global ns

% 输入设计量

T0=10;%设计桨盘拉力

D=0.103\*2;%桨盘直径

nb=5;%桨叶数

D1=0.104\*2;%涵道内壁直径

D2=0.11\*2;%涵道出口直径

L=90/1000;%涵道长度,m

ns=6000/60;%秒转速

delta\_r=D/20;

ld=L/D1;%涵道长径比

A1=pi\*((D1/2)^2-(D/20)^2);%桨盘面积

A2d=pi\*(D2/2)^2;%尾部出口滑流面积

% ------------------------------------------------------------------------%

% 速度参数计算

global q va1 va2 ns v0

% 薄圆柱涵道拉力因子q计算公式

q=(0.8544\*ld^3-1.9389\*ld^2+1.4973\*ld+0.5252)/(0.8544\*ld^3-1.9389\*ld^2+1.4973\*ld+1.5252);

flag2=1;

while abs(flag2)>1e-04

flag2=q;

flag1=1;v0=0;

% 计算悬停工况下的等效来流速度

while abs(flag1)>1e-04

flag1=v0/ns/D;

v\_1=0.5\*(v0+sqrt(v0^2+2\*T0/1.225/A1));

v0=(1-A1\*(1-q)/2/A2d)\*v\_1;

flag1=flag1-v0/ns/D;

end

va2=max(roots([0.5\*1.225\*A1 1.225\*A1\*v0 -T0\*(1-q)]));%尾部滑流速度增量

v2=v0+va2;%尾部滑流速度

qv=A2d\*v2;%流量

v1=qv/A1;%桨盘速度

va1=v1-v0;%桨盘速度增量

q=1-(v0+v2)/2/v1;

flag2=flag2-q;

end

r\_flag=2\*sqrt(0.5\*(1-q)\*va2\*(va1+v0))/2/pi/ns;%气动计算开始半径

phi\_flag=180/pi\*atan(sqrt((v0+va1)\*2/(1-q)/va2));

% %------------------------------------------------------------------------%

% 气动计算

global va1 ns k v0 r

rr=D/10:D/20:D/2;

for k=1:(length(rr)-1)

r(k)=0.5\*(rr(k)+rr(k+1));

end

T\_p=T0/nb;%单桨叶总拉力

mju=17.9e-06;

bb=zeros(length(r),floor(pi\*max(r)/0.001/nb));

Re=zeros(length(r),floor(pi\*max(r)/0.001/nb));

l\_d=zeros(length(r),floor(pi\*max(r)/0.001/nb));

cl=zeros(length(r),floor(pi\*max(r)/0.001/nb));

cd=zeros(length(r),floor(pi\*max(r)/0.001/nb));

attack=zeros(length(r),floor(pi\*max(r)/0.001/nb));

gama=zeros(length(r),floor(pi\*max(r)/0.001/nb));

dT=zeros(length(r),floor(pi\*max(r)/0.001/nb));

dM=zeros(length(r),floor(pi\*max(r)/0.001/nb));

angle=zeros(length(r),1);

phi=zeros(1,length(r));

w=zeros(length(r),1);

% 计算每个截面拉力与扭矩的系列值

for k=1:length(r)

if r(k)>=r\_flag

phi(k)=fsolve('solve\_phi',0.1); %求解气流角

else

phi(k)=atan(v1/2/pi/ns/r(k));

end

w(k)=(v0+va1)./sin(phi(k));%计算截面气流速度

for k1=1:pi\*r(k)/nb/0.001

bb(k,k1)=0.01+0.001\*(k1-1);%弦长范围

R\_e=round((1.225\*bb(k,k1)\*w(k)/mju)/1000)\*1000;%计算截面雷诺数

if isempty(find(Re==R\_e))

flag4=0;

Re(k,k1)=R\_e;

while flag4==0

qd=xfoil1(Re(k,k1),w(k)/340,phi(k),r(k));%计算雷诺数下升阻特性

if isempty(qd)

