CHAIR FOR STRUCTURAL DESIGN AND BUILDING PHYSICS
BY DIBT ACCREDITED TESTING LABORATORY BAY40

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Universität München

FACULTY OF CIVIL ENGINEERING AND ENVIRONMENTAL SCIENCES
INSTITUTE OF STRUCTURAL ENGINEERING

Report - b-04-18-12c

Validation of the calculation software „GLASGLOBAL“

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1 Introduction and Task Definition

The Chair of Structural Design and Building Physics at the University of the Bundeswehr Munich was commissioned to validate the calculation software GLASGLOBAL, Version 7.3226, for the calculation of glazing in accordance with DIN EN 16612 for standard-compliant design and implementation.

The validation is carried out on the basis of comparative calculations with the software MEPLA, Version 4.07. It is performed for a total of 15 reference structures, which include linear supported, laminated and insulating glazing with partly different types of glass, cf. Table 1. For this purpose, the Chair of Structural Design and Building Physics at the University of the Bundeswehr was provided with an executable version of the calculation program GLASGLOBAL Version 7.3226. The validation is based on the specifications in DIN EN 16612 [1] and DIN EN 16613 [2]. For the evaluation, comparative calculations were carried out on the reference structures, described in Table 1. A maximum permissible deviation was not agreed.

Table 1 Reference set-ups for the validation calculations

Nr.	Setup [mm]	Glass	Size [mm]	Geometry	Support	Angle	Loading	Stiffness-Class
1	4/16/4/16/4	TVG	1000X1000	rectangle	4 sided	90°	Climate + Gust Wind (Mediterranean) 2.5 kPa	
2	10/16/10	Float	3000x600	rectangle	2 sided	90°	Climate + Gust Wind (Mediterranean) 1.8 kPa	
3	10/16/10	Float	3000x600	rectangle	4 sided	90°	Climate + Gust Wind (Mediterranean) 3.8 kPa	
4	4/0,76/4	Float	1000x2000	rectangle	3 sided	90°	Gust Wind (Mediterranean) 2 kPa + Balustrade 1.0 kN/m	1
5	6/0,76/6/16/5/0,76/5/0,76/5	TVG	1000x1000	rectangle	4 sided	0°	Snow Load 6 kPa	0
6	6/0,76/6/0,76/6	TVG	1500x1500	rectangle	4 sided	0°	Snow Load (heated) 2.5 kPa + Wind Storm (Mediterranean) 2.5 kPa	2
7	8/1,52/8	TVG	1500x1500	rectangle	2 sided	0°	Snow Load (heated) 2.5 kPa + Windstoß (other) 2.5 kPa	1
8	6/0,76/6/16/6/0,76/6	Float	2000x1000	rectangle	3 sided	90°	Climate + Wind Storm (Mediterranean) 3 kPa	0
9	6/0,76/6/16/8/12/5/0.76/5	TVG	1000x2000	rectangle	4 sided	0°	Climate + Snow Load (unheated) 2 kPa	2
10	6/0.76/6	ESG	1000X1000	rectangle	4 sided	90°	Balustrade (Crowd) 1.0 kN/m + Windstoß (Mediterranean) 1 kPa	1
11	4/0.76/4	ESG	2000X1000	rectangle	4 sided	90°	Balustrade (Crowd) 2.5 kN/m + Wind Storm (Mediterranean) 2.5 kPa	0
12	6/1,52/10	ESG	2000x1000	rectangle	3 sided	90°	Windstoßlast (other) 1.5 kPa	2
13	6/0,76/6/16/8	Float /ESG	1000x2000	rectangle	4 sided	90°	Climate + Wind Storm (Mediterranean) 3 kPa	0
14	6/0,76/6/16/6/14/8	TVG	1000x2000	rectangle	4 sided	90°	Climate + Gust Wind (Mediterranean) 2.5 kPa	1
15	10/1,52/15	ESG	2000x2000	rectangle	4 sided	90°	Balustrade 5 kN/m + Gust Wind (Mediterranean) 5 kPa	0

Further details on the calculation settings as well as the system geometries and loads can be found in Appendix 1.

