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# Evaluation of Morsel Rubber Mathematical Models in Seismic Areas

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**Abstract**

Reinforced concrete is the most consumed material in the world, followed by air and water. As the demand for reinforced concrete as a building material increases, so makes the demand for Portland cement and ordinary cement. On the other hand, environmental protection has become a significant issue due to climate change caused by global warming. This is due to emissions of greenhouse gases such as $CO_2$ from human activities. Of all greenhouse gases, $CO_2$ is responsible for approximately 65% of global warming. The cement industry also contributes to releasing $CO_2$ into the atmosphere by producing large amounts of Portland cement and releasing large amounts of $CO_2$. One can need to protect the environment by preventing the uncontrolled disposal of waste. Several efforts have been made to solve this problem. These include using additional cementitious materials such as fly ash, silica fume, granular blast furnace slag, rice husk ash, grass, metakaolin, and alternative binders to Portland cement. Consumption of morsel rubber concrete can reduce the environmental impact in the cement industry. From the perspective of global warming, the technology of self-compacting morsel rubber concrete can significantly reduce the emission of $CO_2$ into the atmosphere. This report presents the analysis and test results of the properties of class 40 self-compacting Morsel rubber concrete using various new approaches.

*Keywords*: Morsel rubber Reinforced concrete, Fly-ash, Quartz powder, Linear regression, Mathematical Models.

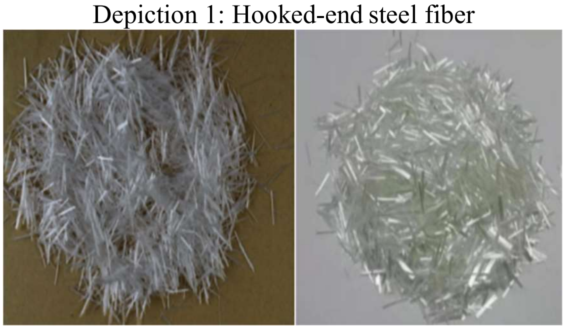
## 1. Introduction

It describes a family of mineral binders with the same chemical composition as zeolites but with a different amorphous microstructure. The two main constituents of Morsel Rubber Concrete are the starting material and the alkaline liquid. The starting material should be rich in silicon and aluminum [1-3]. Fly ash is used as the starting material for this morsel rubber concrete. The process of polymerization is the chemical reaction in this case. Unlike regular Portland pozzolanic cement, Mosel Rubber Concrete does not form calcium silicate hydrates for matrix formation and strength but utilizes silica and alumina polycondensation reactions [26-32]. Morsel gum paste binds together coarse aggregate, fine aggregate, and other unreacted materials to form morsel gum concrete. Self-compacting Morsel Rubber Concrete is manufactured using reinforced concrete technology [4, 5]. The total is approximately 75-80% self-compacting recycled reinforced concrete, similar to Portland cement. Silica and alumina in fly ash are activated by sodium hydroxide and sodium silicate solutions to form a morsel gum paste in the bonding process [6-9].

## *2.* Materials

Materials used to produce self-compacting rubber morsel concrete are fly ash, quartz flour, sodium hydroxide (NaOH), sodium silicate ($Na_2SO_3$), and potassium silicate [11-15]. In addition, hook-end steel fibers and alkali-resistant Cement-fil crack-resistant glass fibers are added to provide crack resistance, improve the strength and durability of reinforced concrete, resist plastic shrinkage cracking, and resist acid attack [16-20].

