(* Appendix 3. H.Ira : The Development of the Two Circle Roller in a Numerical Way *)

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                         (* APPENDIX 3 *)
            (* Select all and copy of this paper,
         and paste on the MATHEMATICA in TEXT type,
           then MATHEMATICA program will be run. *)

(* The ruled surface Ω of the Two - Circle - Roller
                      which is given by vector equations. *)
Off[General::spell]
<< Graphics`Graphics3D`

r = 1.0;
(* "r" is a radius of the Two - Circle - Roller, and any value is permitted,
  1.0 is an example.*)

n = 20 ;
(* "n" is a discrete rate of an arc AoAe on Cad and BoBe on Cbd *)

m = 20;
(* "m" is a discrete rate of a generator line AB and BA *)

listAB = Table[
      r*(2 + Sqrt[2]*Cos[t])/Sqrt[1 + Sqrt[2]*Cos[t]], {t, 0, Pi/2,
        Pi/(2*n)}] // N;
(* A list of the generator line AB *)

listu = Table[j*listAB[[i]]/m, {i, 1, n + 1}, {j, 0, m}];(*
  A list of u and ub *)

listt = Table[i*Pi/(2*n), {i, 0, n}] // N  ;
(* A list of t and τ *)

(* The components of the vector equation (74), that is (78). 0 <= zr  *)

xr[t_, u_] :=
  r *Sin[t] - u *Sqrt[1 + Sqrt[2]*Cos[t]]*Sin[t]/(2 + Sqrt[2]*Cos[t])
yr[t_, u_] := -r*(Sqrt[2]/2 + Cos[t]) +
    u*(1 + Sqrt[2]*Cos[t] + Cos[t]^2)/((Sqrt[2] + Cos[t])*
          Sqrt[1 + Sqrt[2]*Cos[t]] )
zr[t_, u_] := 0 + u* Sqrt[(Sqrt[2] + Cos[t])^2 - 1]/
      ((2 + Sqrt[2]*Cos[t])*Sqrt[1 + Sqrt[2]*Cos[t]])
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(* The components of the vector equation (77), that is (79). 0 <= xrb *)

xrb[τ_, ub_] :=
  0 + ub * Sqrt[(Sqrt[2] + Cos[τ])^2 - 1]/((2 + Sqrt[2]*Cos[τ])*
          Sqrt[1 + Sqrt[2]*Cos[τ]])
yrb[τ_, ub_] :=
  r*(Sqrt[2]/2 + Cos[τ]) -
    ub*(1 + Sqrt[2]*Cos[τ] + Cos[τ]^2)/((Sqrt[2] + Cos[τ])*
          Sqrt[1 + Sqrt[2]*Cos[τ]] )
zrb[τ_, ub_] :=
  r *Sin[τ] - ub *Sqrt[1 + Sqrt[2]*Cos[τ]]*Sin[τ]/(2 + Sqrt[2]*Cos[τ])




(* The list of the ruled surface Ω by parameter "t". *)

ruledΩ1 =
    Table[Table[{xr[listt[[i]], listu[[i, j]]], yr[listt[[i]], listu[[i,
j]]],
          zr[listt[[i]], listu[[i, j]]]}, {i, 1, n + 1}], {j, 1, m + 1}];
ruledΩ2 =
    Table[Table[{-xr[listt[[i]], listu[[i, j]]],
          yr[listt[[i]], listu[[i, j]]], zr[listt[[i]], listu[[i, j]]]}, {i,
          1, n + 1}], {j, 1, m + 1}];
ruledΩ3 =
    Table[Table[{-xr[listt[[i]], listu[[i, j]]],
          yr[listt[[i]], listu[[i, j]]], -zr[listt[[i]], listu[[i, j]]]}, {i,
          1, n + 1}], {j, 1, m + 1}];
ruledΩ4 =
    Table[Table[{xr[listt[[i]], listu[[i, j]]],
          yr[listt[[i]], listu[[i, j]]], -zr[listt[[i]], listu[[i, j]]]}, {i,
          1, n + 1}], {j, 1, m + 1}];



(* The list of the ruled surface Ω by parameter "τ". *)

ruledΩ5 =
    Table[Table[{xrb[listt[[i]], listu[[i, j]]],
          yrb[listt[[i]], listu[[i, j]]], zrb[listt[[i]], listu[[i, j]]]}, {i,
           1, n + 1}], {j, 1, m + 1}];
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ruledΩ6 =
   Table[Table[{-xrb[listt[[i]], listu[[i, j]]],
        yrb[listt[[i]], listu[[i, j]]], zrb[listt[[i]], listu[[i, j]]]}, {i,
         1, n + 1}], {j, 1, m + 1}];
ruledΩ7 =
   Table[Table[{-xrb[listt[[i]], listu[[i, j]]],
        yrb[listt[[i]],
          listu[[i, j]]], -zrb[listt[[i]], listu[[i, j]]]}, {i, 1,
        n + 1}], {j, 1, m + 1}];
ruledΩ8 =
   Table[Table[{xrb[listt[[i]], listu[[i, j]]],
        yrb[listt[[i]],
          listu[[i, j]]], -zrb[listt[[i]], listu[[i, j]]]}, {i, 1,
        n + 1}], {j, 1, m + 1}];


ListSurfacePlot3D[ruledΩ1, ViewPoint -> {-1.373, -2.492, 1.833},
  DisplayFunction -> Identity]
ListSurfacePlot3D[ruledΩ2, ViewPoint -> {-1.373, -2.492, 1.833},
  DisplayFunction -> Identity]
ListSurfacePlot3D[ruledΩ3, ViewPoint -> {-1.373, -2.492, 1.833},
  DisplayFunction -> Identity]
ListSurfacePlot3D[ruledΩ4, ViewPoint -> {-1.373, -2.492, 1.833},
  DisplayFunction -> Identity]
Ωt = Show[%, %%, %%%, %%%%]

ListSurfacePlot3D[ruledΩ5, ViewPoint -> {-1.373, -2.492, 1.833},
  DisplayFunction -> Identity]
ListSurfacePlot3D[ruledΩ6, ViewPoint -> {-1.373, -2.492, 1.833},
  DisplayFunction -> Identity]
ListSurfacePlot3D[ruledΩ7, ViewPoint -> {-1.373, -2.492, 1.833},
  DisplayFunction -> Identity]
ListSurfacePlot3D[ruledΩ8, ViewPoint -> {-1.373, -2.492, 1.833},
  DisplayFunction -> Identity]
Ωτ = Show[%, %%, %%%, %%%%]

Show[Ωt, Ωτ, DisplayFunction -> $DisplayFunction,
  ViewPoint -> {5.012, -2.305, 7.111}, Shading -> False, Boxed -> False]
```