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# LAMPIRAN

**Lampiran 1.** Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.013 Hz tanpa peredam.

```
clc;
clearvars;

%Parameter
omega = 0.013;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0);
ta = 1*3600;
dt = 6;
lambda1 = 0.0061;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.026;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
```

```
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);

%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 2.**Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.043 Hz tanpa peredam.

```
clc;
clearvars;

%Parameter
omega = 0.043;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0);
ta = 1*3600;
dt = 6;
lambda1 = 0.0203;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.013;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 3.**Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.025 Hz tanpa peredam.

```
clc;
clearvars;

%Parameter
omega = 0.025;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0);
ta = 1*3600;
dt = 6;
lambda1 = 0.0118;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.1;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1), 
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 4.** Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.013 Hz dan laju redaman 0.0024 perdetik.

```
clc;
clearvars;

%Parameter
omega = 0.013;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0.000006);
ta = 1*3600;
dt = 6;
lambda1 = 0.0061;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.026;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 5.** Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.043 Hz dan laju redaman 0.02 perdetik.

```
clc;
clearvars;

%Parameter
omega = 0.043;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0.0004);
ta = 1*3600;
dt = 6;
lambda1 = 0.0203;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.013;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 6.**Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.025 Hz dan laju redaman 0.0224 perdetik.

```
clc;
clearvars;

%Parameter
omega = 0.025;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0.0005);
ta = 1*3600;
dt = 6;
lambda1 = 0.0118;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.1;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 7.**Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.013 Hz dan laju redaman 0.026 perdetik.

```
clc;
clearvars;

%Parameter
omega = 0.013;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0.000676);
ta = 1*3600;
dt = 6;
lambda1 = 0.0061;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.026;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 8.**Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.043 Hz dan laju redaman 0.086 perdetik.

```
clc;
clearvars;

%Parameter
omega = 0.043;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0.0074);
ta = 1*3600;
dt = 6;
lambda1 = 0.0203;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.013;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 9**.Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.025 Hz dan laju redaman 0.05 perdetik.

```
clc;
clearvars;

%Parameter
omega = 0.025;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0.0025);
ta = 1*3600;
dt = 6;
lambda1 = 0.0118;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.1;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 10.**Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.013 Hz dan laju redaman 0.0357 perdetik.

```
clc;
clearvars;

%Parameter
omega = 0.013;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0.001276);
ta = 1*3600;
dt = 6;
lambda1 = 0.0061;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.026;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 11.**Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.043 Hz dan laju redaman 0.12 perdetik.

```
clc;
clearvars;

%Parameter
omega = 0.043;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0.0144);
ta = 1*3600;
dt = 6;
lambda1 = 0.0203;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.013;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 12.**Susunan program untuk menyelesaikan simulasi untuk frekuensi gelombang seismik 0.025 Hz dan laju redaman 0.0671 perdetik.

```
clc;
clearvars;

%Parameter
omega = 0.025;
EI0 = 8*10^14;
rho = 1*10^6;
H = 400;
dz = 0.1;
GA0 = 7.2*10^11;
miu = sqrt(0.0045);
ta = 1*3600;
dt = 6;
lambda1 = 0.0118;
deltap = 0.5;
alpha = H*sqrt(GA0/EI0);
lambda2 = sqrt(lambda1^2+alpha^2);
c = 1 - deltap;
Q1 = 0;
Q2 = 0.1;

%Matriks
m11 = M11(lambda1, deltap, 0);
m12 = M12(lambda1, deltap, 0);
m13 = M13(alpha, lambda1, deltap, 0);
m21 = M21(lambda1, deltap, 0);
m22 = M22(lambda1, deltap, 0);
m23 = M23(alpha, lambda1, deltap, 0);
m31 = M31(lambda1, deltap, 1);
m32 = M32(lambda1, deltap, 1);
m33 = M33(alpha, lambda1, deltap, 1);
b1 = -B1(alpha, lambda1, deltap, 0);
b2 = -B2(alpha, lambda1, deltap, 0);
b3 = -B3(alpha, lambda1, deltap, 1);

M = [m11 m12 m13; m21 m22 m23; m31 m32 m33];
B = [b1; b2; b3];

%Konstanta C1, C2, C3, C4
C = M\B;
C(4) = 1;

%Mendefinisikan domain
Z = linspace(0,H,round(H/dz)+1); sizZ = size(Z);
T = linspace(0,ta,round(ta/dt)+1); sizT = size(T);
```

```
%Menyediakan tempat nilai solusi
Solz = zeros(sizZ(2),1);
Solt = zeros(sizT(2),1);
Sol = zeros(sizZ(2),sizT(2));

%Menghitung nilai phi(z)
for s=2:sizZ(2)
  Solz(s) = phiel(lambda1, lambda2, c, Z(s)/H, C(1),
C(2), C(3), C(4));
end

%Menghitung nilai q(t)
for s=2:sizT(2)
  Solt(s) =  q(miu, omega, T(s), Q1, Q2);
end

%Menghitung nilai solusi
Sol = Solz*transpose(Solt);

fig = figure (1)
  for k = 1:sizT(2)
      plot(Sol(:,k), Z);
      xlim([min(min(Sol)) max(max(Sol))]);
      ylim([0 H]);
      xlabel('u');
      ylabel('z');
      title(strcat('t = ',num2str(T(k))));
      getframe;
  end;
clc
```

**Lampiran 13.**Fungsi untuk memperoleh nilai $\lambda_1$

