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APPENDIX

APPENDIX A

Chloride penetration depth tested with simulated solution

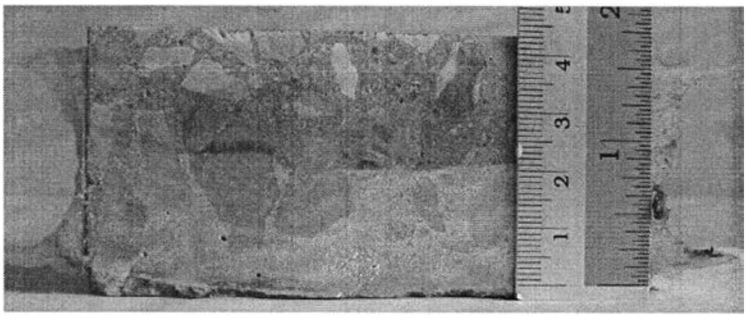

Figure A.1 Chloride penetration depth of specimen with 100% ordinary Portland cement and w/b = 0.4 (case D1)

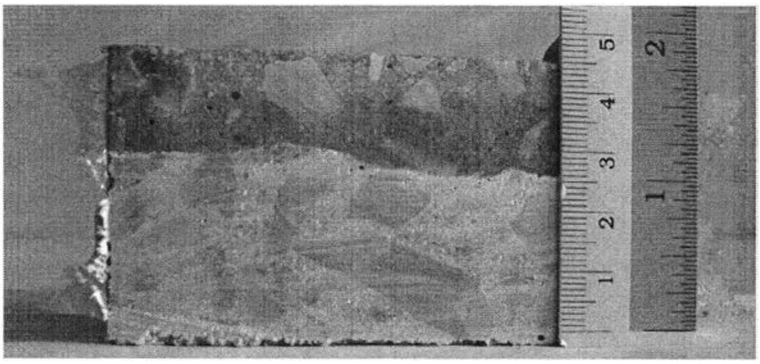

Figure A.2 Chloride penetration depth of specimen with 100% ordinary Portland cement and w/b = 0.5 (case D12)

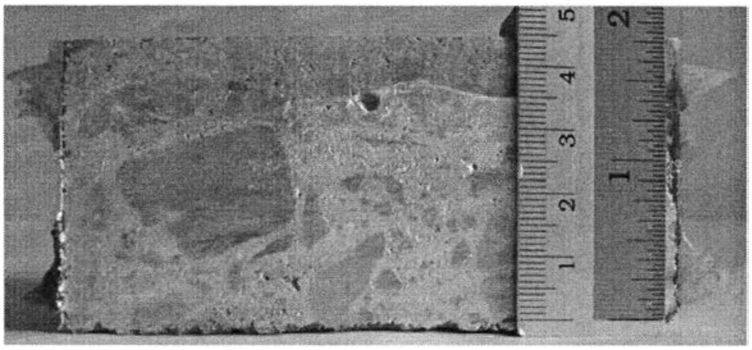

Figure A.3 Chloride penetration depth of specimen with 100% ordinary Portland cement and w/b = 0.6 (case D23)

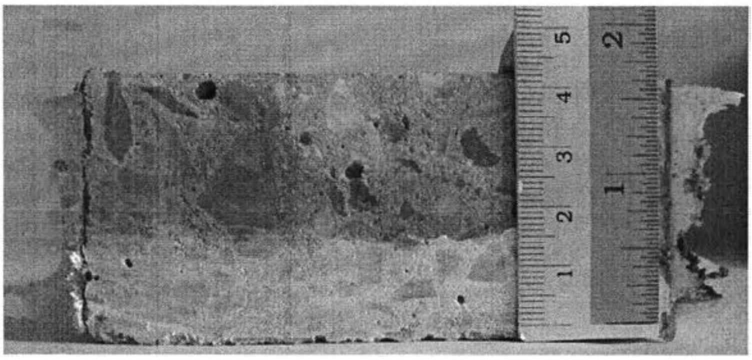

Figure A.4 Chloride penetration depth of specimen with replacement by 15% fly ash and w/b = 0.4 (case D5)

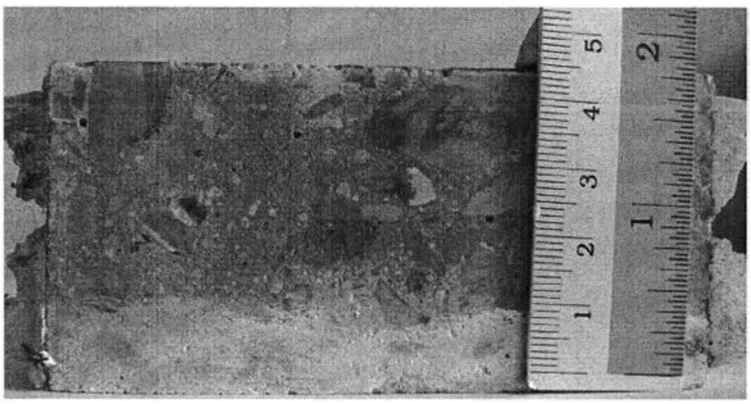

Figure A.5 Chloride penetration depth of specimen with replacement by 25% fly ash and w/b = 0.4 (case D6)

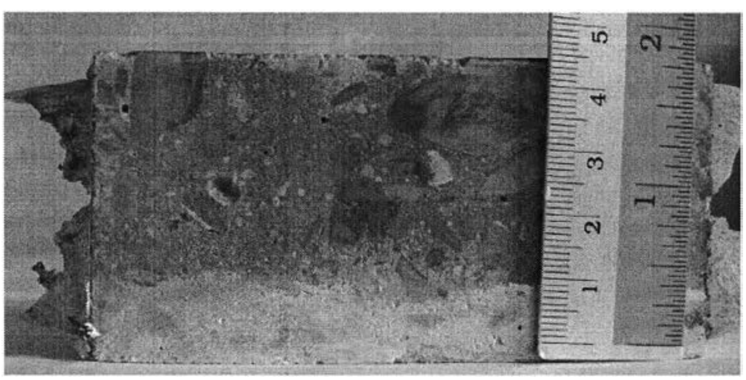

Figure A.6 Chloride penetration depth of specimen with replacement by 35% fly ash and w/b = 0.4 (case D7)

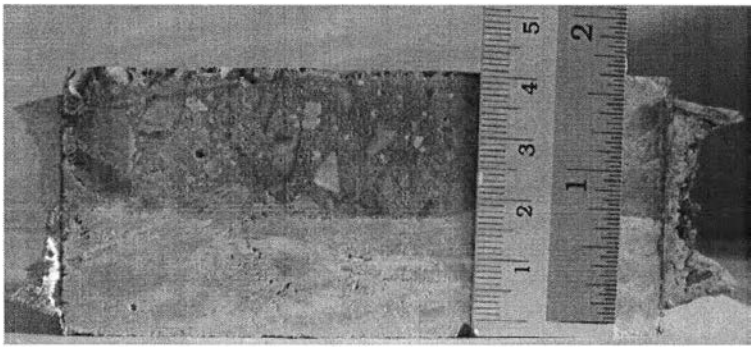

Figure A.7 Chloride penetration depth of specimen with replacement by 15% fly ash and w/b = 0.5 (case D16)

