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Windows as Renewable Energy Sources for Europe
Window Energy Data Network

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Description of Benchmark Cases For Double Skin Facades

Ismo Heimonen[1] and Henk de Bleecker[2]

1) VTT Building and Transport
P.O.Box 1804
02044 VTT
Espoo, FINLAND
Email: ismo.heimonen@vtt.fi

2) Permasteelisa R&D
Via Friuli, 10
31020 San Vendemiano (TV)
ITALY
Email: h.debleecker@permasteelisa.it

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Contact:

On benchmark cases for double skin facades:
The authors of this report

On Thematic Network WinDat:
WinDat coordinator: Dick van Dijk, TNO Building and Construction Research, Delft, The Netherlands
Email: H.vanDijk@bouw.tno.nl

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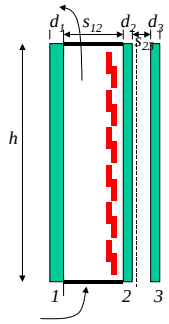
Benchmarks: Double Skin Facades



Ismo Heimonen
VTT Building and Transport
P.O.Box 1804
02044 VTT
Espoo, FINLAND
Ismo.Heimonen@vtt.fi

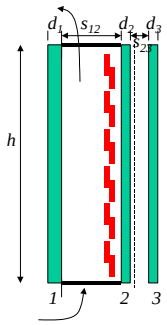
Henk De Bleecker
Permasteelisa R&D
Via Friuli, 10
31020 San Vendemiano (TV)
ITALY
h.debleecker@permasteelisa.it

Aims of common simulation exercise

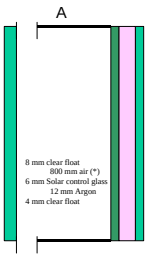
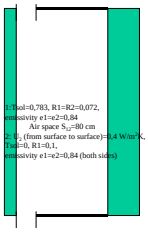
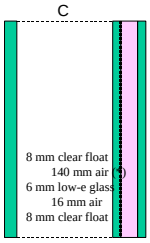
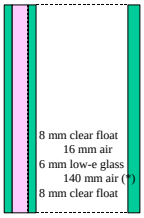
- Work with full combined cases (ventilation, blinds, glasses,…)
- Show different possible options of functions or applications possible to solve with WIS
- Well-defined simulation data set
  - geometry, ventilation strategy, weather conditions, ...
  - glasses & venetian blinds, spectral data
- Well-defined performance parameters
- Compare simulation practice & methods
- Compare performance of the cases
- Find possible errors & problems in combining functions

Different benchmark cases

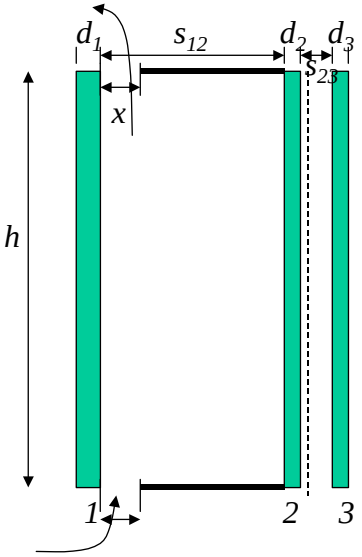
- Double skin façades
  - 1+2 glasses (case A, case C, case D) or
  - 1 glass + opaque wall (known U-value)(case B)
- Ventilated
  - Natural ventilation
    - open gap / closed gap
  - Mechanical ventilation
    - Ventilation on / Ventilation off
    - Ventilation from outside to outside / Ventilation from inside to inside
- known indoor & outdoor conditions
- known material properties
- blinds included (45°) or not included



Cases

	A	B	C	D
				
glazing	1+2 solar control glass	1+opaque	1+2 low-e	2+1 low-e
ventilation	natural out => out	natural out => out	0/13 dm3/s out => out	0/13 dm3/s inside => out
gap	800/50 mm	50/0 mm	140 mm	140 mm
height	20 m	1 m	3 m	3 m
venetian blinds	IEA T27	no	WINDAT	WINDAT

Case A - Natural ventilated facade (idem A3 from IEA)



Glasses

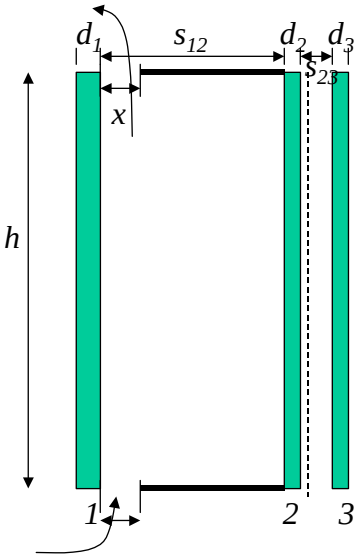
- Case A
  - pane 1 : 8 mm clear float
    - gap 400 mm air (*)
    - blinds in gap white venetian blinds, see for geometry and dimensions Word document: IEA27_A3-2 shading dimensions.doc
    - gap 400 mm air (*)

With or without blinds !