Depiction 1: Hooked-end steel fiber



Depiction 2: Cement-fil anti-crack alkaline resistant glass fibers

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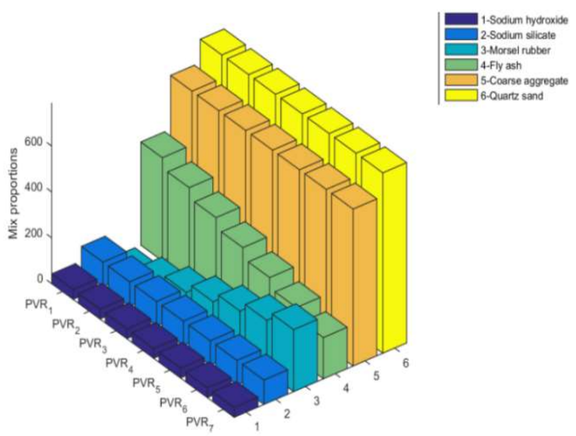
## 3. Mix-Proportions of Self-Compacting Morsel Rubber-Reinforced Concrete

Table 1: Mix proportions of Self-compacting Morsel rubber-reinforced concrete

| Mix | Fly ash | Morsel rubber | Quartz sand ($kg/m^3$) | Coarse aggregate | Sodium silicate solution | Sodium hydroxide solution |
|---|---|---|---|---|---|---|
| | ($kg/m^3$) | ($kg/m^3$) | | ($kg/m^3$) | ($kg/m^3$) | ($kg/m^3$) |
| PVR 1 | 450 | 0 | 786 | 684 | 106 | 43 |
| PVR 2 | 405 | 45 | 786 | 684 | 106 | 43 |
| PVR 3 | 360 | 90 | 786 | 684 | 106 | 43 |
| PVR 4 | 315 | 135 | 786 | 684 | 106 | 43 |
| PVR 5 | 270 | 180 | 786 | 684 | 106 | 43 |
| PVR 6 | 225 | 225 | 786 | 684 | 106 | 43 |
| PVR 7 | 180 | 270 | 786 | 684 | 106 | 43 |

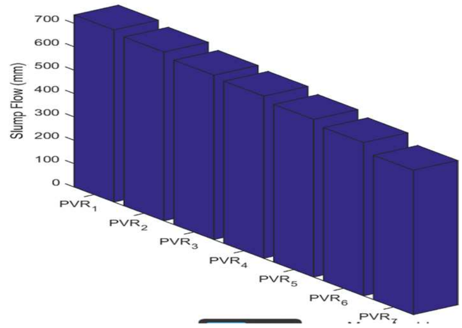
Table 2: Mix proportions of Admixture

| Mix | SP % of powder | Admixture % | Fibers % of the fiber content | |
|---|---|---|---|---|
| | | | Steel | Glass |
| PVR 1 | 2 | 1.2 | - | - |
| PVR 2 | 2 | 1.2 | 2 | - |
| PVR 3 | 2 | 1.2 | 1.75 | 0.25 |
| PVR 4 | 2 | 1.2 | 1.50 | 0.5 |
| PVR 5 | 2 | 1.2 | 1.25 | 0.75 |
| PVR 6 | 2 | 1.2 | 1.00 | 1.00 |
| PVR 7 | 2 | 1.2 | 0.75 | 1.25 |

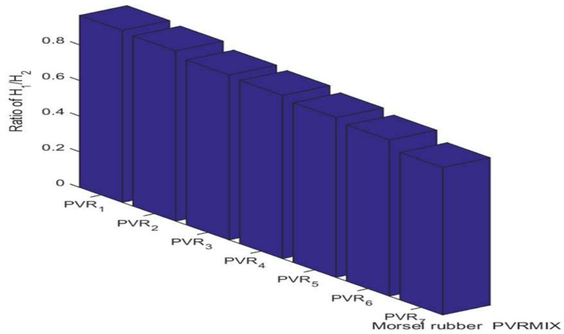



Depiction 3: Mix proportions of Self-compacting Morsel rubber-reinforced concrete

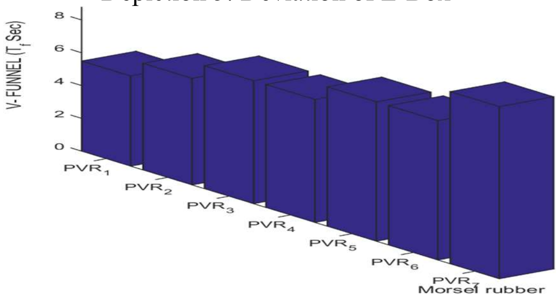
## 4. Results & Discussion: Fresh Properties