Re(k,k1)=Re(k,k1)+1000;

flag4=0;

else

flag4=1;

end

end

l\_d(k,k1)=max(qd(:,4));%升阻比

[n1,n2]=find(qd==l\_d(k,k1));

attack(k,k1)=qd(n1(1),1);%攻角

cl(k,k1)=qd(n1(1),2);%升力系数

cd(k,k1)=qd(n1(1),3);%阻力系数

gama(k,k1)=atan(cd(k,k1)/cl(k,k1));%阻升角

else

[n1,n2]=find(Re==R\_e);

l\_d(k,k1)=l\_d(n1(1),n2(1));

cl(k,k1)=cl(n1(1),n2(1));

cd(k,k1)=cd(n1(1),n2(1));

gama(k,k1)=gama(n1(1),n2(1));

Re(k,k1)=R\_e;

end

end

end

%

% 计算每个截面拉力，扭矩微分

for k=1:length(r)

dT(k,:)=cos(gama(k,:)+phi(k))/sin(phi(k))^2./cos(gama(k,k1))\*0.5\*1.225\*(v0+va1)^2.\*cl(k,:).\*bb(k,:);

dM(k,:)=dT(k,:).\*tan(gama(k,:)+phi(k)).\*r(k);

end

% 对设计量找出沿径向的最佳拉力分布

kk=0;

outcome=zeros(2\*10^7,length(r));

M=zeros(10^8,1);

for k1=1:pi\*r(1)/nb/0.001

add=dT(1,k1);

disp(k1);

for k2=1:pi\*r(2)/nb/0.001

add=dT(1,k1)+dT(2,k2);

disp(k2);

tic

for k3=1:pi\*r(3)/nb/0.001

add=dT(1,k1)+dT(2,k2)+dT(3,k3);

for k4=1:pi\*r(4)/nb/0.001

add=dT(1,k1)+dT(2,k2)+dT(3,k3)+dT(4,k4);

for k5=1:pi\*r(5)/nb/0.001

add=dT(1,k1)+dT(2,k2)+dT(3,k3)+dT(4,k4)+dT(5,k5);

for k6=1:pi\*r(6)/nb/0.001

if add>T\_p

break

end

add=dT(1,k1)+dT(2,k2)+dT(3,k3)+dT(4,k4)+dT(5,k5)+dT(6,k6);

for k7=1:pi\*r(7)/nb/0.001

if add>T\_p

break

end

add=dT(1,k1)+dT(2,k2)+dT(3,k3)+dT(4,k4)+dT(5,k5)+dT(6,k6)+dT(7,k7);

for k8=1:pi\*r(8)/nb/0.001

if add>T\_p

break

end

add=dT(1,k1)+dT(2,k2)+dT(3,k3)+dT(4,k4)+dT(5,k5)+dT(6,k6)+dT(7,k7)+dT(8,k8);

if abs(add-T\_p)<0.01

kk=kk+1;

outcome(kk,:)=[k1,k2,k3,k4,k5,k6,k7,k8];

M(kk)=dM(1,k1)+dM(2,k2)+dM(3,k3)+dM(4,k4)+dM(5,k5)+dM(6,k6)+dM(7,k7)+dM(8,k8);

end

end

end

end

end

end

end

toc

end

end

M=round(M\*10000);

n=find(M(1:kk)==min(M(1:kk)));

for k=1:length(r)

b(k)=bb(k,outcome(n(length(n)),k));

Tp(k)=dT(k,outcome(n(length(n)),k));

Mp(k)=dM(k,outcome(n(length(n)),k));

Pp(k)=Mp(k)\*ns\*60/9550;

gama1(k)=gama(k,outcome(n(length(n)),k));

end

T=nb\*sum(Tp);

M0=nb\*sum(Mp);

P=nb\*sum(Pp);

X\_coeff0=sqrt(T/(1-q)/A1)\*T/(1-q)/P;

% 待最佳拉力分布曲线拟合完成后，细分截面计算弦长与扭角

%%————————————————

delta\_r2=D/200;

r=D/10:delta\_r2:D/2;

bb=zeros(length(r),1);

gama=zeros(length(r),1);

angle=zeros(length(r),1);

phi=zeros(length(r),1);

w=zeros(length(r),1);

b=zeros(length(r),1);

cl=zeros(length(r),1);

cd=zeros(length(r),1);

l\_d=zeros(length(r),1);

flag3=zeros(length(r),1);

for k=1:length(r)

if r(k)>=r\_flag

phi(k)=fsolve('solve\_phi',0.1); %求解气流角

else

phi(k)=atan(v1/2/pi/ns/r(k));

