Experiment - concrete column in an aggressive soil environment

p-y calculation

```
Gauss1D[x_, Tetax_] := Exp[-Pi (x / Tetax) ^2]; (*scale function*)
kele[Ebet_, Ipile_, dl_] :=
 Ebet Ipile / dl^3 {{12, 6 dl, -12, 6 dl}, {6 dl, 4 dl^2, -6 dl, 2 dl^2},
   {-12, -6 dl, 12, -6 dl}, {6 dl, 2 dl^2, -6 dl, 4 dl^2}};
PutToKglob[nr_, Ebet_, Ipile_, dl_] :=
  Table[Kglob[[2 nr - 2 + j, 2 nr - 2 + i]] = Kglob[[2 nr - 2 + j, 2 nr - 2 + i]] +
     kele[Ebet, Ipile, dl][[j, i]], {j, 1, 4}, {i, 1, 4}];
Gp[Gsrf_(*Stifness on surface level*), z_(*depth*), k_
   (*parameter*), A_(*parametr*), sig_(*description rand*)] :=
  Gsrf + (A z) ^k + sig los[[Round[z / dl + 1]]] Gsrf;
kz[z_] := Dpil Gp[Gsrf, z, k, Awz, sig];
pu[z_] := ((1 + Sin[fric + Pi / 180. los[[Round[z / dl + 1]]]]) /
        (1 - Sin[fric + Pi / 180. los[[Round[z / dl + 1]]]])) ^2 gamma z + 10^-20;
p[z_, y_] := A pu[z] Tanh[kz[z] y / A / pu[z] / Dpil];
N1[s_] := 1 - 3 s^2 + 2 s^3
N2[s_, L_] := L (s - 2 s^2 + s^3)
N3[s_] := 3 s^2 - 2 s^3
N4[s_, L_] := L (-s^2 + s^3)
v[s_(*<0,1>*), L_, w1_, f1_, w2_, f2_] :=
 {N1[s], N2[s, L], N3[s], N4[s, L]}.{w1, f1, w2, f2}
r[s_(*<0,1>*), L_, w1_, f1_, w2_, f2_] :=
 {-6 + 12 s, L (-4 + 6 s), 6 - 12 s, L (-2 + 6 s)}.{w1, f1, w2, f2} / L^2
M[s_(*<0,1>*), L_, w1_, f1_, w2_, f2_, Ebet_, Ipile_] :=
 {-6 + 12 s, L (-4 + 6 s), 6 - 12 s, L (-2 + 6 s)}.{w1, f1, w2, f2} Ebet Ipile / L^2
Q[s_(*<0,1>*), L_, w1_, f1_, w2_, f2_, Ebet_, Ipile_] :=
 {-12, -6 L, 12, -6 L}.{w1, f1, w2, f2} Ebet Ipile / L^3
Mel[s_, i_] := M[s, dl, rozwf[[2 (i - 1) + 1]],
  rozwf[[2 (i - 1) + 2]], rozwf[[2 (i - 1) + 3]], rozwf[[2 (i - 1) + 4]],
  Ebet, If[((i) dl) ≥ zonecor, Ipilenor, Ipilecorr]]
Qel[s_, i_] := Q[s, dl, rozwf[[2 (i - 1) + 1]], rozwf[[2 (i - 1) + 2]],
  rozwf[[2 (i - 1) + 3]], rozwf[[2 (i - 1) + 4]], Ebet,
  If[((i) dl) ≥ zonecor, Ipilenor, Ipilecorr]]
rel[s_, i_] := r[s, dl, rozwf[[2 (i - 1) + 1]], rozwf[[2 (i - 1) + 2]],
  rozwf[[2 (i - 1) + 3]], rozwf[[2 (i - 1) + 4]]]
vel[s_, i_] := v[s, dl, rozwf[[2 (i - 1) + 1]], rozwf[[2 (i - 1) + 2]],
  rozwf[[2 (i - 1) + 3]], rozwf[[2 (i - 1) + 4]]]
Mtot[x_] := Mel[x / dl - Floor[(x) / dl], Floor[(x) / dl] + 1]
Qtot[x_] := Qel[x / dl - Floor[(x) / dl], Floor[(x) / dl] + 1]
vtot[x_] := vel[x / dl - Floor[(x) / dl], Floor[(x) / dl] + 1]
rtot[x_] := rel[x / dl - Floor[(x) / dl], Floor[(x) / dl] + 1]
```