  - pane 2 6 mm solar control glass
    - gap 12 mm argon
  - pane 3 4 mm clear float

(*): including space occupied by the blinds in case of no blinds, total gap 800 mm air

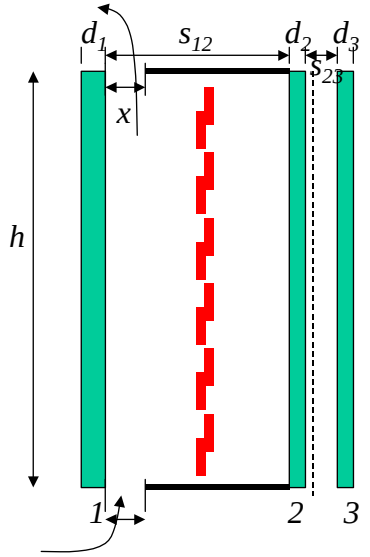
Case A - Natural ventilated facade (idem A3 from IEA)



Boundary values

- X=S12=800 mm or X=50 mm
- h=20 m (5 x 4 m)
- qv calculated based on gap dimensions
- Ventilation modelled as equally distributed
- Indoor conditions
  - Temperature 20 ºC
- Outdoor conditions
  - Temperature 0 ºC and 25 ºC
  - Wind speed 5,0 m/s
  - Constant solar radiation, normal incidence and 45 degrees solar altitude
    - Qs=0 W/m² or
    - Qs=500 W/m²

Case A - Natural ventilated facade (idem A3 from IEA)

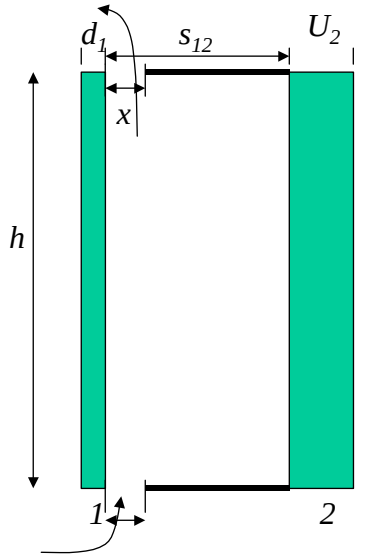


Venetian blinds

- Definition of the venetian blinds, geometry etc. , in separate document: Dick van Dijk, IEA27_A3-2 shading dimensions.doc

Slide 7 Ismo Heimonen – Henk De Bleecker Benchmarks_WINDAT_Double_Skin_Facades.ppt

Case B - Shadow box (identical to B1 from IEA)



Glasses

1: Tsol=0,783, R1=R2=0,072, emissivity e1=e2=0,84

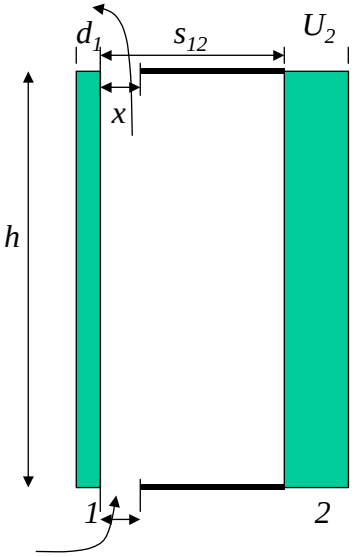
(id 4009 CLEAR6.PGL, Clear Float 6)

- Air space S_{12}=200 mm

2: U_2 (from surface to surface)=0,4 W/m^{2}K, Tsol=0, R1=0,1, emissivity e1=e2=0,84 (both sides)

Slide 8 Ismo Heimonen – Henk De Bleecker Benchmarks_WINDAT_Double_Skin_Facades.ppt

Case B - Shadow box (identical to B1 from IEA)

