MEMO

Projekt **Energy performance of moler bricks**
Kunde **Skamol A/S**
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1. Introduction

A comparison between traditional bricks and moler bricks with regard to energy performance has been carried out.

Having a relatively low density on the moler brick there is an advantage when it comes to the thermal conductivity and energy consumption of a wall made with moler bricks.

The calculation of energy performance has been made for a basic "full brick" house by calculating the difference in heat loss coefficient (U-value) and using simple heating degree day methods. The result is a difference in energy consumption for heating during one year when using the traditional or moler brick as an internal leaf of the external walls.

The heat loss calculations are based on DS418:2011 – "Calculation of heat loss from buildings". U-values are calculated without contribution from wall ties (stainless steel) and line loss due to insulation thickness reduction.

2. Basic properties for normal and moler bricks

Brick properties:	Normal bricks	Moler bricks
Density, bricks	≈1700 kg/m^3	700 kg/m^3
Thermal conductivity, bricks	-	0.15 W/mK
Density, brick work	1800 kg/m^3	900 kg/m^3
Thermal conductivity, brick work	0.62 W/mK	0.27 W/mK
Thermal conductivity, facing wall	0.73 W/mK	-
Thermal conductivity, insulation	0.037 W/mK	

The heat conductivity of the brickwork is also depending on the

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amount of mortar and thermal properties of the mortar. A mortar share of 22% is typical and a density of 1600 kg/m^3 should be suitable for moler bricks.

This normal mortar has a λ_{design} = 0.7 W/mK according to DS418:2011 figure F4. Danish Technological Institute has developed an insulating plaster/mortar with a 10 times lower heat conductivity of 0.07 W/mK which could be used for moler bricks.

Heat conductivity of brickwork (inner leaf) with normal and insulating mortar:

Normal mortar (1600 kg/m^3):	0.27 W/mK
Insulating mortar:	0.13 W/mK

3. Insulation thickness and percentage of window rebate

A typical external wall construction in a dwelling built according to the current Danish energy requirements (BR2015) is insulated with 250 mm of traditional insulation material (a 47 cm wall). The required energy frame can also be met with more or less insulation; e.g. 300 mm (52 cm wall) or 190 mm (41 cm wall) if the better or reduced energy performance is compensated with other measures.

Typical thermal bridge insulation at the window rebate is 30 mm or 70 mm. The typical share of window rebate compared to the exterior wall area (inner dimensions) is between 5 and 10 %. A possible solution is to use lining but it makes a more complicated window mounting.

4. Energy consumption for heating

The yearly heating degree hours is 90.360 Kelvin hours or 90.36 kKh per year which is based on an indoor temperature of 20°C and normal outdoor climate (reference year DRY). The utilization of a reduction in the heat transmission loss depends on the insulation standard, internal heat gains, solar gains, heat capacity etc. A typical utilization factor is between 0.9 and 1.0. As the efficiency of the heating system often is a little less than 1.0 it is fair to say that a reduction in transmission heat loss is converted 100 % to a reduction in the gross energy consumption (bought energy).

The energy savings is also stated for the case of an average indoor temperature in the heating season of 22°C (heating degree hours: 101.5 kKh per year) which is used as the basic temperature in the Bolig+ concept http://www.boligplus.org/ instead of the typical 20°C. Also, the temperature level of 22°C corresponds to measurements in several recent single-family house demonstration projects. The energy savings is about 12 % higher with an indoor temperature of 22°C compared to 20 °C.

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5. Parameter variations

Brick work heat conductivity:	W/mK	0,27; 0.13
Wall thickness:	cm	41; 47; 52
Insulation thickness:	mm	190; 250; 300
Thermal bridge insulation thickness:	mm	30; 70
Window rebate percentage:	%	5; 10
Indoor temperature	°C	20; 22
Dwelling/house size:	m^2	133*; 200

*DS418:2011 example house, used to calculate the areal of external wall. The area for the 200 m^2 house is scaled correspondingly.

6. Results

The Table 1 below shows U-values, heat loss reductions and energy savings for different sizes of detached single-family houses using moler brick instead of normal bricks as an internal leaf of the external walls.

Results for two different indoor temperature levels and house sizes are shown.