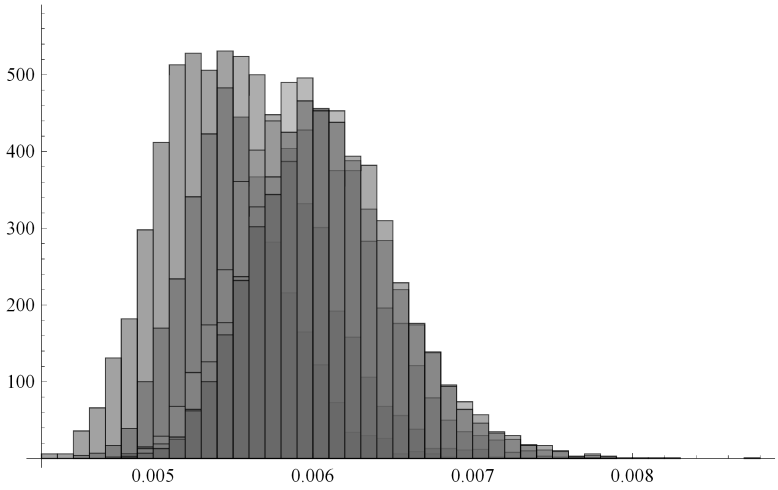
```
FORCE = 50;(*force in head of column*)
zonecor = 5;(*m zone corroded*)
Ebet = 30 × 10^6(*kPa modulus of elasticity of column*);
Dpil = 0.40;(*m diameter of column*)
Ipilenor = Pi (Dpil / 2)^4 / 4;(*inertia of column (pure)*)
Gsrf = 10 000;
Awz = 100;(*Awz*)
k = 1.2;
Ltot = 10; (*m length of column*);
ile = 20;
fric = 30 Pi / 180.; gamma = 20; A = 1.;
sig = 0.1;(*random parameter for substrate*)
dl = Ltot / ile;
rozmiarx = dl;(*element length*)
ilex = ile + 2;(*number of elements*)
WspXMid = Table[rozmiarx (ix - 1 / 2), {ix, 1, ilex}];
TetaX = N[5 dl];
Cov[el1_, el2_, Tetax_] := Gauss1D[WspXMid[[el1]] - WspXMid[[el2]], Tetax]
(*scale function*)
CovVector = Table[N[Cov[i, j, TetaX]], {i, 1, ilex}, {j, 1, ilex}];
LCovDistans = CholeskyDecomposition[CovVector];
```

```
Monitor[
 For[cor = 0; MYMAX = {}, cor ≤ 0.08, cor = cor + 0.02,
  For[zonecor = 1, zonecor ≤ 5, zonecor++,
   Do[
    Block[
     {Ipilecorr = Pi (Dpil / 2 - cor)^4 / 4},
     los = RandomVariate[NormalDistribution[0, 1], {ilex}].LCovDistans;
     Kglob = Table[0, {i, 1, ile * 2 + 2}, {j, 1, ile * 2 + 2}];
     Table[PutToKglob[wezelek, Ebet,
       If[(wezelek dl) ≥ zonecor, Ipilenor, Ipilecorr], dl], {wezelek, 1, ile}];
     ufi = Table[w[i], {i, 1, Length[Kglob]}];
     iost = Length[Kglob];
     ywst = Flatten[Table[{0.01, 0}, {i, 1, iost, 2}]];
     FM = Flatten[Table[
         {-dl p[i dl / 2, ywst[[i]]] / ywst[[i]] ufi[[i]], 0}, {i, 1, iost, 2}]];
     FM[[1]] = FORCE + FM[[1]] / 2;
     FM[[Length[Kglob] - 1]] = FM[[Length[Kglob] - 1]] / 2;
     row = Table[(Kglob.ufi)[[i]] == FM[[i]], {i, 1, Length[Kglob]}];
     rez = NSolve[row, ufi, Reals, WorkingPrecision → 5];
     rozwf = Flatten[ufi /. rez];
     ww = Table[Flatten[ufi /. rez][[i]], {i, 1, Length[Kglob], 2}];
     fi = Table[Flatten[ufi /. rez][[i]], {i, 2, Length[Kglob], 2}];
     FM = Flatten[Table[
         {-dl p[i dl / 2, rozwf[[i]]] / rozwf[[i]] ufi[[i]], 0}, {i, 1, iost, 2}]];
     FM[[1]] = FORCE + FM[[1]] / 2;
     FM[[Length[Kglob] - 1]] = FM[[Length[Kglob] - 1]] / 2;
     row = Table[(Kglob.ufi)[[i]] == FM[[i]], {i, 1, Length[Kglob]}];
     rez = NSolve[row, ufi, Reals, WorkingPrecision → 5];
     rozwf = Flatten[ufi /. rez];
     ww = Table[Flatten[ufi /. rez][[i]], {i, 1, Length[Kglob], 2}];
     fi = Table[Flatten[ufi /. rez][[i]], {i, 2, Length[Kglob], 2}];
     FM = Flatten[Table[
         {-dl p[i dl / 2, rozwf[[i]]] / rozwf[[i]] ufi[[i]], 0}, {i, 1, iost, 2}]];
     FM[[1]] = FORCE + FM[[1]] / 2;
     FM[[Length[Kglob] - 1]] = FM[[Length[Kglob] - 1]] / 2;
     row = Table[(Kglob.ufi)[[i]] == FM[[i]], {i, 1, Length[Kglob]}];
     rez = NSolve[row, ufi, Reals, WorkingPrecision → 5];
     rozwf = Flatten[ufi /. rez];
     ww = Table[Flatten[ufi /. rez][[i]], {i, 1, Length[Kglob], 2}];
     fi = Table[Flatten[ufi /. rez][[i]], {i, 2, Length[Kglob], 2}];
     MYMAX = Append[MYMAX,
       {cor, zonecor, vtot[0], Max[Table[Mtot[x], {x, 0, Ltot - 1, 0.5}]] }]
    ],
    {n, 1, 5000}]](*number of simulations*)
 ],
 ProgressIndicator[Dynamic[n / 5000]]]

Export["out.csv", MYMAX]
```