Depiction 4: Deviation of slump flow




Depiction 5: Deviation of L-Box

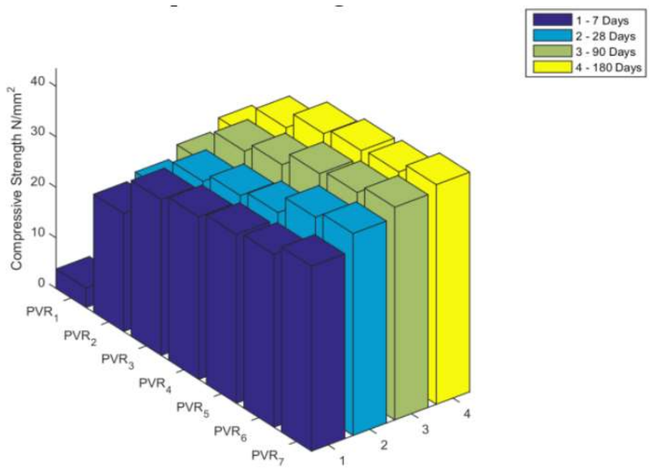



Depiction 6: Deviation of V-Funnel Tf minutes

## 5. Results & Discussion: Hardened Properties

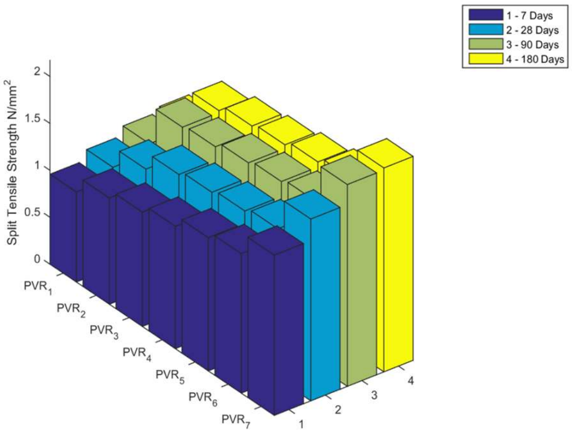
Curing properties such as compressive strength, flexural strength, and split tensile strength are measured. Compressive strength results for 150 mm cube samples aged 7 and 28 days[21-25].

### *5.1. Compressive strength*



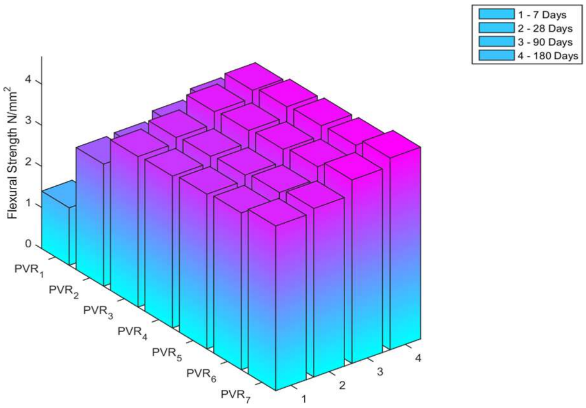

Depiction 7: Compressive strength of PVR mixes

## *5.2 Split Tensile Strength*




Depiction 8: The split tensile strength for PVR

## *5.3 Flexural Strength*




Depiction 9: Flexural strength of PVR mixed results and Discussions.

## *5.4 Split Tensile vs. Compressive Strengths*

Table 3: Regression coefficients for Split Tensile vs. Compressive Strengths in morsel rubber percentage (MR) for seven days