2 Results

The results of the validation calculations with the two software programs, mentioned in section 1 of this report, were randomly compared for stresses and deformations. For the sake of clarity, only the graphs for the maximum stresses and deformations per structure are shown

in this report, cf. **Figure 1 - Figure 6**. A distinction between a linear and a non-linear calculation is made.

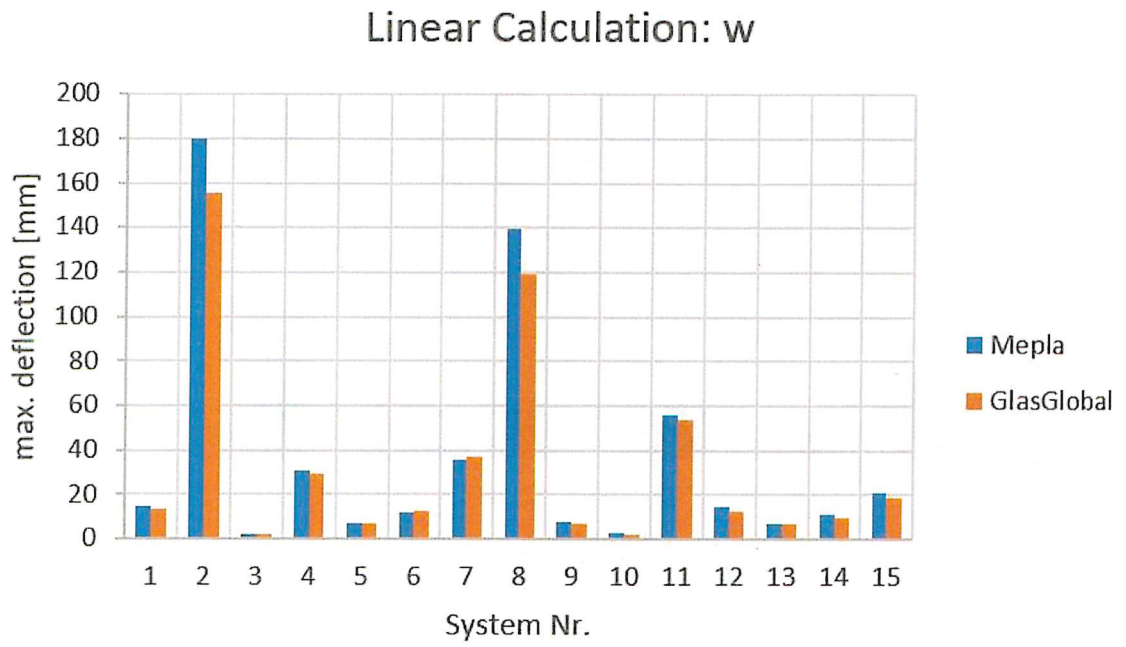

Figure 1 Comparison of the results of the linear calculation regarding the maximum deflections