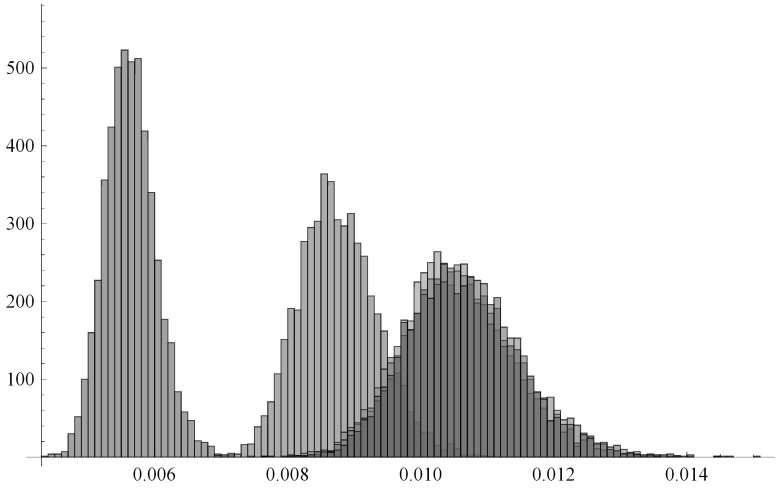
out.csv

results of p-y method from out.dat

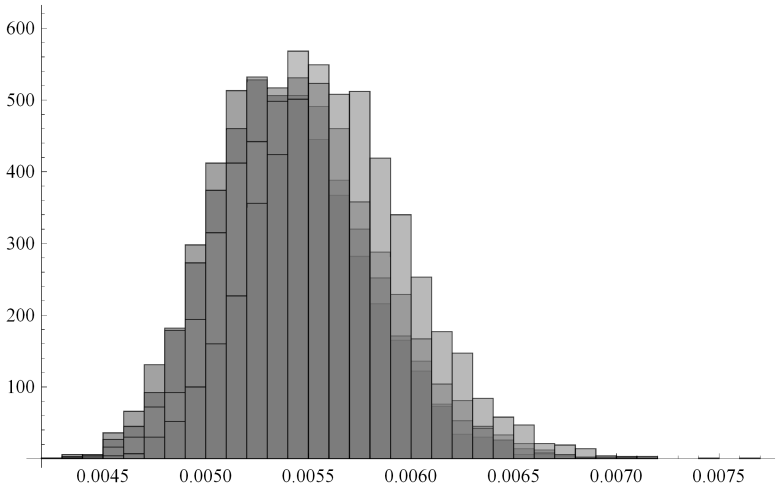
```
MYMAX = Import["out.csv"];

DY[cor_, depth_] := Cases[MYMAX, {cor, depth, _, _}][[ ;; , 3]]
DM[cor_, depth_] := Cases[MYMAX, {cor, depth, _, _}][[ ;; , 4]]

Histogram[Table[DY[0.02, h], {h, 1, 5}], {.0001}]
```



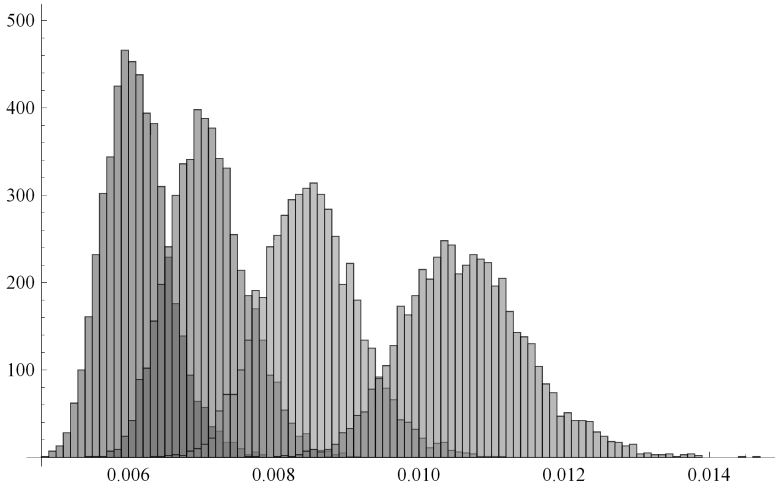

```
Histogram[Table[DY[0.08, h], {h, 1, 5}], {.0001}]
```



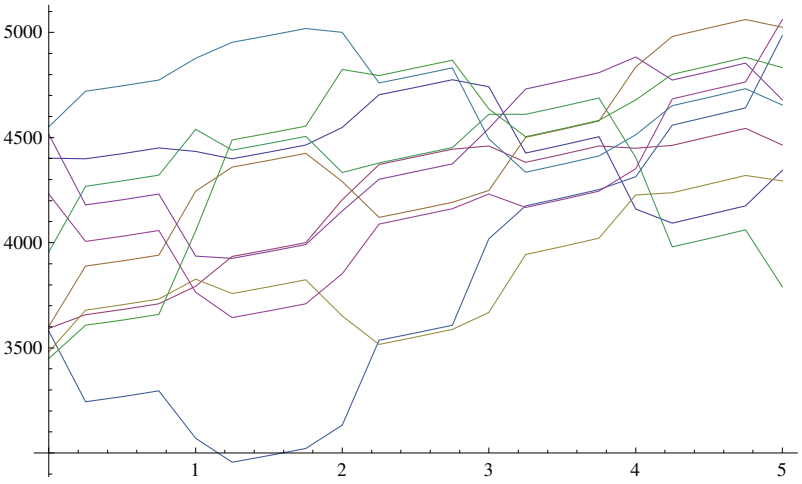
```
Histogram[Table[DY[cr, 1], {cr, 0.02, 0.08, 0.02}], {.0001}]
```



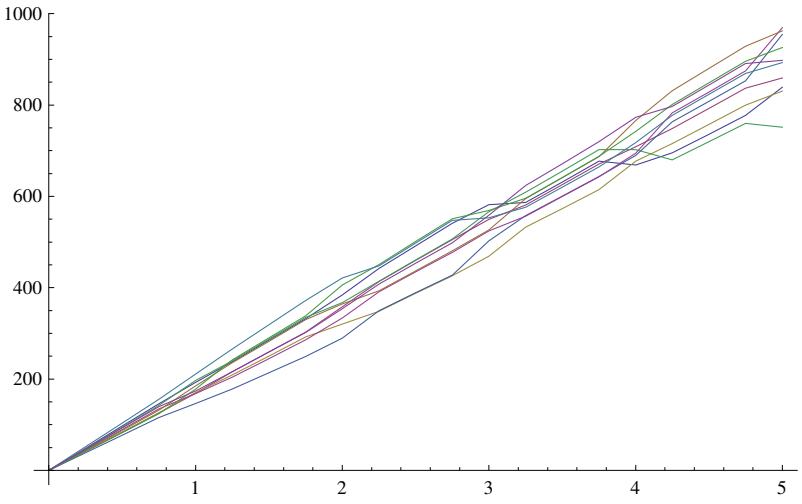

```
Histogram[Table[DY[cr, 5], {cr, 0.02, 0.08, 0.02}], {.0001}]
```



```
rezK = {}; rezPu = {};
Do[
 los = RandomVariate[NormalDistribution[0, 1], {ilex}].LCovDistans;
 AppendTo[rezK, Table[{z, kz[z]}, {z, 0, 5, 0.25}]];
 AppendTo[rezPu, Table[{z, pu[z]}, {z, 0, 5, 0.25}]];
 , {n, 1, 10}]
ListPlot[rezK, Joined → True]
Export["roz_Kz.eps", ListPlot[rezK, Joined → True]]
ListPlot[rezPu, Joined → True]
Export["roz_pu.eps", ListPlot[rezPu, Joined → True]]
```