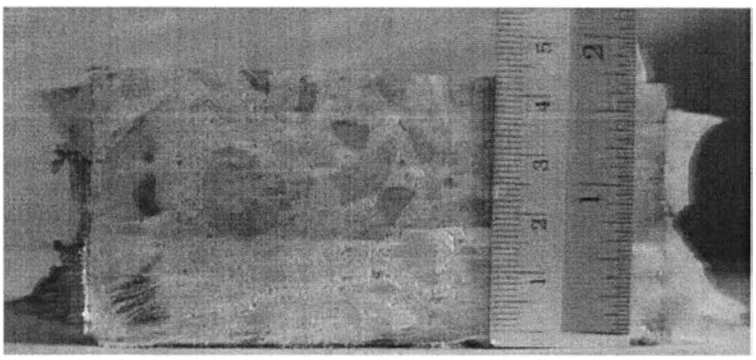

Figure A.8 Chloride penetration depth of specimen with replacement by 25% fly ash and w/b = 0.5 (case D17)

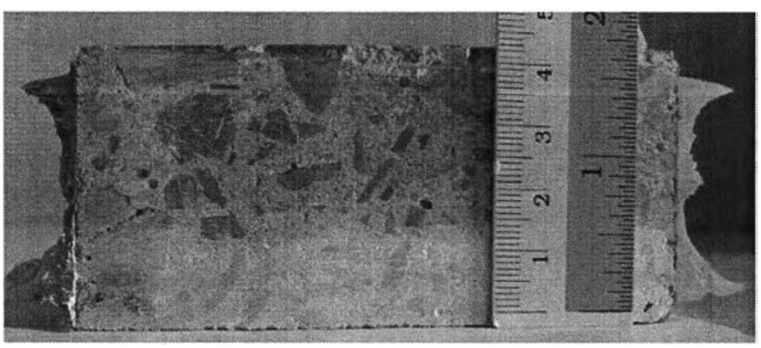

Figure A.9 Chloride penetration depth of specimen with replacement by 35% fly ash and w/b = 0.5 (case D18)

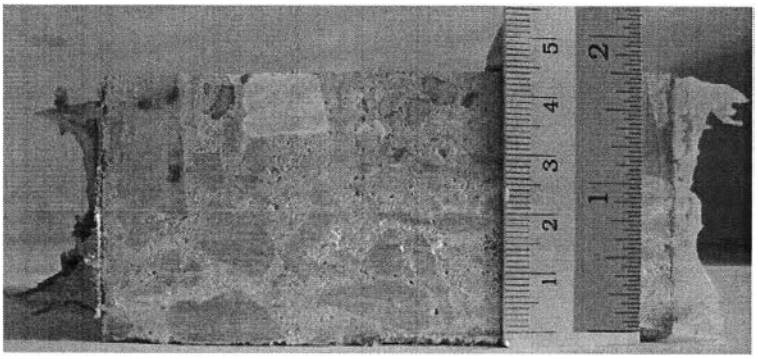

Figure A.10 Chloride penetration depth of specimen with replacement by 15% fly ash and w/b = 0.6 (case D27)

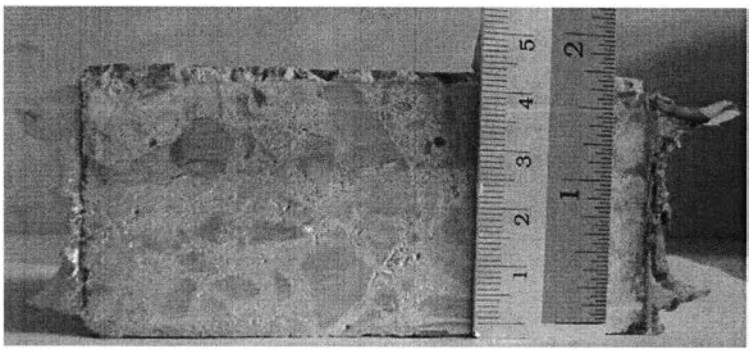

Figure A.11 Chloride penetration depth of specimen with replacement by 25% fly ash and w/b = 0.6 (case D28)

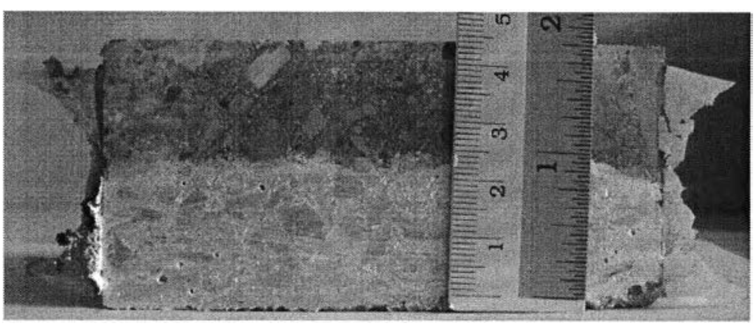

Figure A.10 Chloride penetration depth of specimen with replacement by 35% fly ash and w/b = 0.6 (case D29)

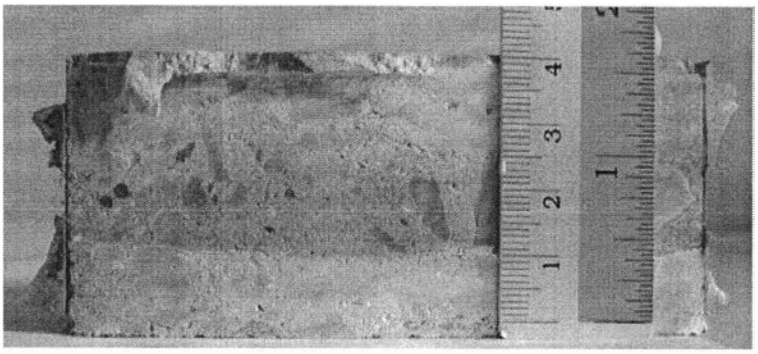

Figure A.13 Chloride penetration depth of specimen with replacement by 5% rice husk ash and w/b = 0.4 (case D2)

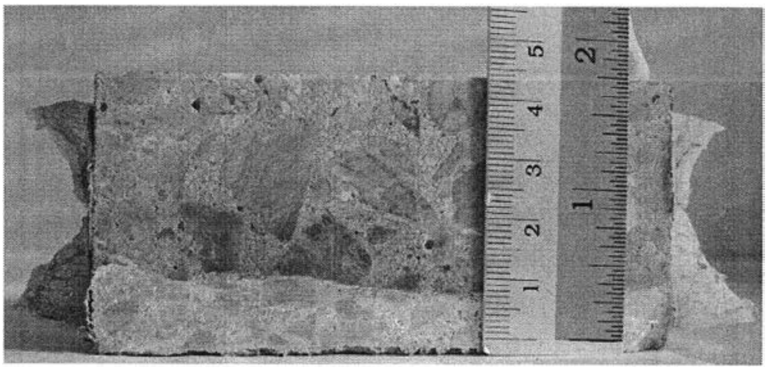

Figure A.14 Chloride penetration depth of specimen with replacement by 10% rice husk ash and w/b = 0.4 (case D3)

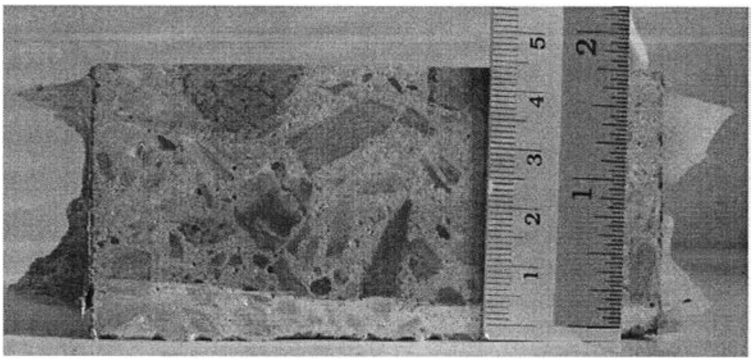

Figure A.15 Chloride penetration depth of specimen with replacement by 15% rice husk ash and w/b = 0.4 (case D4)