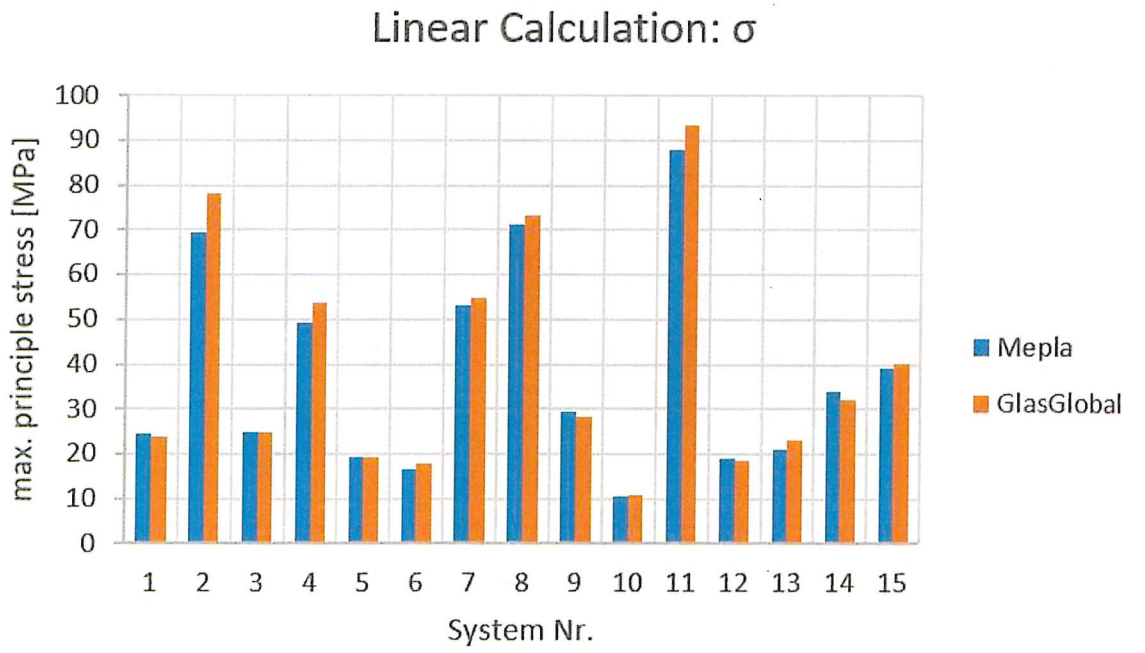

Figure 2 Comparison of the results of the linear calculation regarding the maximum stresses

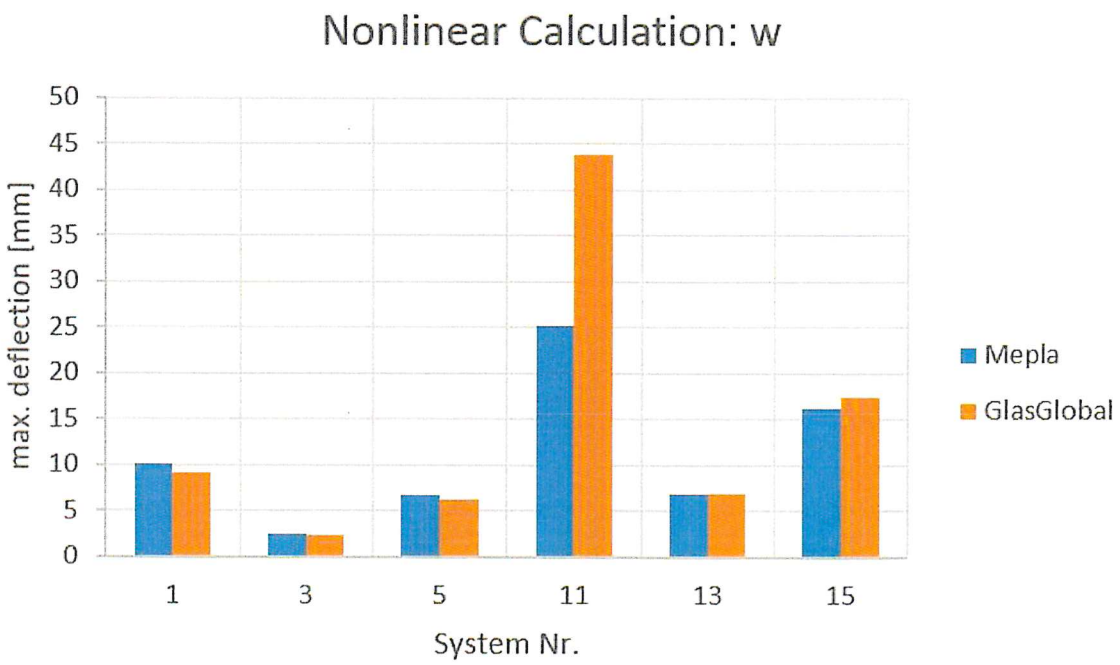

Figure 3 Comparison of the results of the non-linear calculation regarding the maximum deflections