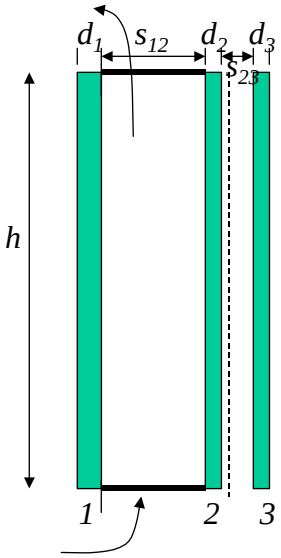


Boundary values

- X=0mm or X=50 mm
- h=1 m
- qv based on gap dimensions
- Indoor conditions
  - Temperature 20 ºC
- Outdoor conditions
  - Temperature 0 ºC and 25 ºC
  - Wind speed 5,0 m/s
  - Constant solar radiation, normal incidence and 45 degrees solar altitude
    - Qs=0 W/m^2 or
    - Qs=500 W/m^2

Case C – Outside Mechanical Ventilated

(outside → outside)



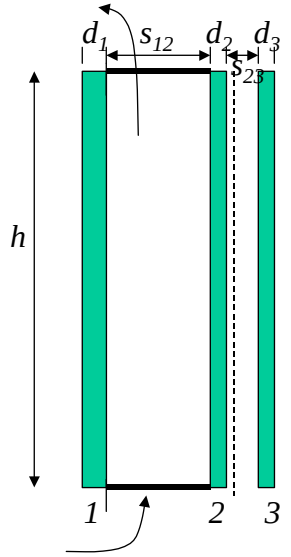
Glasses

- Case C
  - pane 1 : 8 mm clear float
    - gap 70 mm air (*)
    - blinds in gap Venetian blinds with opaque light slats, slats angle 45°
    - gap 70 mm air (*)
  - pane 2 6 mm low_e glass *With or without blinds !*
    - Platzer #2, LowE, 5.93mm low-e coated glass normal emittance 0.08, TC10
    - gap 16 mm air
  - pane 3 8 mm clear float

(*): including space occupied by the blinds in case of no blinds, total gap 140 mm air

Case C – Outside Mechanical Ventilated

(outside → outside)

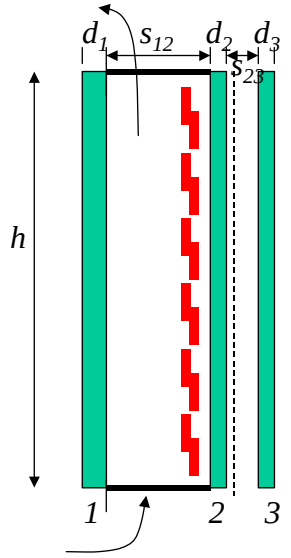


Boundary values

- h= 3 m
- qv fixed: 0 dm3/s/m or 13 dm3/s/m
- Ventilation modelled as 100% through zone between external glass and blinds
- Indoor conditions
  - Temperature 20 ºC
- Outdoor conditions
  - Temperature 0 ºC and 25 ºC
  - Wind speed 4,0 m/s
  - Constant solar radiation, normal incidence and 45 degrees solar altitude
    - Qs=0 W/m² or
    - Qs=700 W/m²

Case C – Outside Mechanical Ventilated

(outside → outside)



Venetian blinds

- Data Platzer
  - Blind1
  - interior
  - Light

Shading in cases C & D

Werner J. Platzer, Description of benchmark cases for window and shading performance calculation

Interior blind system (SHADE 2)

An interior blind system is being decribed in the next paragraph. The system consists of light grey lamellae (Warema Jal-1.25.01, Colour 3050) of the following shape:

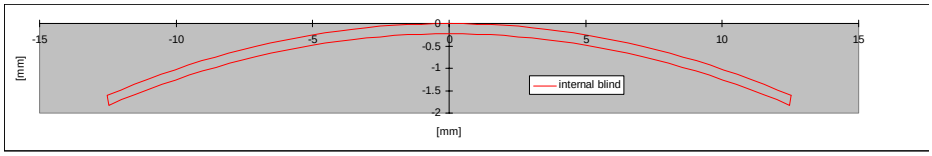
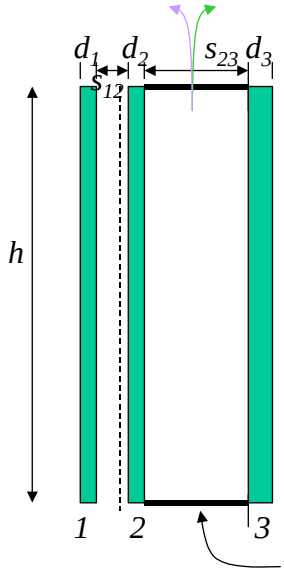