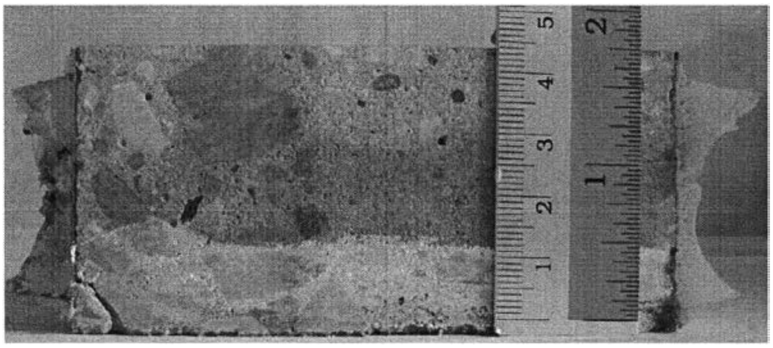

Figure A.16 Chloride penetration depth of specimen with replacement by 5% rice husk ash and w/b = 0.5 (case D13)

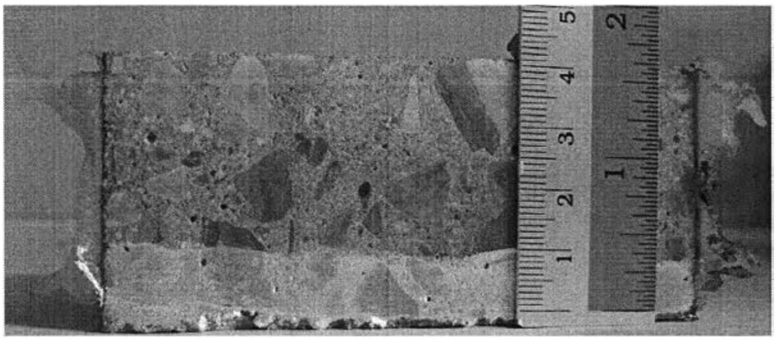

Figure A.17 Chloride penetration depth of specimen with replacement by 10% rice husk ash and w/b = 0.5 (case D14)

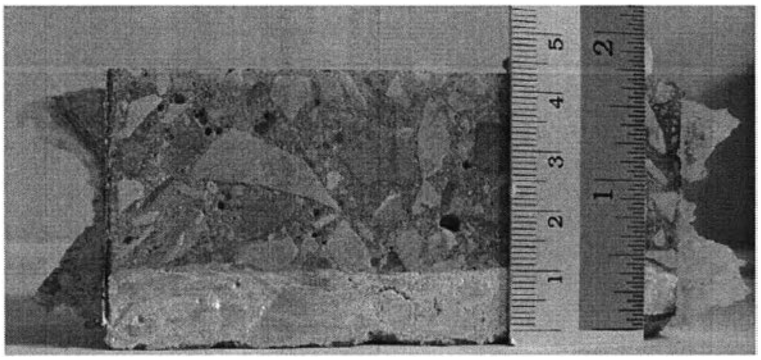

Figure A.18 Chloride penetration depth of specimen with replacement by 15% rice husk ash and w/b = 0.5 (case D15)

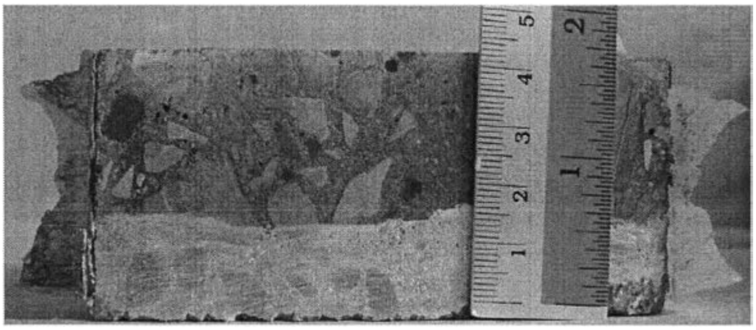

Figure A.19 Chloride penetration depth of specimen with replacement by 5% rice husk ash and w/b = 0.6 (case D24)

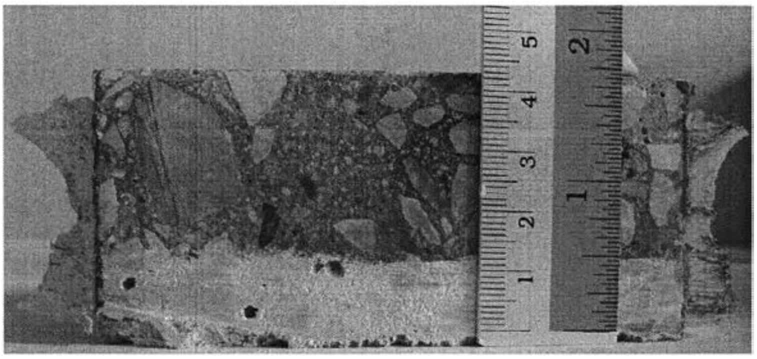

Figure A.20 Chloride penetration depth of specimen with replacement by 10% rice husk ash and w/b = 0.6 (case D25)

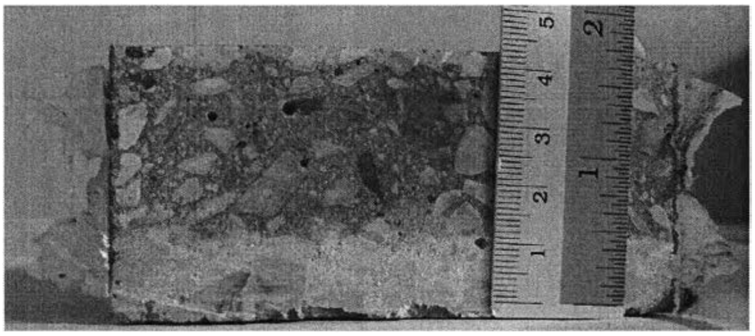

Figure A.21 Chloride penetration depth of specimen with replacement by 15% rice husk ash and w/b = 0.6 (case D26)

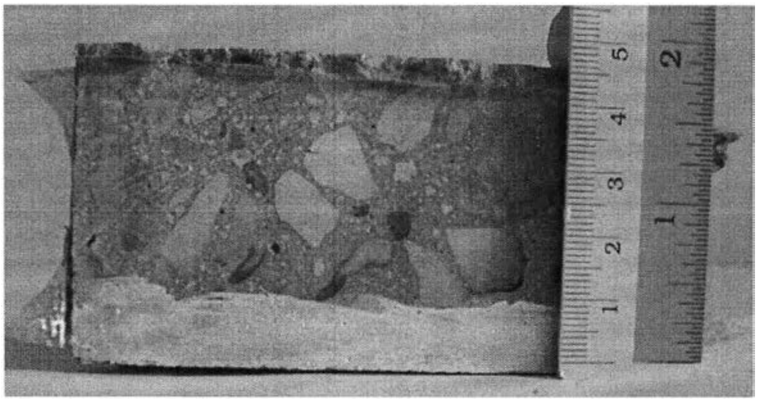

Figure A.22 Chloride penetration depth of specimen with replacement by 15% fly ash and 5% rice husk ash and w/b = 0.4 (case D8)

