# Supplementary materials

**Supplementary materials** for

**Propagation and Impacts on Roadway of Mining-Induced Far-Field Strong Tremors: Insights from Numerical Simulations**

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**Introduction**

This file contains 5 figures and 3 tables. The figure includes the calibration process of strain-softening parameters (**Figure S1**), the determination of the natural vibration period of the model (**Figure S2**), the attenuation rules of S-wave propagating in the model with different frequencies (**Figure S3**), and the plastic zone caused by the action of S-wave of different frequencies (**Figure S4**), BSR cloud images after S waves of different frequencies (**Figure S5**). The table includes the formation structure and mechanical parameter measurement results of 170 boreholes (**Table S1**), the mechanical parameters of rock in the numerical model (**Table S2**), and the mechanical parameters of coal in the numerical model (**Table S3**).

A diagram of a model

Description automatically generated

Figure S1. Procedure for Calibrating Strain Softening Parameters.

A diagram of a graph

Description automatically generated with medium confidenceA graph of a graph

Description automatically generated

(a) (b)

Figure S2. Calculate the Model's Natural Frequency.

|  |  |
| --- | --- |
| A graph of a function  Description automatically generated  (a) 20Hz | A graph of a function  Description automatically generated  (b) 40Hz |
| A graph of a function  Description automatically generated  (c) 70Hz | A graph of a function  Description automatically generated  (d) 100Hz |

Figure S3. S-wave Attenuation Patterns at Varying Frequencies.

|  |  |
| --- | --- |
| A diagram of a blue sphere with green and white circles  Description automatically generated with medium confidence  (a) 2Hz | A diagram of a road way  Description automatically generated  (b) 10Hz |
| A screenshot of a computer  Description automatically generated  (c) 50Hz | A diagram of a system  Description automatically generated with medium confidence  (d) 100Hz |

Figure S4. Plastic failure caused by S-wave.

|  |  |
| --- | --- |
| A blue grid with a diagram of a roof  Description automatically generated  (a) 2Hz | A blue grid with a blue background with a white square with yellow and red lines  Description automatically generated with medium confidence  (b) 5Hz |
| A blue grid with a diagram of a bird  Description automatically generated  (c) 60Hz | A blue grid with a blue background with yellow and red lines  Description automatically generated with medium confidence  (d) 100Hz |

Figure S5. BSR Cloud Images After Different S-wave Loadings.

Table S1. Physical and mechanical parameters of overlying strata in No.6 mining area (170 drilling).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Lithology | Thickness/m | Compressive strength/MPa | Tensile strength/MPa | Elastic modulus/GPa | Poisson’s ratio |
| 1 | Soil | 123.08 | – | – | – | – |
| 2 | Siltstone | 115.66 | 85.60 | 8.17 | 21.01 | 0.29 |
| 3 | Fine sandstone | 21.06 | 68.35 | 5.14 | 20.66 | 0.26 |
| 4 | Medium sandstone | 24.66 | 50.97 | 7.06 | 12.45 | 0.22 |
| 5 | Fine sandstone | 337.66 | 63.22 | 6.29 | 18.70 | 0.22 |
| 6 | Mudstone | 8.65 | – | – | – | – |
| 7 | Fine sandstone | 13.38 | 46.76 | 3.17 | 9.85 | 0.30 |
| 8 | Medium sandstone | 5.50 | 103.01 | 6.65 | 30.13 | 0.27 |
| 9 | Sandy mudstone | 3.08 | 54.87 | 2.47 | 13.80 | 0.26 |
| 10 | Medium sandstone | 30.87 | 90.25 | 8.61 | 36.63 | 0.23 |
| 11 | Claystone | 1.10 | 28.44 | 2.74 | 15.00 | 0.33 |
| 12 | Siltstone | 1.69 | 74.88 | 6.46 | 24.23 | 0.25 |
| 13 | Medium sandstone | 0.72 | 106.58 | 6.23 | 43.35 | 0.24 |
| 14 | Siltstone | 5.73 | 107.14 | 7.57 | 50.89 | 0.26 |
| 15 | 3upper coal | 5.39 | – | – | – | – |

Table S2. Parameters for Coal and Rock in Numerical Model.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Lithology | Thickness/m | Density/(kg.m-3) | *UTS*/MPa | *E*/GPa | Poisson's ratio | Cohesion/MPa | friction /° |
| fine sandstone | 9.5 | 2670 | 3.13 | 16.85 | 0.27 | 14.30 | 44.7 |
| siltstone | 5.7 | 2490 | 1.65 | 8.33 | 0.33 | 13.18 | 31.0 |
| 3under Coal | 3.5 | 1300 | 1.60 | 1.00 | 0.23 | 3.8 | 30 |
| siltstone | 4 | 2490 | 1.65 | 8.33 | 0.33 | 13.18 | 31.0 |
| fine sandstone | 7 | 2670 | 3.13 | 16.85 | 0.27 | 14.30 | 44.7 |
| 3upper Coal | 5 | 1300 | 1.60 | 1.00 | 0.23 | 3.8 | 30 |
| siltstone | 5.7 | 2490 | 1.65 | 8.33 | 0.33 | 13.18 | 31.0 |
| medium sandstone | 28 | 2720 | 3.51 | 24.07 | 0.24 | 24.03 | 32.2 |
| siltstone | 3 | 2490 | 1.65 | 8.33 | 0.33 | 13.18 | 31.0 |
| medium sandstone | 5.5 | 2720 | 3.51 | 24.07 | 0.24 | 24.03 | 32.2 |
| fine sandstone | 13 | 2670 | 3.13 | 16.85 | 0.27 | 14.30 | 44.7 |
| mudstone | 8.3 | 2640 | 2.41 | 7.76 | 0.37 | 12.57 | 29.7 |
| fine sandstone | 11.6 | 2670 | 3.13 | 16.85 | 0.27 | 14.30 | 44.7 |
| siltstone | 4 | 2490 | 1.65 | 8.33 | 0.33 | 13.18 | 31.0 |
| fine sandstone | 50 | 2670 | 3.13 | 16.85 | 0.27 | 14.30 | 44.7 |

Table S3. Mechanical Parameters of Coal.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Density/  (kg.m-3) | Elastic Modulus/  GPa | Poisson | Cohesion/  MPa | Friction/  ° | Tension/  MPa | softening  factor | residual cohesion/  MPa |
| 1300 | 1 | 0.23 | 3.8 | 30 | 1.6 | 1.5% | 0.2 |