Figure 1: Sketch of single lamella sheet tilted horizontal (ignore single red line)
NB: The dimensions are given in Millimeter (mm)

Case D – Inside Mechanical Ventilated

(inside → inside/outside)



Glasses

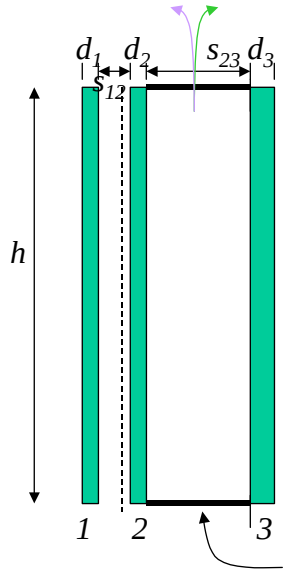
- Case D
  - pane 1 8 mm clear float
    - gap 16 mm air
  - pane 2 6 mm low-e glass
    - Platzer #2, LowE, 5.93mm low-e coated glass normal emittance 0.08, TC10
    - gap 70 mm air (*)
    - blinds in gap Venetian blinds with opaque light slats, slats angle 45
    - gap 70 mm air (*)
  - pane 3 8 mm clear float

With or without blinds !

(*): including space occupied by the blinds in case of no blinds, total gap 140 mm air

Case D – Inside Mechanical Ventilated

(inside → inside/outside)

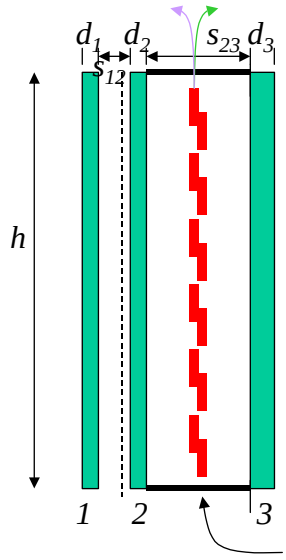


Boundary values

- h = 3 m
- qv fixed: 0 dm3/s/m or 13 dm3/s/m
- Ventilation
  - From inside to inside
  - From inside to outside
- Ventilation modelled as equally distributed
- Indoor conditions
  - Temperature 20 ºC
- Outdoor conditions
  - Temperature 0 ºC and 25 ºC
  - Wind speed 4,0 m/s
  - Constant solar radiation, normal incidence and 45 degrees solar altitude
    - Qs=0 W/m² or
    - Qs=700 W/m²

Case D – Inside Mechanical Ventilated

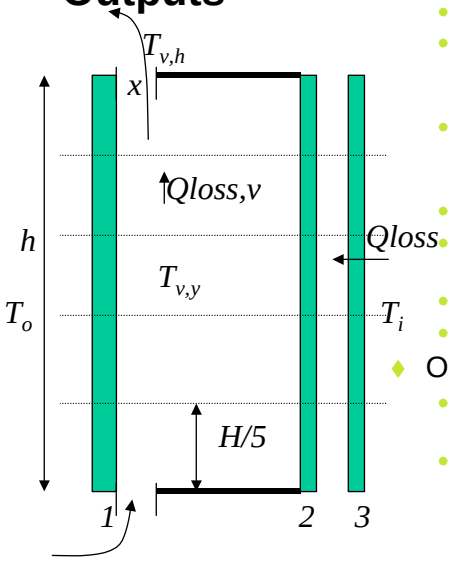
(inside → inside/outside)



Venetian blinds

- Data Platzer
  - Blind1
  - interior
  - Light

Outputs



- Primary outputs
  - U-value = Qloss/(Ti-To)/A, [in case Qsolar=0]
  - Uvent=Qlossv/(Ti-To)/A extracted by vent air
  - gtrans = fraction of solar energy transmitting (direct & inwards flowing)/Qsolar/A, [in case Ti-To=20 and 0]
  - gvent=fraction of energy transmitting to ventilation air (extracted from the gap)/Qsolar/A, [in case Ti-To=20 and 0]
  - heat recovery effect=(Tvh-To)/(Ti-To)
  - air flow rate and air change number (1/h), in case this is not input
  - light transmittance (distribution optional)
  - direct solar transmittance
- Optional outputs
  - average temperatures of the glasses 1, 2, 3, and ventilation air Tv,y at height y=h/5, 2h/5, …, 5h/5
  - ...