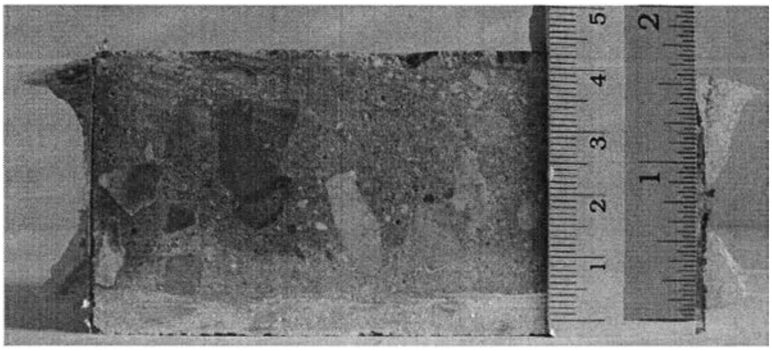

Figure A.23 Chloride penetration depth of specimen with replacement by 15% fly ash and 10% rice husk ash and w/b = 0.4 (case D9)

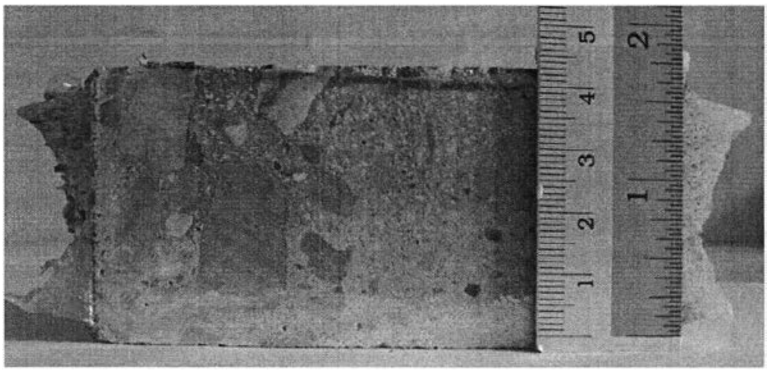

Figure A.24 Chloride penetration depth of specimen with replacement by 25% fly ash and 5% rice husk ash and w/b = 0.4 (case D10)

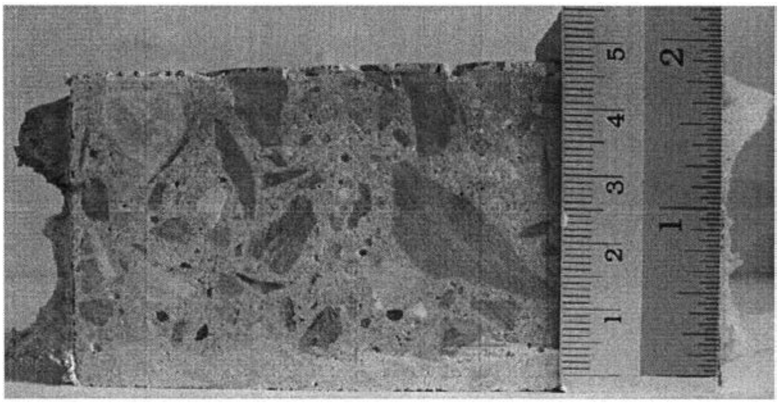

Figure A.25 Chloride penetration depth of specimen with replacement by 25% fly ash and 10% rice husk ash and w/b = 0.4 (case D11)

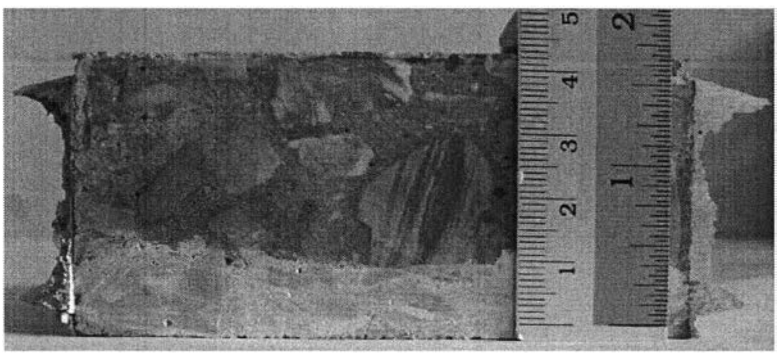

Figure A.26 Chloride penetration depth of specimen with replacement by 15% fly ash and 5% rice husk ash and w/b = 0.5 (case D19)

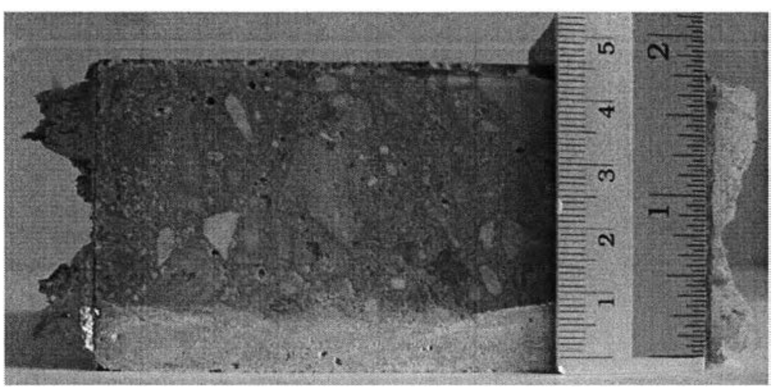

Figure A.27 Chloride penetration depth of specimen with replacement by 15% fly ash and 10% rice husk ash and w/b = 0.5 (case D20)

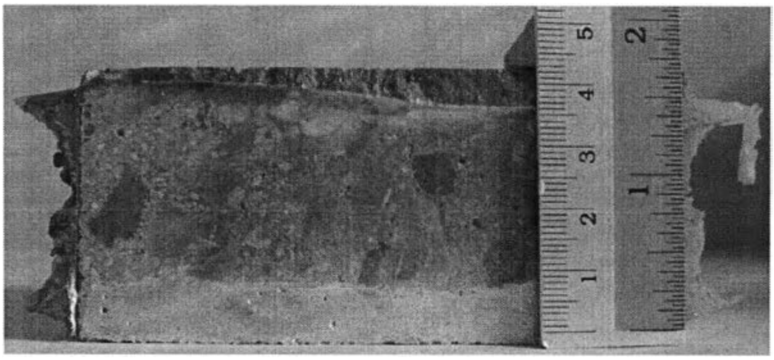

Figure A.28 Chloride penetration depth of specimen with replacement by 25% fly ash and 5% rice husk ash and w/b = 0.5 (case D21)

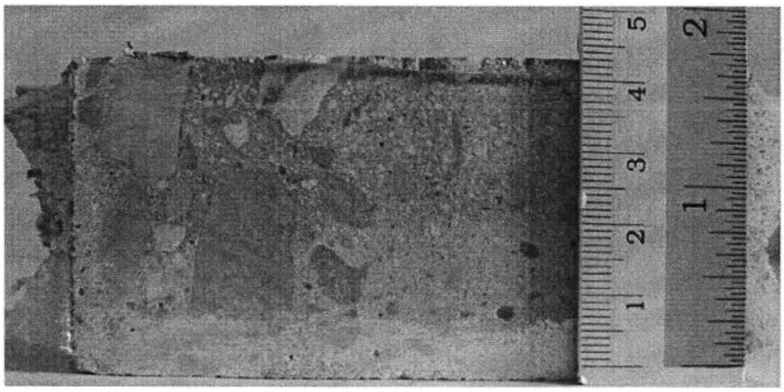

Figure A.29 Chloride penetration depth of specimen with replacement by 25% fly ash and 10% rice husk ash and w/b = 0.5 (case D22)

