5 | 447304 | 5209 | 0.017 |
| | 6 | 73.9 | 428241 | 5045 | 0.018 |

| | | | | | |
|---|---|---|---|---|---|
| Average for Sample 9 | | 74.62356 | 445460.9 | 5250.078 | 0.0180697 |
| Standard Dev for Sample 9 | | 0.549032 | 9151.374 | 177.7501 | 0.0009402 |
| Coefficient of Variation for Sample 9 | | 0.74% | 2.05% | 3.39% | 5.20% |
| **20** | 1 | 63.7 | 185425 | 2747 | 0.040 |
| | 2 | 63.8 | 194336 | 2798 | 0.038 |
| | 3 | 63.3 | 193889 | 2747 | 0.035 |
| | 4 | 62.9 | 187341 | 2751 | 0.039 |
| | 5 | 62.8 | 198313 | 2906 | 0.040 |
| | 6 | 63.5 | 176282 | 2581 | 0.036 |
| Average for Sample 9 | | 63.3409 | 189264.3 | 2755.039 | 0.0379585 |
| Standard Dev for Sample 9 | | 0.398893 | 7949.511 | 104.971 | 0.001967 |
| Coefficient of Variation for Sample 9 | | 0.63% | 4.20% | 3.81% | 5.18% |
| **21** | 1 | 67.6 | 264866 | 3054 | 0.026 |
| | 2 | 69.1 | 289177 | 3143 | 0.021 |
| | 3 | 70.1 | 298515 | 3238 | 0.021 |
| | 4 | 69.4 | 287939 | 3128 | 0.021 |
| | 5 | 69.6 | 289445 | 3132 | 0.022 |
| | 6 | 69.2 | 283538 | 3157 | 0.023 |
| Average for Sample 9 | | 69.15271 | 285580 | 3142.15 | 0.0223883 |
| Standard Dev for Sample 9 | | 0.8401 | 11260.37 | 59.25396 | 0.0016925 |
| Coefficient of Variation for Sample 9 | | 1.21% | 3.94% | 1.89% | 7.56% |
| **22** | 1 | 73.8 | 341346 | 3299 | 0.015 |
| | 2 | 74.5 | 356025 | 3411 | 0.014 |
| | 3 | 73.4 | 345361 | 3258 | 0.015 |
| | 4 | 74.6 | 361624 | 3255 | 0.014 |
| | 5 | 74.5 | 356084 | 3329 | 0.015 |
| | 6 | 73.4 | 401193 | 3233 | 0.015 |
| Average for Sample 22 | | 74.01528 | 360272.1 | 3297.656 | 0.0147444 |
| Standard Dev for Sample 22 | | 0.566825 | 21412.51 | 65.46746 | 0.0006242 |
| Coefficient of Variation for Sample 22 | | 0.77% | 5.94% | 1.99% | 4.23% |
| **23** | 1 | 71.4 | 282006 | 3531 | 0.027 |
| | 2 | 71.3 | 304162 | 3490 | 0.027 |
| | 3 | 71.9 | 304084 | 3465 | 0.025 |
| | 4 | 71.7 | 293589 | 3435 | 0.027 |
| | 5 | 71.7 | 310138 | 3484 | 0.023 |
| | 6 | 71.9 | 309004 | 3610 | 0.034 |
| Average for Sample 22 | | 71.7 | 300497 | 3503 | 0.027 |
| Standard Dev for Sample 22 | | 0.3 | 10782 | 61 | 0.003 |
| Coefficient of Variation for Sample 22 | | 0.4% | 3.6% | 1.7% | 12.8% |
| **24** | 1 | 70.1 | 300777 | 3453 | 0.024 |
| | 2 | 70.4 | 306160 | 3498 | 0.025 |