| Functions | Order | St = f (Cs) = f (x): 7days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.018 | 0.81 | - | 0.71 |
| | 1 | f (x) = a x | 0.0438 | - | - | - 0.87 |
| | 2 | f (x) = $ax^2$ + b x + c | 1.067 | -0.03 | 0.00123 | 0.92 |
| | 2 | f (x) = $ax^2$ + bx | -0.0003 | 0.013 | - | 0.74 |
| | 2 | f (x) = $ax^2$ + b(0) + c | 0.88 | 0 | 0.0005 | 0.84 |
| | 3 | f (x) = a $x^3$ + b $x^2$+ cx +d | - 0.00051 | - 0.0086 | 0.4/0.53 | 0.74 |
| | 3 | f (x) = a x $^3$ + b x+ c | 2e-5 | -0.01 | 1 | 0.93 |
| | 3 | f (x) = a $x^3$ + b | 1.4e-5 | 0.92 | - | 0.91 |
| Log | | f (x) = a log(x) | 0.41 | - | - | 0.18 |
| Log C | | f (x) = a log(x) + b | 0.23 | 0.6 | - | 0.73 |
| Root | | f (x) = $a\sqrt{x}$ | 0.25 | - | - | 0.16 |
| Root C | | f (x) = $a\sqrt{x}+b$ | 0.13 | 0.62 | - | 0.63 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 4.3 | - | - | - 10.2 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -1.4 | 1.63 | - | 0.50 |

Table 4: Regression coefficients for Split Tensile vs. Compressive Strengths in morsel rubber percentage (MR) for 28 days

| Functions | Order | St = f (St) = f (x): 28days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.02 | 0.87 | - | 0.81 |
| | 1 | f (x) = a x | 0.046 | - | - | - 0.61 |
| | 2 | f (x) = $ax^2$ + b x + c | 0.0007 | -0.014 | 1.129 | 0.91 |
| | 2 | f (x) = $ax^2$ + bx | -0.001 | 0.084 | - | - 0.16 |
| | 2 | f (x) = $ax^2$ + b(0) + c | 0.88 | 0 | 1.011 | 0.90 |
| | 3 | f (x) = a $x^3$ + b $x^2$+ cx +d | 4.9e-5 | - 0.0028 | 0.06/0.8 | 0.93 |
| | 3 | f (x) = a x $^3$ + b x+ c | 1.08e-5 | 0.0016 | 1.06 | 0.92 |
| | 3 | f (x) = a $x^3$ + b | 1.15e-5 | 1.08 | - | 0.91 |
| Log | | f (x) = a log(x) | 0.45 | - | - | 0.56 |
| Log C | | f (x) = a log(x) + b | 0.33 | 0.42 | - | 0.67 |
| Root | | f (x) = $a\sqrt{x}$ | 0.27 | - | - | 0.46 |
| Root C | | f (x) = $a\sqrt{x}+b$ | 0.17 | 0.57 | - | 0.74 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 5.82 | - | - | -8.2 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -2.29 | 1.963 | - | 0.60 |

Table 5: Regression coefficients for Split Tensile vs. Compressive Strengths in morsel rubber percentage (MR) for 90 days

| Functions | Order | St = f (St) = f (x): 90days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.02 | 1 | - | 0.77 |
| | 1 | f (x) = a x | 0.048 | - | - | - 0.78 |
| | 2 | f (x) = $ax^2$ + b x + c | 0.0005 | - 0.003 | 1.18 | 0.81 |
| | 2 | f (x) = $ax^2$ + bx | -0.0013 | 0.098 | - | - 0.12 |
| | 2 | f (x) = $ax^2$ + b(0) + c | 0.00043 | 0 | 1.15 | 0.81 |
| | 3 | f (x) = a $x^3$ + b $x^2$+ cx +d | 15.6e-4 | -0.01 | 0.26/ - 0.08 | 0.93 |
| | 3 | f (x) = a x $^3$ + b x+ c | 7.12e-6 | 0.006 | 1.14 | 0.82 |
| | 3 | f (x) = a $x^3$ + b | 9.9e-6 | 1.22 | - | 0.81 |
| Log | | f (x) = a log(x) | 0.49 | - | - | 0.60 |
| Log C | | f (x) = a log(x) + b | 0.36 | 0.45 | - | 0.69 |
| Root | | f (x) = $a\sqrt{x}$ | 0.29 | - | - | 0.42 |
| Root C | | f (x) = $a\sqrt{x}+b$ | 0.18 | 0.67 | - | 0.74 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 6.78 | - | - | -8.8 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -2.7 | 2.2 | - | 0.65 |

