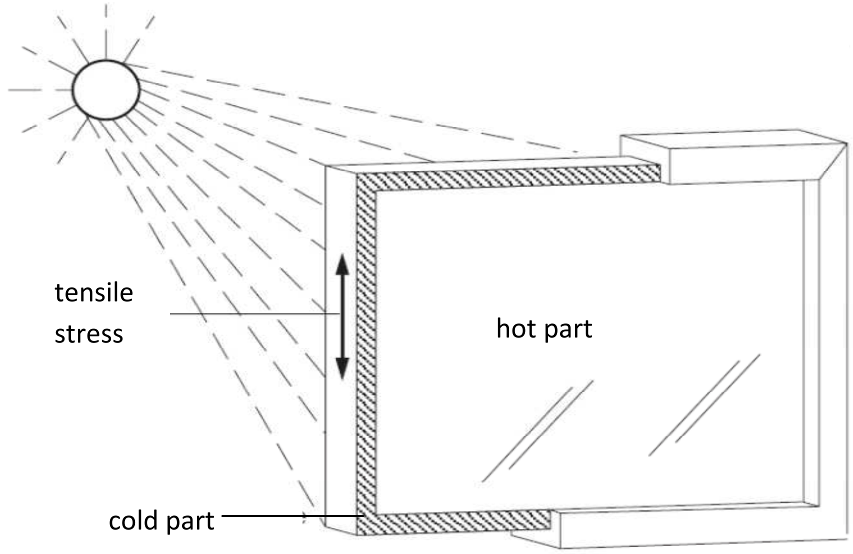
	UGent LMO Project sheet
Research project:	Thermal Breakage of Glass in Façades
Image:	 (source : TV 214, Brussels, WTCB, 12/1999)
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Time span:	2009 – ongoing
Description:	Stresses in windows and façade glazing are induced by permanent actions, such as the own weight of the glass panes; variable actions, such as wind (possibly dynamic of character); and accidental loads, such as impact or a wrong manipulation of the window. However, one of the most frequent claims with regard to glazed façades is caused by thermal breakage. Thermal breakage can only happen when a considerable temperature difference between two parts of a window occurs. Obviously, temperature gradients will often occur because glass is a relatively poor thermal conductor. Consequently, there will be a simultaneous and contradictory mechanical action of warm parts trying to expand, and cold parts trying to withstand this expansion. Because of this phenomenon, the tensile stresses will increase in the cold part, which is in general the glass edge. When the strength is sufficiently larger than the stress, there is no significant risk of thermal breakage. Yet, the stress level caused by thermal actions depends on the magnitude of the temperature gradient, which in turn depends on many parameters, such as geographical location, orientation, shading, frame geometry, cooling, etc... Because of these many parameters it is very difficult to predict the yearly maximum stress for different façade configurations. This is a first major problem to be dealt with in this project.

	However, up till now methods used to directly transform those parameters into thermal stresses are not available for complex façade configurations, rather conservative and not in accordance with nowadays calculation methods for structures, such as the method proposed in EN1990. This is the second problem to be dealt with in this research project. Furthermore, glass breakage will occur when the sum of all the aforementioned stresses exceeds the local glass strength. Yet, at the edges, which are most exposed and critical in terms of thermal breakage as explained above, the glass strength is a parameter which is surprisingly poorly understood. After all, the overwhelming majority of research reporting on the strength of glass has been typically concentrating on the central zone of glass panes, which of course is directly exposed to many other actions such as wind or impact. Anyhow, in the context of thermal breakage, the edge strength is the third major problem. Consequently, the main objectives of this research project are: 1. to investigate and propose a new model to transform climatic data and geometrical parameters into thermo-mechanical stresses; 2. to investigate statistically the glass edge strength in relation to different edge finishings (including cut, polished and water cut edges) and to develop a detailed classification of the edge quality; 3. to establish a calculation method for double skin façades according to Eurocodes, more specifically according to the probabilistic method level III (EN1990) In this research project, different methods are applied to examine and quantify the problems mentioned above regarding thermal breakage. On the one hand, the local glass strength at and near the edges will be investigated by means of non-destructive microscopic observations and destructive bending and thermal shock tests, which enable a statistical analysis. On the other, stresses will be calculated by finite element methods on the basis of real climate data, more specifically for orientations towards the east, south and west and situated in France or Belgium. The final objective is to determine by means of Monte Carlo simulations the probability of failure caused by thermal stresses in two specific types of double skin façades, selected in dialogue with the industry.
Publications:	Marc Vandebroek, Maria Lindqvist, Jan Belis, Christian Louter *Edge strength of cut and polished glass beams* Proc of GPD (Tampere, Finland), 2011: 394-397, 2011. Maria Lindqvist, Marc Vandebroek, Christian Louter, Jan Belis *Influence of edge flaws on failure strength of glass* Proc of GPD (Tampere Finland), 2011: 76-79, 2011. Marc Vandebroek, Jan Belis, Christian Louter *Influence of the load history on the edge strength of glass with cut edge finishing* Proc of CG3 (Delft, The Netherlands), 2012.

	Marc Vandebroek, Jan Belis, Christian Louter, Gustaaf Van Tendeloo *Experimental validation of edge strength model for glass with polished and cut edge finishing* Engineering Fracture Mechanics, 96, 2012, 480-489. Marc Vandebroek, Christian Louter, Gergely Molnar, Jan Belis *Ratio of mirror zone depth to flaw depth after failure of glass beams* Proc of COST (Porec, Croatia), 2013. Marc Vandebroek, Christian Louter, Jan Belis *Thermal breakage of glass* Proc of COST (Porec, Croatia), 2013. Sebastian Schula, Jens Schneider, Marc Vandebroek, Jan Belis *Fracture strength of glass, engineering testing methods and estimation of characteristic values* Proc of COST (Porec, Croatia), 2013. Marc Vandebroek, Jan Belis, Christian Louter, Robby Caspeele *Influence of the load history on the edge strength of glass with arrised and ground edge finishing* Engineering Fracture Mechanics, 104, 2013, 29-40. Marc Vandebroek, Christian Louter, Dispersyn Jonas, Delphine Sonck, Jan Belis *Stress corrosion parameters for glass with different edge finishing* Proc of ICSA (Guimarães, Portugal), 2013
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