roz_Kz.eps



roz_pu.eps

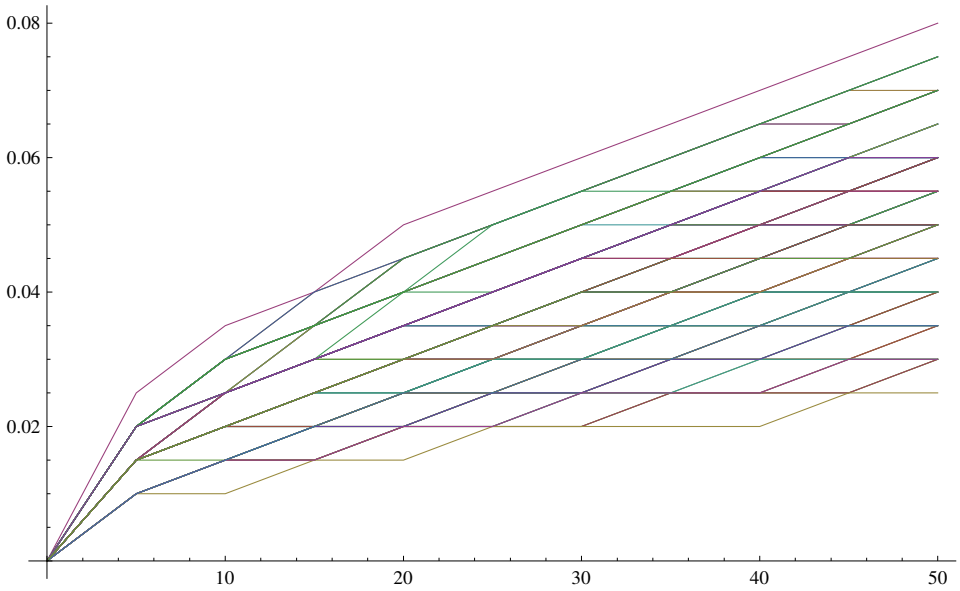
sulphate front

```
Kor[DclMag_, Ctreshold_, Ampl_] :=
 {
  element = 0.2; (*radius of column*)
  dx = 0.005; (*distance*)
  Dcl = DclMag 3.09 / 1 000 000;
  dt = 1; (*time step*)
  ilep = Round[element / dx] ;
  C0 = 0;
  F0 = dt / (dx^2);
  Cc = Table[C0, {i, 1, ilep + 2}];
  period = 50(*yrs*);
  Cmax = Cc;
  crack = 0;
  rez = {};
  alpha = 2.017;
  Do[
   {Cc[[1]] = Ampl 0.5 (Cos[t 2 Pi / 365] + 1);
    Do[
     Dclm = Dcl (element / (element - m dx + 0.01));
     Cc[[m]] = If[Cmax[[m]] > Ctreshold, alpha Dclm, Dclm]
         F0 (Cc[[m + 1]] + Cc[[m - 1]] - 2 Cc[[m]]) + Cc[[m]];
     If[Cc[[m]] > Cmax[[m]], Cmax[[m]] = Cc[[m]]];
     crack = If[Cmax[[m]] > Ctreshold, m dx, crack],
     {m, 2, ilep + 1}]
   };
   AppendTo[rez, crack],
   {t, 0, period 365, dt}];
  CorDep = Table[{i * 5, rez[[i * 365 * 5 + 1]]}, {i, 0, 10}]
  (*read in every 5 yrs*);
}
```

```
varB[x_] := (1 / 8) (-4 + 1 / x^2)(*var 0.25*)
Losowanie[ile_, var_, min_, max_] :=
 RandomVariate[BetaDistribution[varB[var], varB[var]], ile] (max - min) + min
ile = 3000;
var = 0.15;
DclMag = Losowanie[ile, var, 0.1, 0.5](*property*);
Ctreshold = Losowanie[ile, var, 0.30, 0.60](*treshold*);
Ampl = Losowanie[ile, var, 1.0, 4.0](*ions concentr*);
LosStrefa = Losowanie[ile, var, 0, 5](*attaced zone [m] *);
```

```
R =
  Monitor[
   REZ = {};
   Table[
    Kor[DclMag[[i]], Ctreshold[[i]], Ampl[[i]]];
    AppendTo[REZ, CorDep],
    {i, 1, ile}],
   Row[{ProgressIndicator[i, {1, ile}], i}, " "]];
```

```
ListPlot[REZ[[100 ;; 200]], Joined → True]
```




```
Export["rez_korozja.eps", ListPlot[REZ[[1 ;; 200]], Joined → True]]
```