Table 6: Regression coefficients for Split Tensile vs. Compressive Strengths in morsel rubber percentage (MR) for 180 days

| Functions | Order | St = f (St) = f (x): 180days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.02 | 1.04 | - | 0.79 |
| | 1 | f (x) = a x | 0.047 | - | - | - 0.93 |
| | 2 | f (x) = $ax^2$ + b x + c | 0.00058 | -0.009 | 1.26 | 0.85 |
| | 2 | f (x) = $ax^2$ + bx | -0.0013 | 0.1 | - | - 0.22 |
| | 2 | f (x) = $ax^2$ + b(0) + c | 0.00041 | 0 | 1.18 | 0.84 |
| | 3 | f (x) = a $x^3$ + b $x^2$+ cx +d | 16.7e-4 | -0.01 | 0.3/ - 0.24 | 0.96 |
| | 3 | f (x) = a x $^3$ + b x+ c | 7.86e-6 | 0.0029 | 1.21 | 0.85 |
| | 3 | f (x) = a $x^3$ + b | 9.1e-6 | 1.25 | - | 0.86 |

| | | | | | |
|---|---|---|---|---|---|
| Log | f (x) = a log(x) | 0.49 | - | - | 0.59 |
| Log C | f (x) = a log(x) + b | 0.36 | 0.5 | - | 0.70 |
| Root | f (x) = $a\sqrt{x}$ | 0.295 | - | - | 0.37 |
| Root C | f (x) = $a\sqrt{x}+b$ | 0.17 | 0.72 | - | 0.75 |
| Root inv | f (x) = $(\frac{a}{\sqrt{x}})$ | 7.16 | - | - | -9.5 |
| Root inv C | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -2.7 | 2.24 | - | 0.66 |

Table 7: Regression coefficients for Flexural Strength vs. Compressive Strength in morsel rubber percentage (MR) for seven days

| Functions | Order | **Fs = f (Cs) = f (x):** 7 days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b 7days | 0.08 | 1.1 | - | 0.99 |
| | 1 | f (x) = a x 7days | 0.12 | - | - | 0.78 |
| | 2 | f (x) = ax² + b x + c 7days | -0.0002 | 0.09 | 1.06 | 0.99 |
| | 2 | f (x) = ax² + bx 7days | -0.0024 | 0.19 | - | 0.89 |
| | 2 | f (x) = ax² + b(0) + c 7days | 0.002 | 0 | 1.6 | 0.95 |
| | 3 | f (x) = a x³ + b x²+ cx +d | -4.9e-5 | 0.003 | 0.03/1.2 | 0.99 |
| | 3 | f (x) = a x ³ + b x+ c | -3.2e-6 | 0.08 | 1.07 | 0.99 |
| | 3 | f (x) = a x³ + b 7 days | 5.01e-5 | 1.9 | - | 0.87 |
| Log | | f (x) = a log(x) | 1.06 | - | - | 0.96 |
| Log C | | f (x) = a log(x) + b | 1.1 | -0.15 | - | 0.97 |
| Root | | f (x) = $a\sqrt{x}$ | 0.65 | - | - | 0.99 |
| Root C | | f (x) = $a\sqrt{x}+b$ | 0.63 | 0.11 | - | 0.99 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 10.15 | - | - | -6.2 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -6.99 | 4.91 | - | 0.93 |

Table 8: Regression coefficients for Flexural Strength vs. Compressive Strength in morsel rubber percentage (MR) for 28 days