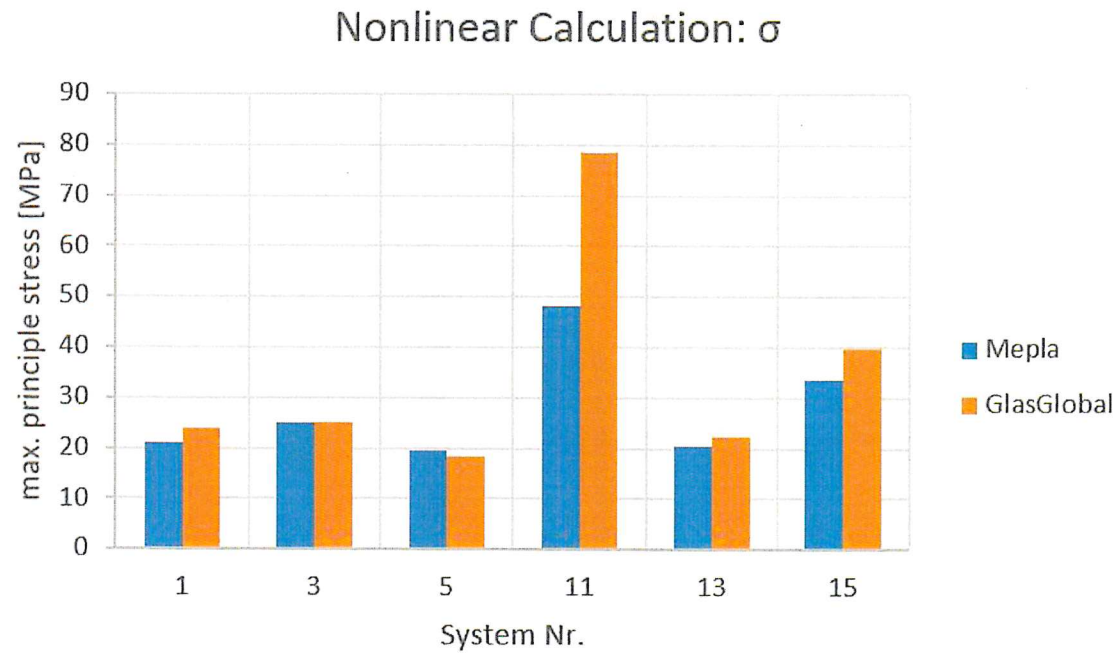

Figure 4 Comparison of the results of the non-linear calculation regarding the maximum stresses