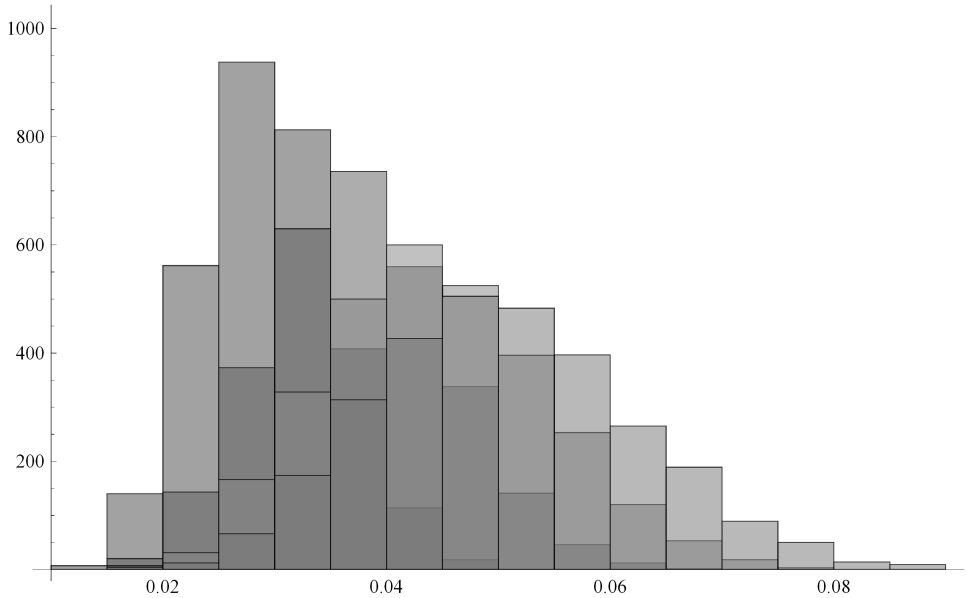
```
rez_korozja.eps
```

```
Export["rozwiazania_korozji.csv", REZ]
```

```
rozwiazania_korozji.csv
```

```
REZLatami = Table[REZ[[1 ;; Length[REZ], rok / 5, 2]], {rok, 5, 50, 5}];
```

```
Histogram[{REZLatami[[4]], REZLatami[[6]], REZLatami[[8]], REZLatami[[10]]}]
(*20lat,30, 40, 50lat*)
```




```
Export["rez_prob_kor.eps",
 Histogram[{REZLatami[[4]], REZLatami[[6]], REZLatami[[8]], REZLatami[[10]]}]]
```

```
rez_prob_kor.eps
```

```
Histogram[REZ[[ ;; , 10]], {.1}]
```

```
rozklady = Table[{i * 5, {μ, σ} /. FindDistributionParameters[REZLatami[[i]],
     LogNormalDistribution[μ, σ]]}, {i, 3, Length[[WynYOM] REZLatami]}]
```

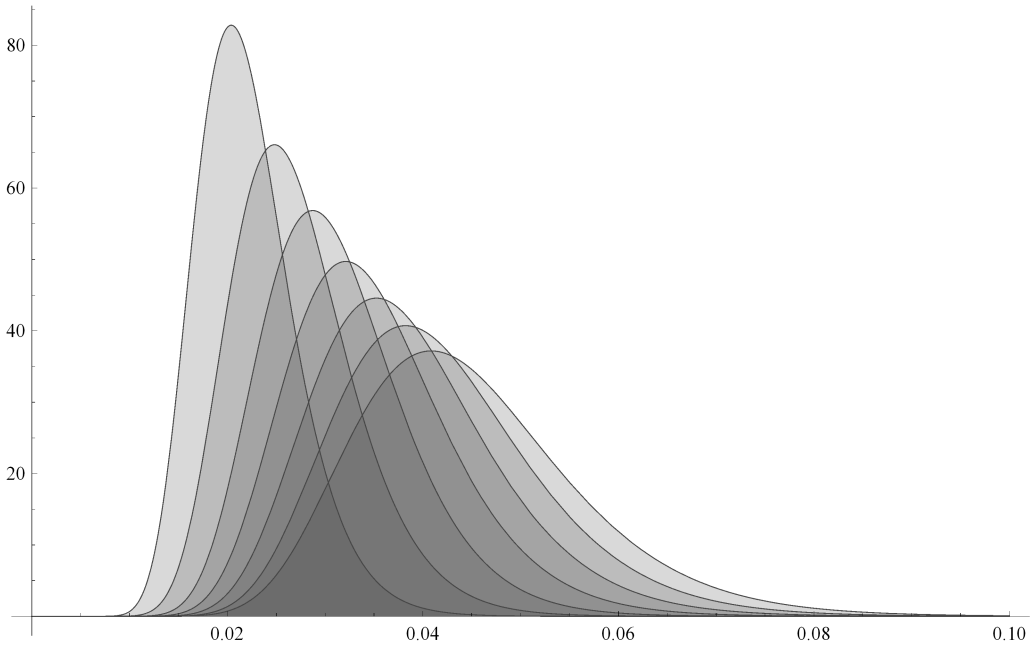
```
(*KLUCZOWE*)
```

```
rozklady = {
  {15, {-3.8394181802092033`, 0.22999970331122815`}},
  {20, {-3.6401019962378536`, 0.2365538283025691`}},
  {25, {-3.4933529717104768`, 0.23746137576420753`}},
  {30, {-3.3796401344260483`, 0.24266088384078896`}},
  {35, {-3.2846885987235366`, 0.24632284420082876`}},
  {40, {-3.202336829706916`, 0.24848943498550727`}},
  {45, {-3.1331625817957685`, 0.2543134333243087`}},
  {50, {-3.0665446998495223`, 0.254817994035441`}}}
```

```
rozklady[[1, 2, 1]]
```

```
-3.83942
```

```
Plot[
 Table[PDF[LogNormalDistribution[rozklady[[i, 2, 1]], rozklady[[i, 2, 2]]], x],
  {i, 1, 7}], {x, 0, 0.1}, PlotRange → All, Filling → Bottom]
```