| Functions | Order | **Fs = f (Cs) = f (x)** : 28 days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.076 | 1.2 | - | 0.98 |
| | 1 | f (x) = a x | 0.11 | - | - | 0.74 |
| | 2 | f (x) = ax² + b x + c | -0.00068 | 0.1 | 0.95 | 0.98 |
| | 2 | f (x) = ax² + bx | -0.0022 | 0.19 | - | 0.92 |
| | 2 | f (x) = ax² + b(0) + c | 0.0016 | 0 | 1.9 | 0.89 |
| | 3 | f (x) = a x³ + b x²+ cx +d | -0.00015 | 0.01 | -0.12 /1.99 | 0.99 |
| | 3 | f (x) = a x ³ + b x+ c | -0.00001 | 0.09 | 1 | 0.98 |
| | 3 | f (x) = a x³ + b | 3.56e-5 | 2.2 | - | 0.78 |
| Log | | f (x) = a log(x) | 1.07 | - | - | 0.93 |
| Log C | | f (x) = a log(x) + b | 1.31 | -0.81 | - | 0.96 |
| Root | | f (x) = $a\sqrt{x}$ | 0.65 | - | - | 0.98 |
| Root C | | f (x) = $a\sqrt{x}+b$ | 0.66 | -0.06 | - | 0.98 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 12.91 | - | - | -5.1 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -9.5 | 5.43 | - | 0.93 |

Table 9: Regression coefficients for Flexural Strength vs. Compressive Strength in morsel rubber percentage (MR) for 90 days

| Functions | Order | **Fs = f (Cs) = f (x)**:90days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.08 | 1.2 | - | 0.98 |
| | 1 | f (x) = a x | 0.11 | - | - | 0.80 |
| | 2 | f (x) = ax² + b x + c | -0.00021 | 0.09 | 1.09 | 0.99 |
| | 2 | f (x) = ax² + bx | -0.0019 | 0.18 | - | 0.92 |
| | 2 | f (x) = ax² + b(0) + c | 0.0016 | 0 | 1.9 | 0.94 |
| | 3 | f (x) = a x³ + b x²+ cx +d | -0.00012 | 0.0097 | -0.13 /2.13 | 0.99 |
| | 3 | f (x) = a x ³ + b x+ c | -3.36e-6 | 0.09 | 1.1 | 0.99 |
| | 3 | f (x) = a x³ + b | 3.4e-5 | 2.2 | - | 0.85 |
| Log | | f (x) = a log(x) | 1.12 | - | - | 0.91 |
| Log C | | f (x) = a log(x) + b | 1.44 | -1.1 | - | 0.95 |
| Root | | f (x) = $a\sqrt{x}$ | 0.67 | - | - | 0.98 |
| Root C | | f (x) = $a\sqrt{x}+b$ | 0.7 | -0.18 | - | 0.98 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 14.5 | - | - | -4.9 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -10.9 | 5.89 | - | 0.92 |

Table 10: Regression coefficients for Flexural Strength vs. Compressive Strength in morsel rubber percentage (MR) for 180 days

| Functions | Order | **Fs = f (Cs) = f (x) :** 180days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.08 | 1.2 | - | 0.99 |
| | 1 | f (x) = a x | 0.11 | - | - | 0.82 |
| | 2 | f (x) = ax² + b x + c | 3.18e-5 | 0.08 | 1.21 | 0.99 |
| | 2 | f (x) = ax² + bx | -0.0018 | 0.18 | - | 0.92 |
| | 2 | f (x) = ax² + b(0) + c | 0.0016 | 0 | 1.88 | 0.96 |
| | 3 | f (x) = a x³ + b x²+ cx +d | -0.00013 | 0.01 | -0.16 /2.4 | 0.99 |
| | 3 | f (x) = a x ³ + b x+ c | -9.9e-8 | 0.08 | 1.2 | 0.99 |
| | 3 | f (x) = a x³ + b | 3.37e-5 | 2.2 | - | 0.88 |
| Log | | f (x) = a log(x) | 1.16 | - | - | 0.90 |
| Log C | | f (x) = a log(x) + b | 1.51 | -1.22 | - | 0.96 |
| Root | | f (x) = $a\sqrt{x}$ | 0.69 | - | - | 0.98 |
| Root C | | f (x) = $a\sqrt{x}+b$ | 0.72 | -0.2 | - | 0.98 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 15.62 | - | - | -5.0 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -11.7 | 6.18 | - | 0.93 |