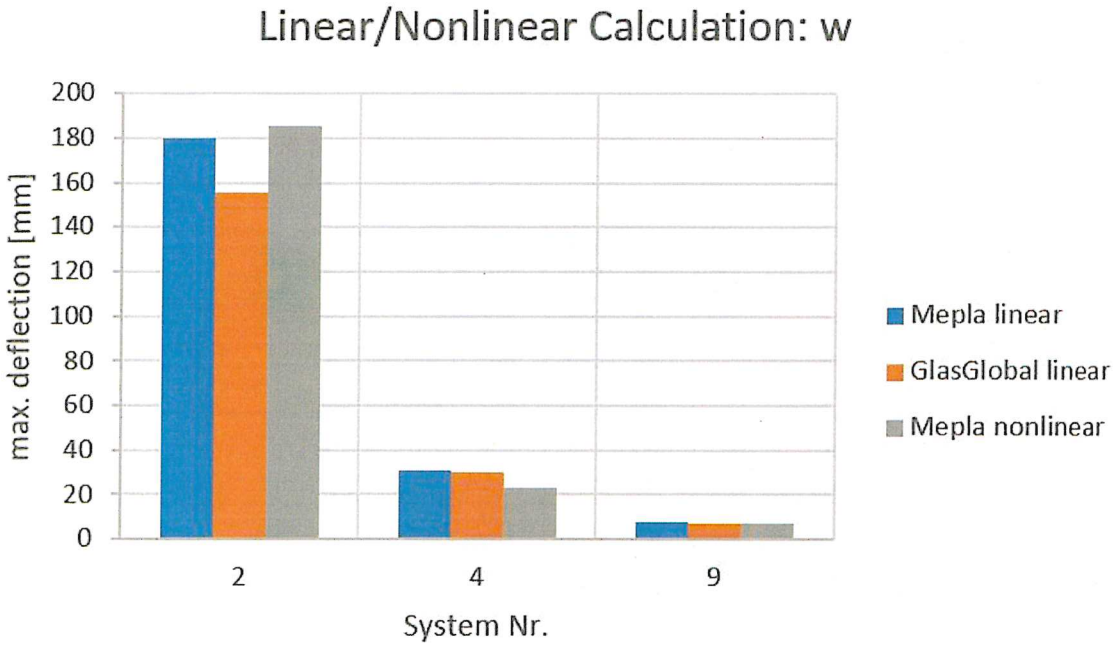

Figure 5 Exemplary comparison of selected results of the linear and non-linear calculation in Mepla with the linear calculation in GlasGlobal regarding the maximum deflections

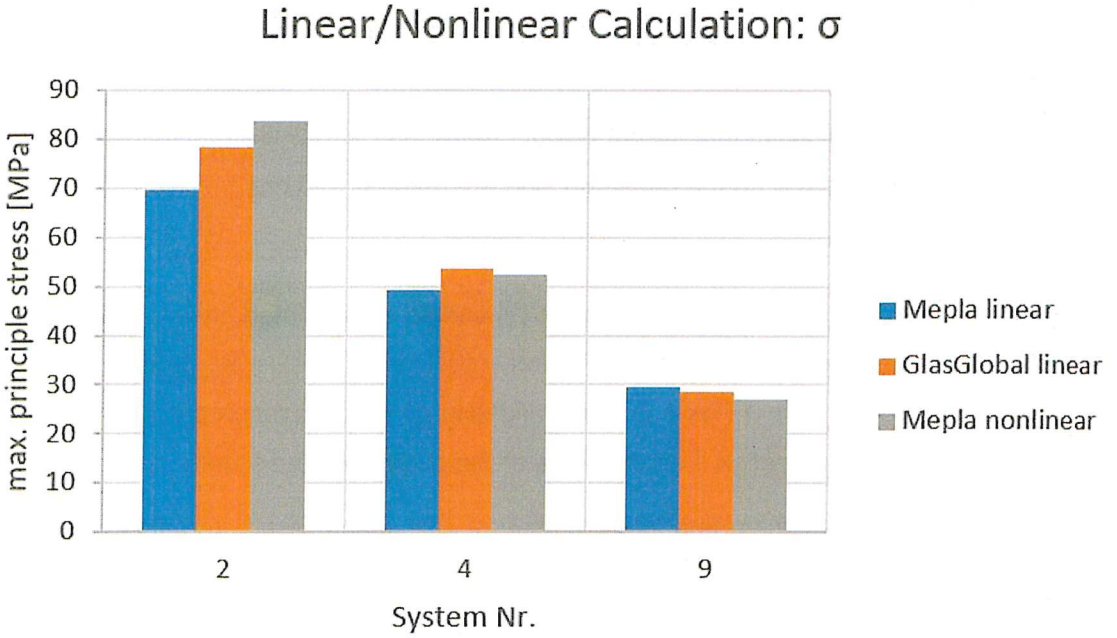

Figure 6 Exemplary comparison of selected results of the linear and non-linear calculation in Mepla with the linear calculation in GlasGlobal regarding the maximum stresses

The results of the calculations with GLASGLOBAL are in the range of less than 10% deviation from the MEPLA software for the stresses and corresponding utilizations for the majority

of the examples, larger deviations are on the safe side in each case. For the results of the deflections, larger deviations can be determined, which are less than 20% in each case or are on the safe side.