wyniki dopasowania dla kolejnych pięciolatek poczynając od 15, 20, 25, 30 .. 50

```
Export["rez_prob_kor_lognormal.eps", Plot[
  Table[PDF[LogNormalDistribution[rozklady[[i, 2, 1]], rozklady[[i, 2, 2]]], x],
   {i, 1, 7}], {x, 0, 0.1}, PlotRange → All, Filling → Bottom]]
```

```
rez_prob_kor_lognormal.eps
```

```
Export["rez_prob_kor_lognormal30lat.eps",
 Plot[PDF[LogNormalDistribution[rozklady[[3, 2, 1]], rozklady[[3, 2, 2]]], x],
  {x, 0, 0.1}, PlotRange → All, Filling → Bottom]]
```

```
rez_prob_kor_lognormal30lat.eps
```

```
Export["rez_prob_kor_lognormal50lat.eps",
 Plot[PDF[LogNormalDistribution[rozklady[[7, 2, 1]], rozklady[[7, 2, 2]]], x],
  {x, 0, 0.1}, PlotRange → All, Filling → Bottom]]
```

```
rez_prob_kor_lognormal50lat.eps
```

analisys

```
rezdopasowania = Table[
  Table[{cr, h, μ, σ} /.
    FindDistributionParameters[DY[cr, h], LogNormalDistribution[μ, σ]],
   {cr, 0.02, 0.08, 0.02}],
  {h, 1, 5, 1}]
```

```
{{{0.02, 1, -5.2262, 0.0697323}, {0.04, 1, -5.21949, 0.069173},
  {0.06, 1, -5.20653, 0.0682436}, {0.08, 1, -5.1802, 0.0685058}},
 {{0.02, 2, -5.17635, 0.0703939}, {0.04, 2, -5.09408, 0.067643},
  {0.06, 2, -4.95851, 0.06719}, {0.08, 2, -4.73994, 0.067668}},
 {{0.02, 3, -5.12451, 0.0711253}, {0.04, 3, -4.98456, 0.071219},
  {0.06, 3, -4.79531, 0.0726066}, {0.08, 3, -4.55573, 0.0787569}},
 {{0.02, 4, -5.10463, 0.0729799}, {0.04, 4, -4.95363, 0.0735328},
  {0.06, 4, -4.76854, 0.0769749}, {0.08, 4, -4.54696, 0.0812426}},
 {{0.02, 5, -5.10074, 0.0727889}, {0.04, 5, -4.95119, 0.0737252},
  {0.06, 5, -4.76931, 0.0766479}, {0.08, 5, -4.54558, 0.0795973}}}
```

```
Export["5m.eps",
 Show[
  Histogram[
   {DY[0.02, 5], DY[0.04, 5], DY[0.06, 5], DY[0.08, 5]}, {0.0001}, "PDF"],
  Plot[
   {PDF[
     LogNormalDistribution[-5.1007353617279545`, 0.07278890747812172`], x],
    PDF[LogNormalDistribution[-4.951193361416223`,
      0.07372524398900229`], x],
    PDF[LogNormalDistribution[-4.7693102321930185`,
      0.0766478806269529`], x],
    PDF[LogNormalDistribution[-4.545583230972011`,
      0.07959733781869058`], x]},
   {x, 0, 0.015}, PlotRange → All, PlotStyle → Thick]
 ]]
```

```
5m.eps
```

```
Export["1m.eps",
 Show[
  Histogram[
   {DY[0.02, 1], DY[0.04, 1], DY[0.06, 1], DY[0.08, 1]}, {0.0001}, "PDF"],
  Plot[
   {PDF[
     LogNormalDistribution[-5.226198210264447`, 0.06973229408779939`], x],
    PDF[LogNormalDistribution[-5.219485326069791`,
      0.06917297209037444`], x],
    PDF[LogNormalDistribution[-5.206531699753524`,
      0.06824359523678832`], x],
    PDF[LogNormalDistribution[-5.180196296365432`,
      0.0685057747497439`], x]},
   {x, 0, 0.015}, PlotRange → All, PlotStyle → Thick]
 ]]
```

1m.eps

multiplication of probability

data 1

```
rozkladyKOR = {
   {15, -3.8394181802092033`, 0.22999970331122815`},
   {20, -3.6401019962378536`, 0.2365538283025691`},
   {25, -3.4933529717104768`, 0.23746137576420753`},
   {30, -3.3796401344260483`, 0.24266088384078896`},
   {35, -3.2846885987235366`, 0.24632284420082876`},
   {40, -3.202336829706916`, 0.24848943498550727`},
   {45, -3.1331625817957685`, 0.2543134333243087`},
   {50, -3.0665446998495223`, 0.254817994035441`}};
```

```
rozkladyMECH = {
    {0.02`, 1, -5.226198210264447`, 0.06973229408779939`},
    {0.04`, 1, -5.219485326069791`, 0.06917297209037444`},
    {0.06`, 1, -5.206531699753524`, 0.06824359523678832`},
    {0.08`, 1, -5.180196296365432`, 0.0685057747497439`},
    {0.02`, 2, -5.176347780474413`, 0.07039388522124598`},
    {0.04`, 2, -5.094076261655867`, 0.06764295279240555`},
    {0.06`, 2, -4.958511334395738`, 0.06719003797685816`},
    {0.08`, 2, -4.73994447165115`, 0.06766802698386734`},
    {0.02`, 3, -5.1245106919727474`, 0.07112532928100367`},
    {0.04`, 3, -4.984561544044052`, 0.07121901779533808`},
    {0.06`, 3, -4.795311898135812`, 0.07260655046075556`},
    {0.08`, 3, -4.555732018885752`, 0.0787569276319436`},
    {0.02`, 4, -5.104634014949098`, 0.07297987612364099`},
    {0.04`, 4, -4.953630475956158`, 0.07353277451394861`},
    {0.06`, 4, -4.768536979814507`, 0.07697486847998744`},
    {0.08`, 4, -4.546958897527682`, 0.08124255804565737`},
    {0.02`, 5, -5.1007353617279545`, 0.07278890747812172`},
    {0.04`, 5, -4.951193361416223`, 0.07372524398900229`},
    {0.06`, 5, -4.7693102321930185`, 0.0766478806269529`},
    {0.08`, 5, -4.545583230972011`, 0.07959733781869058`}};
```