Table 11: Regression coefficients for Split Tensile vs. Flexural Strengths in morsel rubber percentage (MR) for seven days

| Functions | Order | **St = f (Fs) = f (x) :** 7days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b 7days | 0.22 | 0.58 | - | 0.68 |
| | 1 | f (x) = a x 7days | 0.39 | - | - | 0.29 |
| | 2 | f (x) = ax² + b x + c 7days | 0.19 | -0.79 | 1.7 | 0.86 |
| | 2 | f (x) = ax² + bx 7days | -0.066 | 0.62 | - | 0.49 |
| | 2 | f (x) = ax² + b(0) + c 7days | 0.04 | 0 | 0.8 | 0.75 |
| | 3 | f (x) = a x³ + b x²+ cx +d | 0.38 | -3.03 | 7.62/-4.8 | 0.98 |
| | 3 | f (x) = a x ³ + b x+ c | 0.02 | -0.31 | 1.34 | 0.88 |
| | 3 | f (x) = a x³ + b 7 days | 0.01 | 0.87 | - | 0.81 |
| Log | | f (x) = a log(x) | 1.09 | - | - | -0.23 |
| Log C | | f (x) = a log(x) + b | 0.51 | 0.72 | - | 0.60 |
| Root | | f (x) = $a\sqrt{x}$ | 0.73 | - | - | 0.64 |
| Root C | | f (x) = $a\sqrt{x}+b$ | 0.69 | 0.08 | - | 0.64 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 2.16 | - | - | -2.96 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -1.5 | 2.17 | - | 0.57 |

Table 12: Regression coefficients for Split Tensile vs. Flexural Strengths in morsel rubber percentage (MR) for 28 days

| Functions | Order | St = f (Fs) = f (x); 28 days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.26 | 0.59 | - | 0.74 |
| | 1 | f (x) = a x | 0.42 | - | - | 0.43 |
| | 2 | f (x) = ax$^2$ + b x + c | 0.16 | -0.67 | 1.73 | 0.85 |
| | 2 | f (x) = ax$^2$ + bx | -0.06 | 0.66 | - | 0.62 |
| | 2 | f (x) = ax$^2$ + b(0) + c | 0.05 | 0 | 0.89 | 0.79 |
| | 3 | f (x) = a x$^3$ + b x$^2$+ cx +d | 0.47 | -3.9 | 10.4/-7.5 | 0.98 |
| | 3 | f (x) = a x $^3$ + b x+ c | 0.02 | -0.25 | 1.4 | 0.86 |
| | 3 | f (x) = a x$^3$ + b | 0.01 | 0.99 | - | 0.83 |
| Log | | f (x) = a log(x) | 1.2 | - | - | 0.16 |
| Log C | | f (x) = a log(x) + b | 0.65 | 0.71 | - | 0.68 |
| Root | | f (x) = $a\sqrt{x}$ | 0.81 | - | - | 0.71 |
| Root C | | f (x) = $a\sqrt{x} + b$ | 0.83 | -0.04 | - | 0.71 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 2.52 | - | - | -2.78 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -2.0 | 2.6 | - | 0.65 |

Table 13: Regression coefficients for Split Tensile vs. Flexural Strengths in morsel rubber percentage (MR) for 90 days

| Functions | Order | St = f (Fs) = f (x): 90 days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.25 | 0.72 | - | 0.74 |
| | 1 | f (x) = a x | 0.44 | - | - | 0.32 |
| | 2 | f (x) = ax$^2$ + b x + c | 0.74 | -0.19 | 1.31 | 0.76 |
| | 2 | f (x) = ax$^2$ + bx | -0.08 | 0.74 | - | 0.64 |
| | 2 | f (x) = ax$^2$ + b(0) + c | 0.04 | 0 | 1.04 | 0.76 |
| | 3 | f (x) = a x$^3$ + b x$^2$+ cx +d | 0.44 | -4.02 | 11.8/-9.4 | 0.98 |
| | 3 | f (x) = a x $^3$ + b x+ c | 0.009 | -0.01 | 1.2 | 0.77 |
| | 3 | f (x) = a x$^3$ + b | 0.008 | 1.15 | - | 0.77 |
| Log | | f (x) = a log(x) | 1.27 | - | - | 0.19 |
| Log C | | f (x) = a log(x) + b | 0.69 | 0.78 | - | 0.70 |
| Root | | f (x) = $a\sqrt{x}$ | 0.87 | - | - | 0.72 |
| Root C | | f (x) = $a\sqrt{x} + b$ | 0.85 | 0.04 | - | 0.72 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 2.91 | - | - | -3.07 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -2.24 | 2.86 | - | 0.69 |