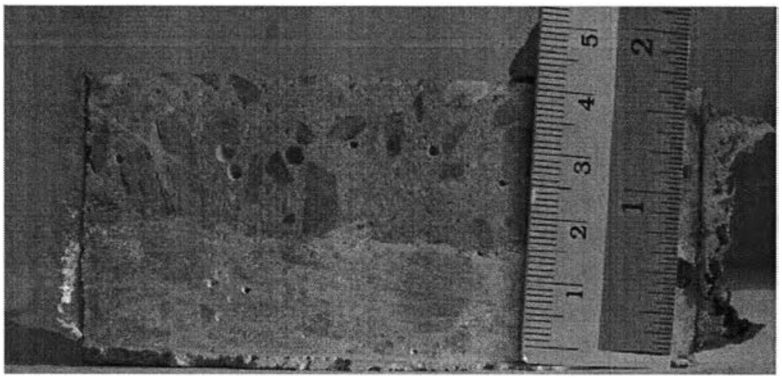

Figure A.30 Chloride penetration depth of specimen with replacement by 15% fly ash and 5% rice husk ash and w/b = 0.6 (case D30)

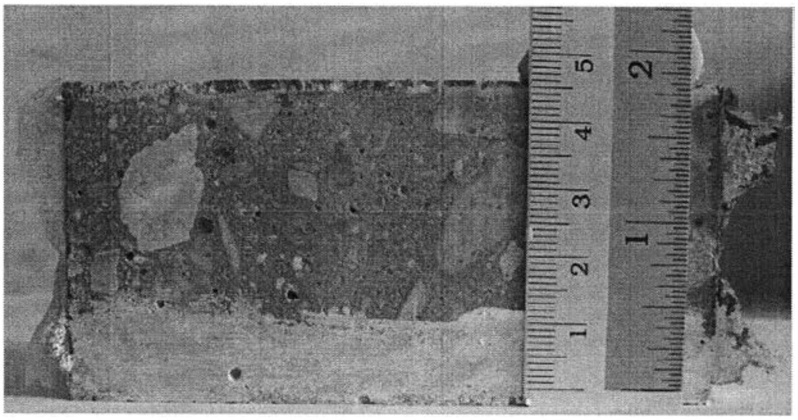

Figure A.31 Chloride penetration depth of specimen with replacement by 15% fly ash and 10% rice husk ash and w/b = 0.6 (case D31)

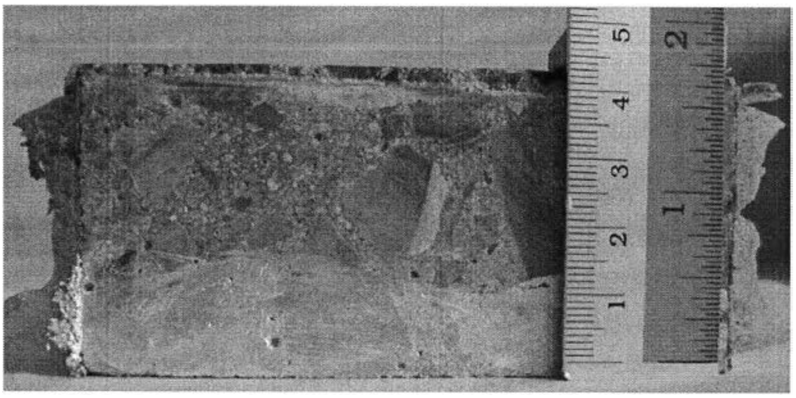

Figure A.32 Chloride penetration depth of specimen with replacement by 25% fly ash and 5% rice husk ash and w/b = 0.6 (case D32)

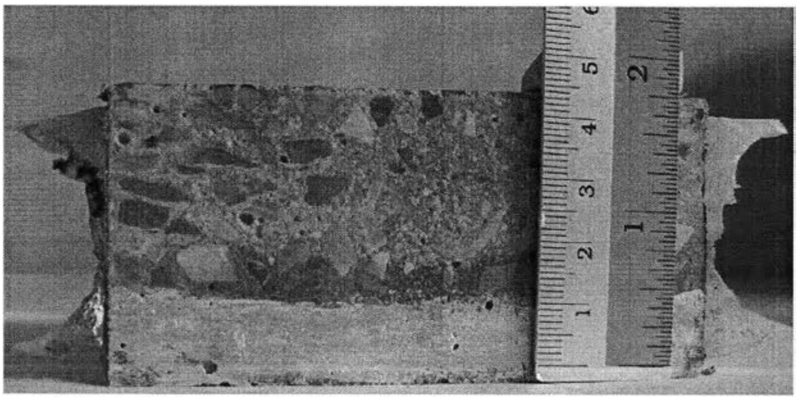

Figure A.33 Chloride penetration depth of specimen with replacement by 25% fly ash and 10% rice husk ash and w/b = 0.6 (case D33)

APPENDIX B

Chloride penetration depth tested with real sea water

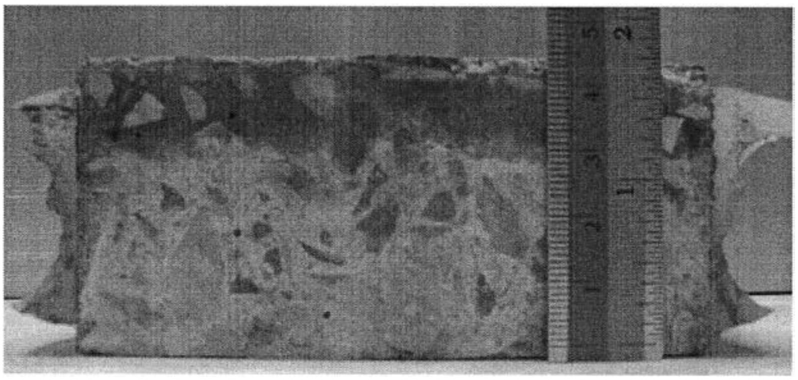

Figure B.1 Chloride penetration depth of specimen with 100% Portland cement and w/b = 0.5 (case O1)

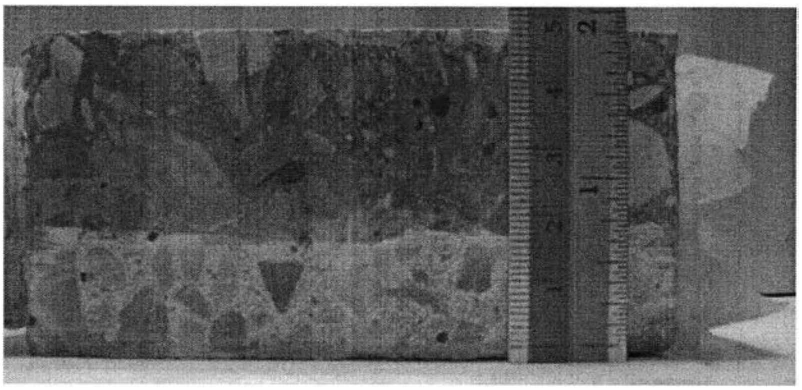

Figure B.2 Chloride penetration depth of specimen with replacement by 25% fly ash and w/b = 0.5 (case F1)