Table 2 Summary of all results of the linear calculation

Example-Nr.	linear											
	Displacement [mm]		Deviation [-]	l_{max} [mm]	Utilisation [-]		Stress [Mpa]		Deviation [-]	Resistance [Mpa]	Utilisation [-]	
	GlasGlobal	Mepla			GlasGlobal	Mepla	GlasGlobal	Mepla			GlasGlobal	Mepla
1	13,06	14,81	1,13	15,38	0,85	0,96	23,69	24,43	1,03	39,33	0,60	0,62
2	155,17	179,81	1,16	46,15	3,36	3,90	78,31	69,59	0,89	20	1,99	1,77
3	2,3	2,52	1,10	9,23	0,25	0,27	24,94	24,91	1,00	25	0,63	0,63
4	29,71	30,45	1,02	15,38	1,93	1,98	53,69	49,34	0,92	20	1,37	1,25
5	7,05	7,38	1,05	15,38	0,46	0,48	19,17	19,23	1,00	35,33	0,49	0,49
6	12,5	12,04	0,96	23,08	0,54	0,52	17,9	16,46	0,92	39,33	0,46	0,42
7	37,12	35,99	0,97	23,08	1,61	1,56	54,92	53,16	0,97	45,83	1,40	1,35
8	119,34	139,22	1,17	30,77	3,88	4,52	73,32	71,12	0,97	14,8	1,86	1,81
9	7,08	8,04	1,14	15,38	0,46	0,52	28,54	29,57	1,04	35,33	0,73	0,75
10	2,5	2,75	1,10	15,38	0,16	0,18	11,1	10,69	0,96	87,5	0,28	0,27
11	54,04	55,65	1,03	15,38	3,51	3,62	93,41	88,09	0,94	81,75	2,38	2,24
12	12,45	14,77	1,19	30,77	0,40	0,48	18,54	18,97	1,02	87,5	0,47	0,48
13	7,17	7,23	1,01	15,38	0,47	0,47	23,12	21,24	0,92	81	0,59	0,54
14	9,94	11,53	1,16	15,38	0,65	0,75	32,07	33,85	1,06	45,83	0,82	0,86
15	19,07	21	1,10	30,77	0,62	0,68	40,16	39,11	0,97	87,5	1,02	0,99

Table 3 Summary of all results of the non-linear calculation

Example-Nr.	nonlinear											
	Displacement [mm]		Deviation [-]	l_{max} [mm]	Utilisation [-]		Stress [Mpa]		Deviation [-]	Resistance [Mpa]	Utilisation [-]	
	GlasGlobal	Mepla			GlasGlobal	Mepla	GlasGlobal	Mepla			GlasGlobal	Mepla
1	9,11	10,19	1,12	15,38	0,59	0,66	23,82	21,06	0,88	39,33	0,61	0,54
3	2,3	2,52	1,10	9,23	0,25	0,27	24,94	24,92	1,00	25	0,63	0,63
5	6,21	6,7	1,08	15,38	0,40	0,44	18,27	19,68	1,08	35,33	0,46	0,50
11	43,93	25,15	0,57	15,38	2,86	1,63	78,53	48,15	0,61	81,75	2,00	1,22
13	6,98	6,98	1,00	15,38	0,45	0,45	22,24	20,56	0,92	81	0,57	0,52
15	17,52	16,3	0,93	30,77	0,57	0,53	39,83	33,61	0,84	87,5	1,01	0,85

In **Table 2** and **Table 3**, all fields that do not deviate more than +/-5% are marked green. Deviations that are more than 5% on the uncertain side are marked with red.

3 Evaluation

The standard-compliant calculation according to [1] and [2] of laminated glass and multi-pane insulating glass can be confirmed. This validation report refers exclusively to the calculation program described in section 1 (Table 1). The validation of the calculation program evaluates the functions described in section 1 on the basis of the examples listed there.

The responsibility for evaluation and interpretation of calculation results remains unchanged with expert users.

Only the complete test documentation or an abridged version prepared or approved by the Chair of Structural Design and Building Physics may be used for information or advertising purposes. If the test documentation is published on the Internet, it must be ensured that the file is protected against changes (only read/print authorization in pdf format); a corresponding file will be provided by the Chair of Building Construction and Building Physics.

This declaration is valid for 3 years, after which it must be clarified whether conformity with the then valid testing and assessment principles is still ensured.

4 Related documents and regulations

[1] DIN EN 16612:2019-12: Glass in building – Determination of the lateral load resistance of glass by calculation

[2] DIN EN 16613:2020-01: Glass in building – Laminated glass and laminated safety glass - Determination of interlayer viscoelastic properties

Attachment to the report: The corresponding calculation protocols can be found on the enclosed CD