Table 14: Regression coefficients for Split Tensile vs. Flexural Strengths in morsel rubber percentage (MR) for 180 days

| Functions | Order | St = f (Fs) = f (x): 180 days | a | b | c | $r^2$ |
|---|---|---|---|---|---|---|
| Poly | 1 | f (x) = ax + b | 0.24 | 0.77 | - | 0.76 |
| | 1 | f (x) = a x | 0.43 | - | - | 0.28 |
| | 2 | f (x) = ax$^2$ + b x + c | 0.08 | -0.25 | 1.43 | 0.79 |
| | 2 | f (x) = ax$^2$ + bx | -0.07 | 0.74 | - | 0.65 |
| | 2 | f (x) = ax$^2$ + b(0) + c | 0.04 | 0 | 1.09 | 0.79 |
| | 3 | f (x) = a x$^3$ + b x$^2$+ cx +d | 0.39 | -3.79 | 11.7/-9.7 | 0.99 |
| | 3 | f (x) = a x $^3$ + b x+ c | 0.009 | -0.04 | 1.26 | 0.80 |
| | 3 | f (x) = a x$^3$ + b | 0.007 | 1.19 | - | 0.80 |
| Log | | f (x) = a log(x) | 1.26 | - | - | 0.20 |
| Log C | | f (x) = a log(x) + b | 0.69 | 0.79 | - | 0.73 |
| Root | | f (x) = $a\sqrt{x}$ | 0.87 | - | - | 0.74 |
| Root C | | f (x) = $a\sqrt{x} + b$ | 0.82 | 0.09 | - | 0.75 |
| Root inv | | f (x) = $(\frac{a}{\sqrt{x}})$ | 3.07 | - | - | -3.34 |
| Root inv C | | f (x) = $(\frac{a}{\sqrt{x}})$ + b | -2.27 | 2.90 | - | 0.71 |

## 6. Conclusions

Based on the above studies, the following observations are made regarding the strength properties of ternary mixed self-compacting rubber morsel concrete. • Strength properties of self-compacting rubber-reinforced morsel concrete mixes containing various combinations were observed with increasing percentages of various quartz flours. • Among all blends, the 20% quartz powder blend achieved the best strength properties compared to other combinations. • There was little difference in compressive strength between 20%, 30%, 40%, and 50% replacement. • Negligible strength is observed for nominal mixtures with 0% quartz flour content. • The presence of silica in both fly ash and quartz powder is responsible for imparting strength to self-compacting rubber morsel concrete. • Based on the test results observed that the strength properties of the self-compacting Morsel rubber-reinforced concrete with quartz powder substitutes were significantly improved compared to the fully fly ash-based self-compacting Morsel rubber-reinforced concrete. I was. • As the substitution rate of quartz flour in morsel rubber-reinforced self-compacting concrete increases, its hardening properties increase, but its workability decreases. • Efflorescence was observed in the nominal mix, which is undesirable. Also, the increased displacement of quartz powder is noticeable when incorporated into self-compacting morsel rubber concrete. • Replacing fly ash with quartz powder improved the overall performance of freshness and mechanical properties of self-compacting Morsel rubber concrete. • After running regression analysis with three different tools. The positive linearity between variables depends on the real and adjusted $R^2$, which are almost identical for the datasets obtained, but with varying standard errors. One can obtain the lowest counting error from the Mini Tab and suggest it as the best tool for the proposed data. • It can be concluded that the $R^2$ values obtained in the mini-tab are 0.678 & 0.969 and are suitable for the selected data set.

## Disclosures

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