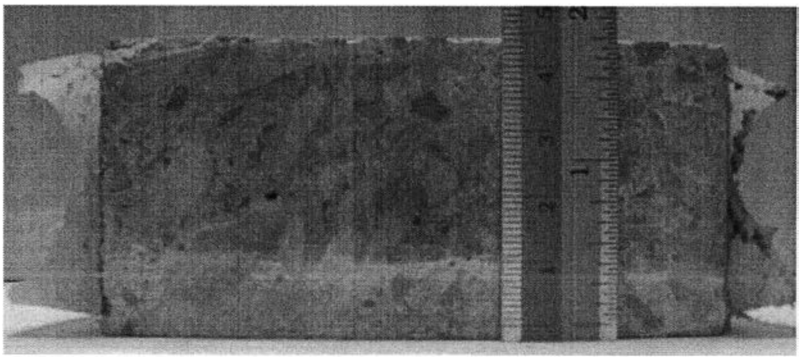

Figure B.3 Chloride penetration depth of specimen with replacement by 10% rice husk ash and w/b = 0.5 (case R1)

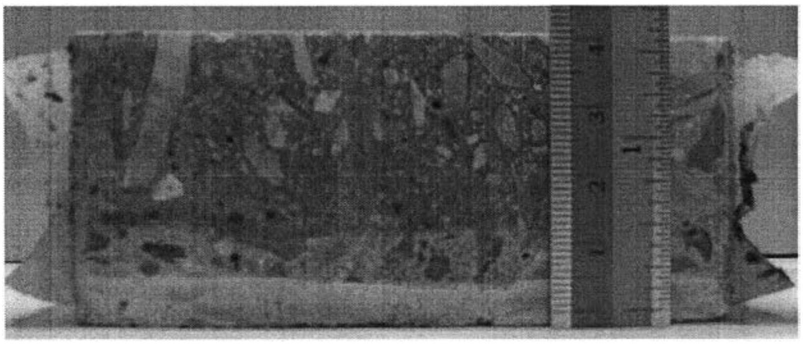

Figure B.4 Chloride penetration depth of specimen with replacement by 25% fly ash and 10% rice husk ash and w/b = 0.5 (case T1)

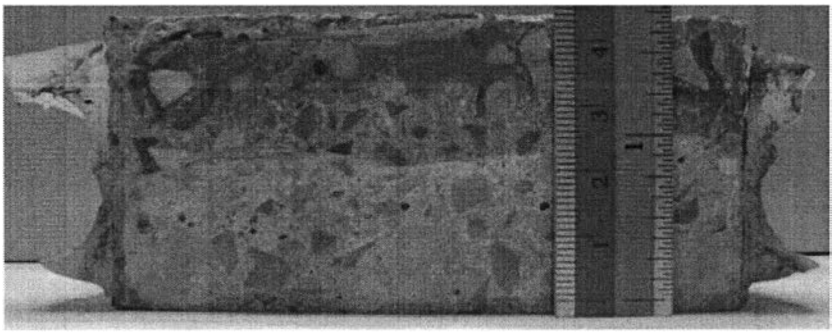

Figure B.5 Chloride penetration depth of specimen with 100% Portland cement and w/b = 0.5 (case O2)

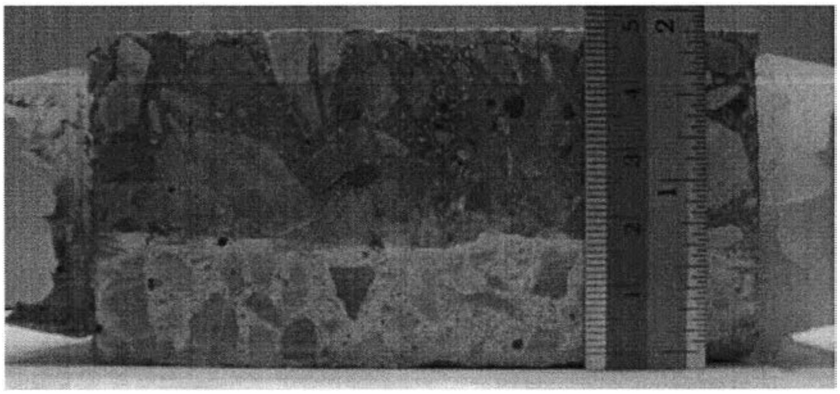

Figure B.6 Chloride penetration depth of specimen with replacement by 25% fly ash and w/b = 0.5 (case F2)

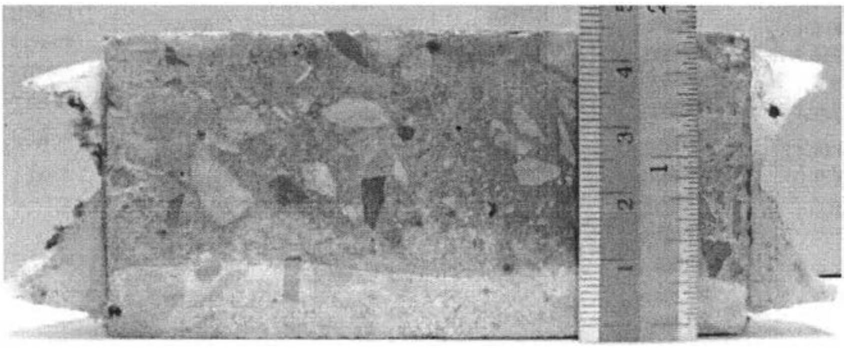

Figure B.7 Chloride penetration depth of specimen with replacement by 10% rice husk ash and w/b = 0.5 (case R2)

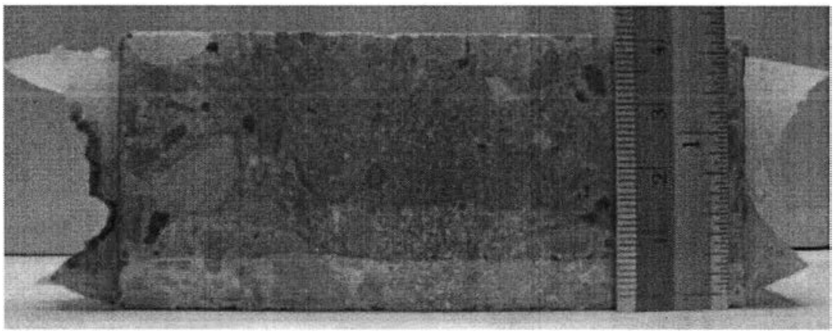

Figure B.8 Chloride penetration depth of specimen with replacement by 25% fly ash and 10% rice husk ash and w/b = 0.5 (case T2)

APPENDIX C

Properties of cement and pozzolana

Table C.1 Chemical properties of ordinary Portland cement type 1 (as provided by Siam city concrete Company LTD)

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	SO_3 (%)	MgO (%)	$3CaO.SiO_2$ (%)	$2CaO.SiO_2$ (%)	Loss of ignition (%)	Insoluble residue (%)	Alkali (%)	CaO (%)
20.4	5.60	3.45	2.8	1.58	54.98	17.05	0.97	0.10	0.46	1.03

Table C.2 Physical properties of fly ash and rice husk ash (tested by Research and Development Office of Electricity Generating Authority of Thailand)

Type	**Specific Gravity**	**Specific surface area (cm^2/gm.)**
Fly ash	2.23	11,450
Rice husk ash	2.51	2,363

Table C.3 Chemical composition of fly ash and rice husk ash (tested by Research and Development Office of Electricity Generating Authority of Thailand)

Type	**Chemical composition (%)**										
	SiO_2	Al_2O_3	Fe_2O_3	CaO	TiO_2	MgO	Na_2O	K_2O	P_2O_5	SO_3	LOL
Fly ash	33.03	18.56	17.74	20.17	0.45	2.46	1.56	2.76	0.23	2.69	0.34
Rice husk ash	87.74	0.79	3.03	1.84	0.09	0.40	0.34	2.66	0.00	0.84	2.27

APPENDIX D

Table D.1 Sea water composition (tested by Chulalongkorn University, Thailand and Ho Chi Minh University of Technology, Vietnam)