end

w(k)=(v0+va1)./sin(phi(k));%计算截面气流速度

end

T\_p=T0/nb;%单桨叶总拉力

Tp=fittedmodel.a\*r.^fittedmodel.b;%曲线拟合公式，此处随拟合曲线变化而变化

Tp=Tp\*T\_p/sum(Tp\*delta\_r2);

disp(sum(Tp\*delta\_r2));

mju=17.9e-06;

for k=1:length(r)

gama(k)=atan(1/50);%假设升阻比

bb(k)=0.1;

angle(k)=180\*phi(k)/pi;%桨距=气流角+攻角

k1=1;

flag3(k)=1;

while abs(flag3(k))>1e-04&&k1<=15

flag3(k)=bb(k);

b(k)=Tp(k)/(cos(gama(k)+phi(k))/sin(phi(k))^2/cos(gama(k))\*0.5\*1.225\*(v0+va1)^2);%求解 Cl\*b

Re=round((1.225\*bb(k)\*w(k)/mju)/1000)\*1000;%计算截面雷诺数

flag4=0;

while flag4==0

qd=xfoil1(Re,w(k)/340,phi(k),r(k));%计算雷诺数下升阻特性

if isempty(qd)

Re=Re+1000;

flag4=0;

else

flag4=1;

end

end

l\_d(k)=max(qd(:,4));%拉扭比

[m,n]=find(qd==l\_d(k));

cl(k)=qd(m(1),2);%升力系数

cd(k)=qd(m(1),3);%阻力系数

gama(k)=atan(cd(k)/cl(k));%阻升角

bb(k)=b(k)/cl(k);%弦长

flag3(k)=(bb(k)-flag3(k))/bb(k);

k1=k1+1;

angle(k)=qd(m(1),1)+180\*phi(k)/pi;%桨距=气流角+攻角

end

disp(k);

end

T1\_0=0.5\*1.225\*(v0+va1)^2\*bb.\*cl.\*cos(phi+gama)./sin(phi).^2./cos(gama);%计算后升力分布

Mp=T1\_0.\*r.\*tan(phi+gama);%力矩

M\_p0=nb\*sum(delta\_r2\*Mp);%桨叶扭矩

T\_p0=nb\*sum(delta\_r2\*T1\_0);%桨叶拉力

X\_coeff0=sqrt(T\_p0/(1-q)/A1)\*T\_p0/(1-q)/(M\_p0\*ns\*60/9550);

function F = solve\_phi(x)

global q va2 ns r k v0 va1

F=0.5\*tan(x)\*va2\*(1-q)-2\*pi\*ns\*r(k)+(va1+v0)/tan(x);

end

function J2 = xfoil1( Re ,Ma ,phi,r)

delete output-RAF6.dat;

fid=fopen('input-RAF6.dat','wt');

fprintf(fid,'LOAD \n');

fprintf(fid,'RAF 6.dat \n');

fprintf(fid,'PANE \n');

fprintf(fid,'OPER \n');

fprintf(fid,'VISC %12d \n',Re); %雷诺数

fprintf(fid,'M %12.3f \n',Ma); %马赫数

fprintf(fid,'ITER %12.3f \n',50);

fprintf(fid,'50 \n');

fprintf(fid,'PACC \n');

fprintf(fid,'output-RAF6.dat \n');

fprintf(fid,' \n');

fprintf(fid,'ASEQ %12.3f %12.3f %12.3f \n', [0 10 0.1]);

%fprintf(fid,'A %f \n',2);

fprintf(fid,'PACC \n');

fprintf(fid,'CPWR \n');

fprintf(fid,'RAF 6.txt \n');

fprintf(fid,'PACC \n');

fprintf(fid,'QUIT \n');

%fprintf(fid,'polar.txt \n');

fclose(fid);

!xfoil<input-RAF6.dat

clc

[A,B,C,D,E,F,G]=textread('output-RAF6.dat','%12.5f %12.5f %12.5f %12.5f %12.5f %12.5f %12.5f','delimiter',',','headerlines',12);

b\_c=(B.\*cos(phi)-C.\*sin(phi))./(C.\*cos(phi)+B.\*sin(phi))/r;

H2=[A,B,C,b\_c,D,E,F,G];

J2=unique(H2,'rows'); %返回不同行组成的矩阵

end