U-values are calculated without contribution from wall ties (stainless steel) and line loss from effect of insulation thickness reduction (acc. to DS418:2011)

Energy savings for the scenario with normal mortar and 10 % window rebate is highlighted. The case with a “normal” 47 cm wall is also highlighted with light blue colour.

Table 1. Energy savings etc. - Indoor temperature of 20˚C and 22˚ and house size 133 and 200 m² .

								Heat loss reduction			Energy savings, T_i = 20˚C		Energy savings, T_i = 22˚C	
t_{wall}	$t_{insulation}$	$t_{thermal\ bridge\ insul.}$	Window rebate	$\lambda_{back\ wall}$	$U'_{Trad.\ bricks}$	$U'_{moler\ bricks}$	$\Delta t_{insul.\ Moler}$		Ti = 20˚C	Ti = 22˚C	133 m² house	200 m² hus	133 m² house	200 m² hus
cm	mm	mm	%	W/mK	W/m²K	W/m²K	mm	%	kWh/m²/year	kWh/m²/year	kWh/year	kWh/year	kWh/year	kWh/year
41	190	70	10	0,27	0,198	0,186	15	6,2	1,1	1,2	**100**	**160**	**110**	**170**
41	190	70	10	0,13	0,198	0,168	38	15,1	2,7	3,0	240	370	270	410
41	190	70	5	0,27	0,188	0,178	12	5,1	0,9	1,0	80	130	90	140
41	190	70	5	0,13	0,188	0,164	31	12,9	2,2	2,5	190	290	220	340
41	190	30	10	0,27	0,224	0,201	26	10,3	2,1	2,3	**190**	**290**	**210**	**320**
41	190	30	10	0,13	0,224	0,175	55	21,9	4,4	5,0	390	590	430	650
41	190	30	5	0,27	0,201	0,186	18	7,5	1,4	1,5	120	190	140	220
41	190	30	5	0,13	0,201	0,167	41	16,8	3,0	3,4	270	410	300	460
47	250	70	10	0,27	0,161	0,151	21	6,6	1,0	1,1	**90**	**140**	**100**	**160**
47	250	70	10	0,13	0,161	0,137	49	15,4	2,2	2,5	200	310	220	340
47	250	70	5	0,27	0,150	0,142	15	5,0	0,7	0,8	60	100	70	110
47	250	70	5	0,13	0,150	0,131	38	12,1	1,6	1,8	150	230	160	250
47	250	30	10	0,27	0,184	0,163	38	11,6	1,9	2,2	**170**	**260**	**190**	**290**
47	250	30	10	0,13	0,184	0,141	73	23,2	3,9	4,3	340	520	380	580
47	250	30	5	0,27	0,161	0,148	24	7,9	1,2	1,3	100	160	120	190
47	250	30	5	0,13	0,161	0,134	51	16,8	2,4	2,7	220	340	240	370
52	300	70	10	0,27	0,141	0,131	28	7,2	0,9	1,0	**80**	**130**	**90**	**140**
52	300	70	10	0,13	0,141	0,118	59	16,1	2,0	2,3	180	280	200	310
52	300	70	5	0,27	0,128	0,122	17	5,1	0,6	0,7	60	100	60	100
52	300	70	5	0,13	0,128	0,113	43	12,0	1,4	1,6	130	200	140	220
47	250	250	10	0,27	0,138	0,134	9	3,1	0,4	0,4	**40**	**70**	**40**	**70**
47	250	250	10	0,13	0,138	0,126	25	8,3	1,0	1,2	90	140	110	170

Note: $\Delta t_{insul.\ moler}$ states the reduction in the insulation thickness using moler bricks achieving the same U-value as in the case of normal bricks

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7. Conclusion

Calculations show possible energy savings of about 190 to 290 kWh per year using moler bricks as an internal leaf of the external walls instead of traditional bricks (assuming 30 mm thermal bridge insulation and typical indoor temperature of 22°C). You can achieve the same U-value as in the case of normal bricks with 38 mm less insulation / wall thickness using moler bricks (i.e. 212 mm insulation instead of 250 mm). If an insulating mortar is applied, the energy savings amount to about 380 to 580 kWh per year. Less window rebate and more thermal bridge insulation result in reduced savings.

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