Composition	Content (mg/l)	
	Cha-Am (Thailand Gulf)	Ca Na (Vietnam)
NaCl	24,926	27,444
$MgCl_2$	2,481	3,118
$MgSO_4$	2,467	2,412
$CaSO_4$	875	674

Table D.2 Chloride diffusion coefficient from the experiment of Yang and Wang 2003

w/b	**Cement (Kg/m^3)**	**Water (Kg/m^3)**	**Fine aggregate (Kg/m^3)**	**Coarse aggregate (Kg/m^3)**	**Diffusion coefficient (10^{-12} m^2/s)**
0.35	694	243	593	734	20.39
0.45	540	243	724	734	30.73
0.55	442	243	807	734	41.77
0.65	374	243	865	734	63.43

Table D.3 Some values of chloride diffusion coefficient from Yang and Wang 2003 for fly ash case

w/b	**Cement (Kg/m^3)**	**Water (Kg/m^3)**	**Fly ash (Kg/m^3)**	**Fine aggregate (Kg/m^3)**	**Coarse aggregate (Kg/m^3**	**Diffusion coefficient (10^{-12} m^2/s)**
0.35	534	234	134	593	734	3.98
0.45	417	234	104	724	734	5.51
0.55	343	236	86	807	734	7.97
0.65	291	236	73	865	734	7.26

APPENDIX E

Surface chloride concentration

Table E.1 Average composition of sea water in Vietnam

Salt	Content (mg/l)
NaCl	27,444
$MgCl_2$	3,118
$MgSO_4$	2,412
$CaSO_4$	674
Σ	33,824

For sea water in Vietnam, quantities of particular salts are:

Salt	Quantity (%)	Density (Kg/dm^3)
NaCl	81.138	2.165
$MgCl_2$	9.218	2.316

And assume these salts completely fill the volume of capillary pores V_c (dm^3) in 1 m^3 concrete, their quantities are:

$$M_{NaCl}=V_c\times0.81138\times\rho_{NaCl}=V_c\times0.81138\times2.165=M_{Cl}+M_{Na}=M_{Cl}+\frac{1}{1.542}M_{Cl}\ (Kg/m^3)$$

$$M_{MgCl_2}=V_c\times0.09218\times\rho_{MgCl_2}=V_c\times0.09218\times2.316=2M_{Cl}+M_{Mg}=2M_{Cl}+\frac{1}{1.459}M_{Cl}\ (Kg/m^3)$$

$$\Rightarrow\sum M_{Cl}=\frac{V_C\times0.81138\times2.165}{1+0.648}+2\frac{V_C\times0.09218\times2.316}{2+0.686}=V_C\times1.2249\ (Kg/m^3)$$

Table E.2 Average composition of sea water in Thailand

Salt	Content (mg/l)
NaCl	24,926
$MgCl_2$	2,481
$MgSO_4$	2,467
$CaSO_4$	875
Σ	30,749

For sea water in Gulf of Thailand, quantities of particular salts are:

Salt	Quantity (%)	Density (Kg/dm^3)
NaCl	81.062	2.165
$MgCl_2$	8.068	2.316

And assume these salts completely fill the volume of capillary pores V_c (dm^3) in 1 m^3 concrete, their quantities are:

$$M_{NaCl}=V_c\times0.81062\times\rho_{NaCl}=V_c\times0.81062\times2.165=M_{Cl}+M_{Na}=M_{Cl}+\frac{1}{1.542}M_{Cl}\ (Kg/m^3)$$

$$M_{MgCl_2}=V_c\times0.08068\times\rho_{MgCl_2}=V_c\times0.08068\times2.316=2M_{Cl}+M_{Mg}=2M_{Cl}+\frac{1}{1.459}M_{Cl}\ (Kg/m^3)$$

$$\Rightarrow\sum M_{Cl}=\frac{V_C\times0.81062\times2.165}{1+0.648}+2\frac{V_C\times0.08068\times2.316}{2+0.686}=V_C\times1.2040\ (Kg/m^3)$$

APPENDIX F

Matlab source code for predicting service life

```
%-----------------------------------------------------------------------
%The purpose of this source code is to predict service life of
%certain concrete structure
%Input data
Qcl=input('Chloride concentration of sea water:');
FA=input('Percent of replacement by fly ash (%):');
RHA=input('Percent of replacement by rice husk ash (%):');
Ct=input('Threshold chloride concentration:');
wb=input('Water binder ratio:');
x=input('Cover thickness (mm):');
d=input('Rebar dimension (mm):');
%Main process
%Frist phase
    %Degree of hydration
    if (wb<0.42)
    h = wb/0.42;
  else
    h =1;
  end
  Co=(wb-0.382*h)*Qcl*100;
  if (FA == 0) & (RHA == 0)
    D=25.28-71.98*wb+172.5*(wb^2);
    t1=1;
    ts=t1*365*24*60*60;
    C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    while (C < Ct)
      t1=t1+0.1;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    end
  end
  if (FA > 0) & (RHA == 0)
    D= (25.28-71.98*wb+172.5*(wb^2))* (- 3.02*FA + 5.53*(FA^2) – 3.24*(FA^3));
    t1=1;
    ts=t1*365*24*60*60;
    C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    while (C < Ct)
      t1=t1+0.1;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    end
  end
```

```
  if (FA == 0) & (RHA > 0)
    D=  (25.28-71.98*wb+172.5*(wb^2))*(-  20.1*RHA  +  100.88*(RHA^2)  -
127.54*(RHA^3));
    t1=1;
    ts=t1*365*24*60*60;
    C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    while (C < Ct)
      t1=t1+0.1;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    end
  end
  if (FA > 0) & (RHA > 0)
    D= (25.28-71.98*wb+172.5*(wb^2))* (- 3.02*FA + 5.53*(FA^2) - 3.24*(FA^3))
*(-  20.1*RHA  +  100.88*(RHA^2)  -  127.54*(RHA^3))*(93.7*FA*RHA-
255.8*FA^2*RHA-550.6*FA*RHA^2+1091.9*FA^2*RHA^2);
    t1=1;
    ts=t1*365*24*60*60;
    C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    while (C < Ct)
      t1=t1+0.1;
      ts=t1*365*24*60*60;
      C=0.65*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    end
  end
fprintf('The initial time (year):');
t1/100
%Second phase
q = (-0.51 - 7.6*Ct +44.97*(wb^2)+67.95*Ct*(wb^2))*(d/(x^2))*365;
t2=(0.602*d*((1+2*x/d)^0.85)/q);
fprintf('The time of propagation phase (year):');
t2
%total service life
t1=t1/1000;
t=t1+t2;
fprintf('The total service life (year):');
t
%End of source code
%------------------------------------------------------------------------
```