data 2

```
data0 = rozkladyMECH[[ ;; , 1 ;; 3]]
```

```
{{0.02, 1, -5.2262}, {0.04, 1, -5.21949},
 {0.06, 1, -5.20653}, {0.08, 1, -5.1802}, {0.02, 2, -5.17635},
 {0.04, 2, -5.09408}, {0.06, 2, -4.95851}, {0.08, 2, -4.73994},
 {0.02, 3, -5.12451}, {0.04, 3, -4.98456}, {0.06, 3, -4.79531},
 {0.08, 3, -4.55573}, {0.02, 4, -5.10463}, {0.04, 4, -4.95363},
 {0.06, 4, -4.76854}, {0.08, 4, -4.54696}, {0.02, 5, -5.10074},
 {0.04, 5, -4.95119}, {0.06, 5, -4.76931}, {0.08, 5, -4.54558}}
```

```
nlm1 = NonlinearModelFit[data0,
   a1 x^2 + a2 x + a3 x y + a4 y^2 + a5 y + a6, {a1, a2, a3, a4, a5, a6}, {x, y}];
Normal[
 nlm1]
```

$$-5.45583 - 3.51623\,x + 50.0385\,x^2 + 0.221819\,y + 1.90305\,x\,y - 0.0381356\,y^2$$

```
miu[x_, y_] :=
 -5.455825287262648` - 3.516229928687693` x + 50.038517330500675` x^2 +
  0.22181858766002857` y + 1.903052150815703` x y - 0.03813562348256178` y^2
```

```
(* dopasowanie odchylen dla palowania*)
(* x- glebokosc korozji, y - strefa skorodowana na dlugosci pala*)
data1 = Table[ Append[rozkladyMECH[[k, 1 ;; 2]], rozkladyMECH[[k, 4]]],
  {k, 1, Length[rozkladyMECH] - 1}]
```

```
{{0.02, 1, 0.0697323}, {0.04, 1, 0.069173},
 {0.06, 1, 0.0682436}, {0.08, 1, 0.0685058},
 {0.02, 2, 0.0703939}, {0.04, 2, 0.067643}, {0.06, 2, 0.06719},
 {0.08, 2, 0.067668}, {0.02, 3, 0.0711253}, {0.04, 3, 0.071219},
 {0.06, 3, 0.0726066}, {0.08, 3, 0.0787569}, {0.02, 4, 0.0729799},
 {0.04, 4, 0.0735328}, {0.06, 4, 0.0769749}, {0.08, 4, 0.0812426},
 {0.02, 5, 0.0727889}, {0.04, 5, 0.0737252}, {0.06, 5, 0.0766479}}
```

```
nlm2 = NonlinearModelFit[data1,
   a1 x^2 + a2 x + a3 x y + a4 y^2 + a5 y + a6, {a1, a2, a3, a4, a5, a6}, {x, y}];
Normal[
 nlm2]
```

```
sigma[x_, y_] := 0.07638430061650064` - 0.3693860381125798` x +
  2.6206460683179795` x^2 - 0.0009006507373644527` y +
  0.061777612419016525` x y + 0.000036565568816691157` y^2
```

```
prawdDISP[d_(*0.02 ... 0.08m*), c_(*1..5m*), lim_(*m*)] :=
 - InverseCDF[NormalDistribution[0, 1],
   1 - CDF[LogNormalDistribution[miu[d, c], sigma[d, c]], lim]]
```

```
Export["beta.eps", Show[Plot3D[prawdDISP[cr, h, 0.008], {cr, 0.02, 0.08},
   {h, 2, 5}, ColorFunction → "RustTones", BoundaryStyle → Thick,
   RegionFunction → Function[{cr, h, z}, z ≥ 0], Filling → Bottom, Mesh → 10],
  Plot3D[prawdDISP[cr, h, 0.01], {cr, 0.02, 0.08},
   {h, 2, 5}, ColorFunction → "RustTones"],
  Plot3D[prawdDISP[cr, h, 0.012], {cr, 0.02, 0.08},
   {h, 2, 5}, ColorFunction → "RustTones"]]
]
```

```
beta.eps
```

```
prawdDISPA[d_(*0.02 ... 0.08m*), c_(*1..5m*), lim_(*m*)] :=
 1 - CDF[LogNormalDistribution[miu[d, c], sigma[d, c]], lim]
```

fitting

```
data0 = rozkladyKOR[[ ;; , 1 ;; 2]]
```

```
{{15, -3.83942}, {20, -3.6401}, {25, -3.49335}, {30, -3.37964},
 {35, -3.28469}, {40, -3.20234}, {45, -3.13316}, {50, -3.06654}}
```

```
nlm1 = NonlinearModelFit[data0, a1 x^2 + a2 x + a3, {a1, a2, a3}, {x}]
```

```
Normal[nlm1]
```

$$-4.44538 + 0.0476279\,x - 0.00040626\,x^2$$

```
miuK[x_] :=
 -4.445378010309725` + 0.04762787438412194` x - 0.0004062599210582354` x^2
```

```
rozkladyKOR[[1, 1 ;; 3]]
```

```
{15, -3.83942, 0.23}
```

```
data1 = Table[ {rozkladyKOR[[k, 1]], rozkladyKOR[[k, 3]]},
   {k, 1, Length[rozkladyKOR] - 1}]
```

```
{{15, 0.23}, {20, 0.236554}, {25, 0.237461},
 {30, 0.242661}, {35, 0.246323}, {40, 0.248489}, {45, 0.254313}}
```

```
nlm2 = NonlinearModelFit[data1, a1 x^2 + a2 x + a3, {a1, a2, a3}, {x}]
Normal[nlm2]
```

```
sigmaK[x_] :=
 0.21944895196456424` + 0.0007671137154575651` x - 2.050057526571628`*^-7 x^2
```