| | | | | | |
|---|---|---|---|---|---|
| | 3 | 70.5 | 312452 | 3618 | 0.027 |
| | 4 | 70.1 | 293275 | 3452 | 0.029 |
| | 5 | 70.4 | 316206 | 3560 | 0.032 |
| | 6 | 70.2 | 291270 | 3418 | 0.028 |
| Average for Sample 22 | | 70.3 | 303357 | 3500 | 0.027 |
| Standard Dev for Sample 22 | | 0.2 | 10100 | 76 | 0.003 |
| Coefficient of Variation for Sample 22 | | 0.2% | 3.3% | 2.2% | 9.9% |
| | 1 | 68.3 | 283715 | 3432 | 0.029 |
| | 2 | 68.6 | 286436 | 3490 | 0.033 |
| **25** | 3 | 68.6 | 270289 | 3245 | 0.030 |
| | 4 | 68.5 | 279594 | 3291 | 0.028 |
| | 5 | 68.7 | 267705 | 3284 | 0.032 |
| | 6 | 67.8 | 290246 | 3506 | 0.032 |
| Average for Sample 22 | | 68.4 | 279664 | 3375 | 0.031 |
| Standard Dev for Sample 22 | | 0.3 | 9002 | 115 | 0.002 |
| Coefficient of Variation for Sample 22 | | 0.5% | 3.2% | 3.4% | 6.9% |
| | 1 | 77.4 | 545238 | 6419 | 0.016 |
| | 2 | 77.2 | 544048 | 6582 | 0.017 |
| **26** | 3 | 76.8 | 532361 | 6751 | 0.019 |
| | 4 | 76.8 | 545090 | 6688 | 0.018 |
| | 5 | 77.0 | 532565 | 6204 | 0.016 |
| | 6 | 76.6 | 529209 | 6758 | 0.019 |
| Average for Sample 22 | | 77.0 | 538085 | 6567 | 0.017 |
| Standard Dev for Sample 22 | | 0.3 | 7454 | 219 | 0.001 |
| Coefficient of Variation for Sample 22 | | 0.4% | 1.4% | 3.3% | 7.8% |
| | 1 | 80.0 | 620059 | 6886 | 0.015 |
| | 2 | 80.5 | 673533 | 7054 | 0.015 |
| **27** | 3 | 81.1 | 661816 | 7092 | 0.015 |
| | 4 | 80.9 | 665518 | 7046 | 0.015 |
| | 5 | 81.2 | 691196 | 7058 | 0.015 |
| | 6 | 80.2 | 640541 | 6799 | 0.015 |
| Average for Sample 22 | | 80.6 | 658777 | 6989 | 0.015 |
| Standard Dev for Sample 22 | | 0.5 | 25120 | 118 | 0.000 |
| Coefficient of Variation for Sample 22 | | 0.6% | 3.8% | 1.7% | 2.5% |
| | 1 | 77.4 | 361130 | 3203 | 0.010 |
| | 2 | 76.7 | 376812 | 3409 | 0.011 |
| **28** | 3 | 77.6 | 376196 | 3372 | 0.012 |
| | 4 | 77.4 | 365807 | 3398 | 0.013 |
| | 5 | 77.4 | 381155 | 3434 | 0.011 |
| | 6 | 77.8 | 398580 | 3603 | 0.013 |
| Average for Sample 22 | | 77.4 | 376613 | 3403 | 0.012 |

| | | | | | |
|---|---|---|---|---|---|
| Standard Dev for Sample 22 | | 0.4 | 13114 | 128 | 0.001 |
| Coefficient of Variation for Sample 22 | | 0.5% | 3.5% | 3.8% | 11.1% |
| **29** | 1 | 79.2 | 370178 | 3102 | 0.011 |
| | 2 | 79.0 | 328677 | 2958 | 0.013 |
| | 3 | 80.1 | 362286 | 3231 | 0.011 |
| | 4 | 78.4 | 317604 | 3034 | 0.013 |
| | 5 | 79.5 | 361432 | 3210 | 0.011 |
| | 6 | 76.9 | 339470 | 3015 | 0.012 |
| Average for Sample 22 | | 78.8 | 346608 | 3092 | 0.012 |
| Standard Dev for Sample 22 | | 1.1 | 21142 | 110 | 0.001 |
| Coefficient of Variation for Sample 22 | | 1.4% | 6.1% | 3.6% | 8.0% |


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