APPENDIX G

Matlab source code for designing water binder ratio

```
%-------------------------------------------------------------------------
%The purpose of this source code is to design the water binder ratio based
%on the desire service life
%Input data
Qcl=input('Chloride concentration of sea water:');
FA=input('Percent of replacement by fly ash (%):');
RHA=input('Percent of replacement by rice husk ash (%):');
Ct=input('Threshold chloride concentration:');
x=input('Cover thickness (mm):');
d=input('Rebar dimension (mm):');
t=input('Design service life (year):');
t3=input('Assume service life value for trial (year):');
wb=input('Assume water binder ratio value for trial :');
%Main process
%Frist phase
while (t3<t)
   wb=wb-0.01;
      %Degree of hydration
      if (wb<0.42)
      h = wb/0.42;
   else
      h =1;
   end
   Co=(wb-0.382*h)*Qcl*100;
   if (FA == 0) & (RHA == 0)
      D=25.28-71.98*wb+172.5*(wb^2);
      t1=t3;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      while (C < Ct)
         t1=t1+0.1;
         ts=t1*365*24*60*60;
         C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      end
   end

   if (FA > 0) & (RHA == 0)
      D= (25.28-71.98*wb+172.5*(wb^2))* (- 3.02*FA + 5.53*(FA^2) – 3.24*(FA^3));
      t1=t3;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      while (C < Ct)
```

```
        t1=t1+0.1;
        ts=t1*365*24*60*60;
        C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      end
    end

    if (FA == 0) & (RHA > 0)
D=    (25.28-71.98*wb+172.5*(wb^2))*(-    20.1*RHA    +    100.88*(RHA^2)    –
127.54*(RHA^3));
      t1=t3;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      while (C < Ct)
        t1=t1+0.1;
        ts=t1*365*24*60*60;
        C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      end
    end

    if (FA > 0) & (RHA > 0)
      D= (25.28-71.98*wb+172.5*(wb^2))* (- 3.02*FA + 5.53*(FA^2) – 3.24*(FA^3))
*(-    20.1*RHA    +    100.88*(RHA^2)    –    127.54*(RHA^3))*(93.7*FA*RHA-
255.8*FA^2*RHA-550.6*FA*RHA^2+1091.9*FA^2*RHA^2);
      t1=t3;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      while (C < Ct)
        t1=t1+0.1;
        ts=t1*365*24*60*60;
        C=0.65*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      end
    end

%Second phase
q = (-0.51 - 7.6*Ct +44.97*(wb^2)+67.95*Ct*(wb^2))*(d/(x^2))*365;
t2=(0.602*d*((1+2*x/d)^0.85)/q);
%total service life
t1=t1/1000;
t3=t1+t2;
end
fprintf('Water binder ratio:');
wb
%End of source code
%------------------------------------------------------------------------
```

APPENDIX H

Matlab source code for designing cover thickness

```
%------------------------------------------------------------------------
%The purpose of this source code is to design the cover thickness based
%on the desire service life
%Input data
Qcl=input('Chloride concentration of sea water:');
FA=input('Percent of replacement by fly ash (%):');
RHA=input('Percent of replacement by rice husk ash (%):');
Ct=input('Threshold chloride concentration:');
wb=input('Water binder ratio:');
d=input('Rebar dimension (mm):');
t=input('Design service life (year):');
t3=input('Assume service life value for trial (year):');
x=input('Assume cover thickness value for trial (mm):');
x=x/100;
%Main process
%Frist phase
while (t3<t)
  x=x+0.001;
    %Degree of hydration
    if (wb<0.42)
    h = wb/0.42;
  else
    h =1;
  end
  Co=(wb-0.382*h)*Qcl*100;
  if (FA == 0) & (RHA == 0)
    D=25.28-71.98*wb+172.5*(wb^2);
    t1=t3;
    ts=t1*365*24*60*60;
    C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    while (C < Ct)
      t1=t1+0.1;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    end
  end
  if (FA > 0) & (RHA == 0)
    D= (25.28-71.98*wb+172.5*(wb^2))* (- 3.02*FA + 5.53*(FA^2) – 3.24*(FA^3));
    t1=t3;
    ts=t1*365*24*60*60;
    C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    while (C < Ct)
```

```
        t1=t1+0.1;
        ts=t1*365*24*60*60;
        C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      end
    end
    if (FA == 0) & (RHA > 0)
D=    (25.28-71.98*wb+172.5*(wb^2))*(-    20.1*RHA    +    100.88*(RHA^2)    –
127.54*(RHA^3));
      t1=t3;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      while (C < Ct)
        t1=t1+0.1;
        ts=t1*365*24*60*60;
        C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      end
    end
    if (FA > 0) & (RHA > 0)
D= (25.28-71.98*wb+172.5*(wb^2))* (- 3.02*FA + 5.53*(FA^2) – 3.24*(FA^3)) *(-
20.1*RHA + 100.88*(RHA^2) – 127.54*(RHA^3))*(93.7*FA*RHA-255.8*FA^2*RHA-
550.6*FA*RHA^2+1091.9*FA^2*RHA^2);
      t1=t3;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      while (C < Ct)
        t1=t1+0.1;
        ts=t1*365*24*60*60;
        C=0.65*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      end
    end
%Second phase
q = (-0.51 - 7.6*Ct +44.97*(wb^2)+67.95*Ct*(wb^2))*(d/(x^2))*365;
t2=(0.602*d*((1+2*x/d)^0.85)/q);
%total service life
t1=t1/1000;
t3=t1+t2;
end
fprintf('Cover thickness (mm):');
x
%End of source code
%-------------------------------------------------------------------------
```

APENDIX I

Matlab source code for designing rebar dimension

```
%------------------------------------------------------------------------
%The purpose of this source code is to design the rebar dimension based
%on the desire service life

%Input data
Qcl=input('Chloride concentration of sea water:');
FA=input('Percent of replacement by fly ash (%):');
RHA=input('Percent of replacement by rice husk ash (%):');
Ct=input('Threshold chloride concentration:');
wb=input('Water binder ratio:');
x=input('Cover thickness (mm):');
t=input('Design service life (year):');
d=input('Assume rebar dimension value for trial (mm):');
%Main process
%Frist phase
    %Degree of hydration
    if (wb<0.42)
    h = wb/0.42;
  else
    h =1;
  end
  Co=(wb-0.382*h)*Qcl*100;
  if (FA == 0) & (RHA == 0)
    D=25.28-71.98*wb+172.5*(wb^2);
    t1=1;
    ts=t1*365*24*60*60;
    C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    while (C < Ct)
      t1=t1+0.1;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    end
  end
  if (FA > 0) & (RHA == 0)
    D= (25.28-71.98*wb+172.5*(wb^2))* (- 3.02*FA + 5.53*(FA^2) – 3.24*(FA^3));
t1=1;
    ts=t1*365*24*60*60;
    C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
    while (C < Ct)
      t1=t1+0.1;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
```

```
      end
    end
    if (FA == 0) & (RHA > 0)
      D=    (25.28-71.98*wb+172.5*(wb^2))*(-    20.1*RHA    +    100.88*(RHA^2)    –
127.54*(RHA^3));
      t1=1;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      while (C < Ct)
        t1=t1+0.1;
        ts=t1*365*24*60*60;
        C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      end
    end
    if (FA > 0) & (RHA > 0)
D= (25.28-71.98*wb+172.5*(wb^2))* (- 3.02*FA + 5.53*(FA^2) – 3.24*(FA^3)) *(-
20.1*RHA + 100.88*(RHA^2) – 127.54*(RHA^3))*(93.7*FA*RHA-255.8*FA^2*RHA-
550.6*FA*RHA^2+1091.9*FA^2*RHA^2);
      t1=1;
      ts=t1*365*24*60*60;
      C=Co*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      while (C < Ct)
        t1=t1+0.1;
        ts=t1*365*24*60*60;
        C=0.65*(1-erf(x/(2*(((D*1e-12)*ts)^1/2))));
      end
    end
%total service life
t1=t1/1000;
t2=t-t1;
%Second phase
t3=1;
while (t3<t2)
    q = (-0.51 - 7.6*Ct +44.97*(wb^2)+67.95*Ct*(wb^2))*(d/(x^2))*365;
    t3=(0.602*d*((1+2*x/d)^0.85)/q);
    d=d-1;
end
fprintf('Rebar dimension (mm):');
d
%End of source code
%-----------------------------------------------------------------------
```

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