Output table - example case A

Glazing/Case	Shading (Yes/No)	Air flow rate (Fixed/Calc) [dm3/s]	Inlet/Outlet gap X [mm]	Tin [oC]	Tout [oC]	Qsol [W/m2]	qv,air [dm3/s]	Qloss [W/m2]	Qloss, ven [W/m2]	gtrans(*) [-] 0…1	gvent(*) [-] 0…1	Tsol [-] 0…2	Tvis [-] 0…3	Tair(h/5) [oC]	T [o
A	N	C	800	20	0	0									
	N	C	50	20	0	0									
	Y	C	800	20	0	0									
	Y	C	50	20	0	0									
	N	C	800	20	25	0									
	N	C	50	20	25	0									
	Y	C	800	20	25	0									
	Y	C	50	20	25	0									
	N	C	800	20	0	500									
	N	C	50	20	0	500									
	Y	C	800	20	0	500									
	Y	C	50	20	0	500									
	N	C	800	20	25	500									
	N	C	50	20	25	500									
	Y	C	800	20	25	500									
	Y	C	50	20	25	500									

Output summary table (DSF: Double Skin Facades)

- Format in WINDAT_benchmarks_DSF.xls
- please fill and rename: (Name=acronym of organisation)
  Name_ WINDAT_benchmarks_DSF.xls

Input data set + additional document

- Spectral properties of glasses & blinds in file
  DEFWINDAT_Spectralspecs01.xls
- blinds documented in
  - Dick van Dijk: IEA27_A3-2 shading dimensions.doc &
  - Werner Platzer: Description of benchmark cases for window and shading performance calculation, shade #2 & glass #2

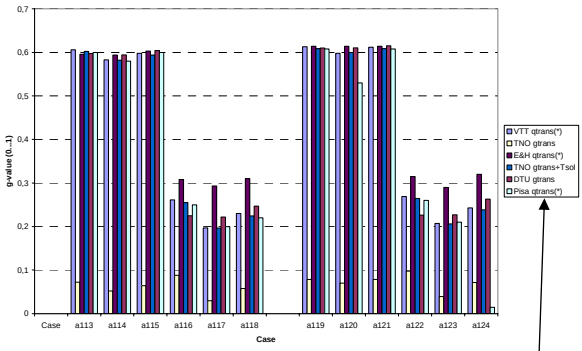
Collection of results

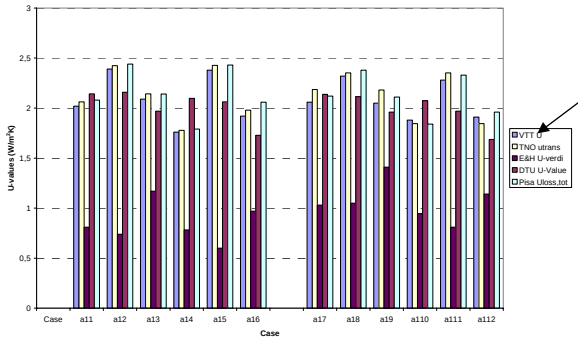
- Reply to Ismo.Heimonen@vtt.fi
- deadline 4.9.2003
- Summary in Copenhagen meeting 11-12.9.2003

Items to be discussed

- Common interests with IEA Task 27, partly same cases
  - glazing selections done in T27 (A&B cases)
  - shading device selections done in T27 (A&B cases)
  - extension WINDAT(C&D) => selection of the glasses and solar control devices => data sets collected
- minimum set of cases needed => updated data set exists, not delivered yet
  - Structure A…D, glazing 1…4, shading Y/N
  - boundary conditions: summer/winter - sol rad/no sol rad
    - defined in exercise or
    - calculated internally in programs
    - from existing standards
- compared outputs: U, g, Uvent, gvent, ...
- only WIS exercise or more general ?
- Participants
  - Henk de Bleecker, Henk Oversloot, Leo Bakker, Gilles Flamant, Ismo Heimonen
  - Others ?

Example of results in Task 27 exercise





Why differences ?

- Not clear enough definition of outputs & symbols
- Different level of expertice using WIS & other tools
- Quite many steps in description => lot of sources for error
- Differences in description, e.g ventilated from ? to ?, 90 % or 100 % argon filling, ...