```
clc;
clearvars;

omega = 30;
EI0 = 8*10^11;
rho = 1*10^6;
H = 400;
GA0 = 7.2*10^8;

alpha = H*sqrt(GA0/EI0);
a = (rho*(H^4)*(omega^2))/EI0;
f = [1 0 alpha^2 0 -a];
lambda1 = roots(f)
lambda2 = sqrt(lambda1.^2+alpha^2)
b = EI0/(rho*(H^4));
deltap = 0.5;

for m=1:max(size(lambda1))
    ome(m)=sqrt((lambda1(m)^2)*(lambda2(m)^2)*b);
end
transpose(ome)
```

**Lampiran 14.**Fungsi untuk menghitung nilai fungsi $g(x)$ dan $h(x)$

1. Fungsi $g(x)$

```
function ret = g(lambda1, deltap, x)

ret = (2*lambda1).*sqrt((1-(1-deltap).*x))/(1-
deltap);

end
```

2. Fungsi $h(x)$

```
function ret = h(alpha, lambda1, deltap, x)

ret = (2*sqrt(lambda1^2+alpha^2))*sqrt((1-(1-
deltap)*x))/(1-deltap);

end
```

**Lampiran 15.**Fungsi untuk memperoleh nilai elemen matriks $M$

1. Elemen $m_{11}$

```
function ret = M11(lambda1, deltap, x)

gg = g(lambda1, deltap, x);

ret = besselj(1,gg)/gg;

end
```

2. Elemen $m_{12}$

```
function ret = M12(lambda1, deltap, x)

gg = g(lambda1, deltap, x);

ret = bessely(1,gg)/gg;

end
```

3. Elemen $m_{13}$

```
function ret = M13(alpha, lambda1, deltap, x)

hh = h(alpha, lambda1, deltap, x);

ret = besseli(1,hh)/hh;

end
```

4. Elemen $m_{21}$

```
function ret = M21(lambda1, deltap, x)

syms xi

func = diff(M11(lambda1, deltap, xi),xi);

ret = eval(subs(func,xi,x));

end
```

5. Elemen $m_{22}$

```
function ret = M22(lambda1, deltap, x)

syms xi

func = diff(M12(lambda1, deltap, xi),xi);

ret = eval(subs(func,xi,x));

end
```

6. Elemen $m_{23}$

```
function ret = M23(alpha,lambda1, deltap, x)

syms xi

func = diff(M13(alpha,lambda1, deltap, xi),xi);

ret = eval(subs(func,xi,x));

end
```

7. Elemen $m_{31}$

```
function ret = M31(lambda1, deltap, x)

syms xi

func = diff(M11(lambda1, deltap, xi),xi,2);

ret = eval(subs(func,xi,x));

end
```

8. Elemen $m_{32}$

```
function ret = M32(lambda1, deltap, x)

syms xi

func = diff(M12(lambda1, deltap, xi),xi,2);

ret = eval(subs(func,xi,x));

end
```

9. Elemen $m_{33}$

```
function ret = M33(alpha,lambda1, deltap, x)

syms xi

func = diff(M13(alpha,lambda1, deltap, xi),xi,2);

ret = eval(subs(func,xi,x));

end
```

**Lampiran 16.**Fungsi untuk memperoleh nilai elemen matriks *B*

1. Elemen $b_{11}$

```
function ret = B1(alpha, lambda1, deltap, x)

hh = h(alpha, lambda1, deltap, x);

ret = besselk(1,hh)/hh;

end
```

2. Elemen $b_{21}$

```
function ret = B2(alpha,lambda1, deltap, x)

syms xi

func = diff(B1(alpha,lambda1, deltap, xi),xi);

ret = eval(subs(func,xi,x));

end
```

3. Elemen $b_{31}$

```
function ret = B3(alpha,lambda1, deltap, x)

syms xi

func = diff(B1(alpha,lambda1, deltap, xi),xi,2);

ret = eval(subs(func,xi,x));

end
```

**Lampiran 17.** Fungsi $\phi(z)$

```
function ret = phiel(lambda1, lambda2, c, x, C1, C2,
C3, C4)

A = C1*c*besselj(1,2*lambda1*sqrt(1-
c*x)/c)/(2*lambda1*sqrt(1-c*x));
B = C2*c*bessely(1,2*lambda1*sqrt(1-
c*x)/c)/(2*lambda1*sqrt(1-c*x));
C = C3*c*besseli(1,2*lambda2*sqrt(1-
c*x)/c)/(2*lambda2*sqrt(1-c*x));
D = C4*c*besselk(1,2*lambda2*sqrt(1-
c*x)/c)/(2*lambda2*sqrt(1-c*x));

ret = A + B + C + D;
end
```

**Lampiran 18.**Fungsi $q(t)$

```
function ret = q(miu, omega, t, Q1, Q2)

ret = exp(-miu*t/2);

if miu^2 < 4*(omega^2)
    Omega = sqrt(omega^2 - (miu/2)^2);
    ret =
ret*(Q1*cos(Omega*t)+(2*Q2+miu*Q1)*sin(Omega*t)/(2*Om
ega));
else

if miu^2 > 4*(omega^2)
    a = ((miu + sqrt(miu^2 - 4*(omega^2)))*Q1 + 2*Q2)
/ (2*sqrt(miu^2 - 4*(omega^2)));
    b = exp(sqrt(miu^2 - 4*(omega^2))*t/2);
    c = ((-miu + sqrt(miu^2 - 4*(omega^2)))*Q1 -
2*Q2) / (2*sqrt(miu^2 - 4*(omega^2)));
    d = exp(-sqrt(miu^2 - 4*(omega^2))*t/2);
    ret = ret*(a*b + c*d);
else
    ret = ret*(Q1 + (Q1*miu + 2*Q2)*t/2);
end
end
end
```