final calculation

```
As[lim_] := Table[prawdDISPA[k, 5, lim], {k, 0.02, 0.08, 0.01}]
```

```
B =
  Table[
   Table[
    1 - CDF[LogNormalDistribution[miuK[t], sigmaK[t]], rysa],
    {rysa, 0.02, 0.08, 0.01}],
   {t, 15, 50, 1}];
```

```
(*kolumny 0.02  0.03  0.04 ... 0.08m*)
```

```
(*wiersze czas*)
```

```
ABrez = Table[Max[As[0.01] * B[[i]]], {i, 1, Length[B]}]
```

```
{1.51912×10^-7, 3.19997×10^-7, 6.43896×10^-7, 1.2406×10^-6,
 2.29394×10^-6, 4.0796×10^-6, 7.41896×10^-6, 0.0000135029, 0.0000236958,
 0.0000401702, 0.0000659048, 0.000104825, 0.000161909, 0.000243235,
 0.000355948, 0.000508135, 0.000708598, 0.000966534, 0.00129113,
 0.00169109, 0.00217417, 0.00274667, 0.00341304, 0.00417544,
 0.00503357, 0.00598443, 0.00702233, 0.00813897, 0.0093236, 0.0105633,
 0.0118434, 0.0131478, 0.0144593, 0.0157602, 0.0170328, 0.0182594}
```

```
RRREEEZZZ = -InverseCDF[NormalDistribution[0, 1], ABrez]
```

```
{5.12106, 4.97874, 4.84163, 4.70967, 4.5828, 4.46096, 4.33108, 4.19735, 4.06813,
 3.94338, 3.82305, 3.7071, 3.59546, 3.4881, 3.38496, 3.28598, 3.19113, 3.10033,
 3.01353, 2.93068, 2.85172, 2.77658, 2.70521, 2.63754, 2.57351, 2.51306, 2.45612,
 2.40262, 2.35251, 2.30571, 2.26217, 2.22182, 2.1846, 2.15044, 2.1193, 2.0911}
```

```
REZ[lim_] := Table[{i + 14, -InverseCDF[NormalDistribution[0, 1],
      Table[Max[As[lim] * B[[i]]], {i, 1, Length[B]}]][[i]]}, {i, 1, 36}]
```

```
REZ[0.008]
REZ[0.01]
REZ[0.012]
```

```
{{15, 3.7356}, {16, 3.61925}, {17, 3.50886}, {18, 3.40434},
 {19, 3.30561}, {20, 3.20796}, {21, 3.08284}, {22, 2.96263},
 {23, 2.84729}, {24, 2.73677}, {25, 2.63101}, {26, 2.52995},
 {27, 2.43355}, {28, 2.34172}, {29, 2.25439}, {30, 2.17149},
 {31, 2.09292}, {32, 2.0186}, {33, 1.94844}, {34, 1.88232}, {35, 1.82013},
 {36, 1.76178}, {37, 1.70713}, {38, 1.65607}, {39, 1.60847}, {40, 1.56422},
 {41, 1.52318}, {42, 1.48523}, {43, 1.44563}, {44, 1.39586}, {45, 1.34953},
 {46, 1.30659}, {47, 1.26699}, {48, 1.23069}, {49, 1.19764}, {50, 1.1678}}
```

```
{{15, 5.12106}, {16, 4.97874}, {17, 4.84163}, {18, 4.70967},
 {19, 4.5828}, {20, 4.46096}, {21, 4.33108}, {22, 4.19735}, {23, 4.06813},
 {24, 3.94338}, {25, 3.82305}, {26, 3.7071}, {27, 3.59546}, {28, 3.4881},
 {29, 3.38496}, {30, 3.28598}, {31, 3.19113}, {32, 3.10033},
 {33, 3.01353}, {34, 2.93068}, {35, 2.85172}, {36, 2.77658},
 {37, 2.70521}, {38, 2.63754}, {39, 2.57351}, {40, 2.51306},
 {41, 2.45612}, {42, 2.40262}, {43, 2.35251}, {44, 2.30571}, {45, 2.26217},
 {46, 2.22182}, {47, 2.1846}, {48, 2.15044}, {49, 2.1193}, {50, 2.0911}}
```

```
{{15, 5.90352}, {16, 5.74192}, {17, 5.58514}, {18, 5.43313},
 {19, 5.28584}, {20, 5.14323}, {21, 5.00525}, {22, 4.87184},
 {23, 4.74295}, {24, 4.61854}, {25, 4.49856}, {26, 4.38295},
 {27, 4.27165}, {28, 4.16462}, {29, 4.06179}, {30, 3.96312},
 {31, 3.86854}, {32, 3.77799}, {33, 3.69141}, {34, 3.60874}, {35, 3.52992},
 {36, 3.45489}, {37, 3.38357}, {38, 3.31591}, {39, 3.25184}, {40, 3.1913},
 {41, 3.13422}, {42, 3.08052}, {43, 3.03016}, {44, 2.98306}, {45, 2.93916},
 {46, 2.89839}, {47, 2.8607}, {48, 2.82603}, {49, 2.79431}, {50, 2.76549}}
```

```
Export["rrrezzz.eps",
 ListPlot[{REZ[0.006], REZ[0.008], REZ[0.010], REZ[0.012], REZ[0.014]},
  Joined → True, PlotRange → {All, {0, 5}}]]
```

```
rrrezzz.eps
```