TEST REPORT

Reduction of Bird – Window Strikes

SEEN glass elements

Reflective and semi-reflective 9mm dots

Tests in Flight Tunnel II
according to WIN-test procedure
at Biologische Station Hohenau-Ringelsdorf,
Austria

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AURING BIOLOGISCHE STATION HOHENAU - RINGELSDORF

collabs collision laboratories

1 TASK AND TEST METHOD

In commission of SEEN GmbH, Waldstatt, Switzerland, two prototypes of glass applied with a novel marking technique of aluminum coated elements were examined to assess their efficacy in reducing bird-window collisions. To this end, dichotomous choice experiments were conducted using wild birds in a flight tunnel. Both prototypes consisted of a double-glazed unit of 2 x 4mm low iron glass laminated with a PVB interlayer where the bird deterring elements were situated. The reference pane was an unmarked 4mm thick float glass (Fig. 1 and Fig. 2). The test panes were exposed to natural sunlight.

1.1 Test specimens

Figure 1: Test candidate “SEEN shiny” (left) and unmarked float glass reference (right) in the perspective of an approaching bird in the flight tunnel.

Figure 2: Test candidate “SEEN matt” to the left, float glass reference to the right.

Tab. 1 shows characteristics, reference pane used in the choice experiment, test period and test sample sizes of the two prototypes with reflective dots (“SEEN shiny”, Fig. 1) and semi-reflective dots (“SEEN matt”, Fig. 2).

Table 1: Description of test specimens, reference, test periods and number of valid tests.

2019 test code	Type	Description	Reference	Test period	Number of valid tests
SEEN shiny	PVB laminated glass 4/1,5/4	Dots, 9mm diameter, distance from centre to centre 90mm; multi-layer elements with reflective aluminium coating	Clear float glass, 4mm	**26.08. – 27.09**	**90**
SEEN matt		Dots, 9mm diameter, distance from centre to centre 90mm; multi-layer elements with semi-reflective aluminium coating			**97**

The specimens were made of PVB laminated glass. The pattern was a grid of metallic reflective spots applied to the PVB layer.

<u>Reflective dots – “SEEN shiny”</u>
Glass composition: 4mm low iron glass + 2 x 0.76mm PVB interlayer + 4mm low iron glass, SEEN glass elements applied between the foil layers.
Pattern: 9mm dots with a distance of 90mm from point centre to point centre, covered area 0,8%.
Material: dots (SEEN glass elements) are multi-layer elements with reflective aluminium coating on the front, colored black on the rear side (rear side can also be the same as front side). Due to the composition of the layers, they are having a 3D effect. The visual reflection of the reflective aluminium coating is 89% (measured in the laminated glass).

<u>Semi-reflective dots – “SEEN matt”</u>
Glass composition: 4mm low iron glass + 2 x 0.76mm PVB interlayer + 4mm low iron glass, SEEN glass elements applied between the foil layers.
Pattern: 9mm dots with a distance of 90mm from point centre to point centre, covered area 0,8 %.
Material: Same material as reflective dots, but the visual reflection of the semi-reflective aluminium coating is 75% (measured in the laminated glass).

1.2 Test set-up

The Flight Tunnel II used in this study was devised and constructed in 2006 (see Rössler et al. 2007). A mechanical pivoting device allows rotation of the whole tunnel apparatus and thus constant adjustment of the tunnel’s orientation relative to the position of the sun, resulting in parallel, uniform and symmetrical lighting at all times during testing. The original test procedure (‘ONR test’ - from *Austrian Normative Rule,* Rössler et al. 2007) was designed to assess glass markings under ideal reflection-free see-through conditions.

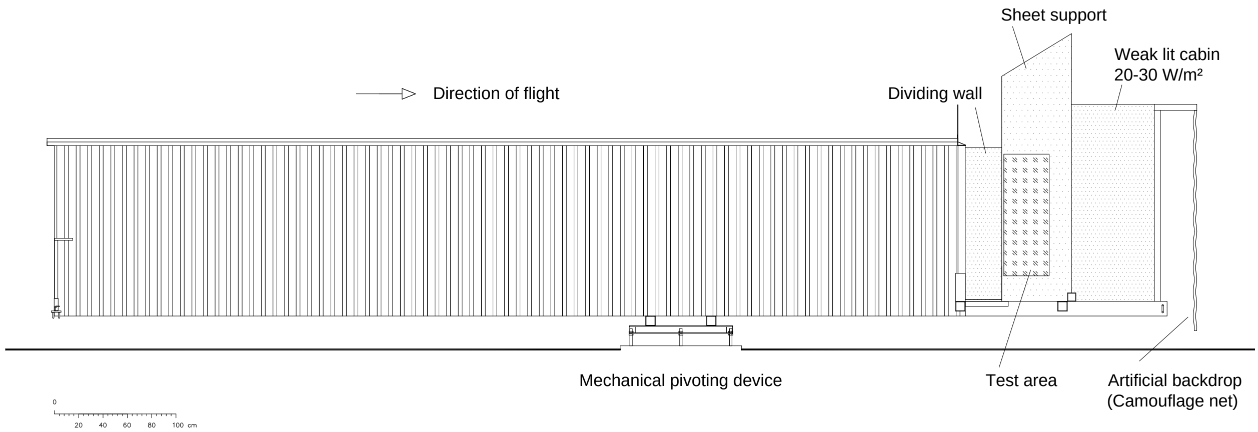

Figure 3: Flight tunnel in WIN tests with the simulation of a room in the background of the test sheets. The trapezoidal shape of the sheet support prevents birds from seeing the environment or sky other than in the test sheets (test area). To the right of the sheet support, sidewalls and backdrop are indicated.

The test setup used and described here is called ‘WIN test’ (from ‘window’). It is appropriate to test for the effects of reflections on the panes, as they occur on windows and facades of buildings. Because the light intensity behind building facades or windows is usually lower than on the outside, window panes often generate significant reflections. In the ‘WIN test’, the installation of sidewalls, a roof, and a white blanket with camouflage netting behind the test area

(Fig. 3 and Fig 4, see also Fig. 1 and 2) simulates these conditions to create an enclosed chamber in which the intensity of the light reflected outward is limited to target values of around 1 – 5 % of the outside daylight. Test pane and reference pane (unmarked float glass of 4mm width) are mounted at an angle of 125° to the flight path of the birds. Similar to rearview side mirrors of vehicles, the panes create mirror images of the surrounding habitat to the birds flying through the tunnel. The markings to be tested 'compete' (contrast) with the reflected images of the surroundings or, depending on the light conditions, with images from the background.

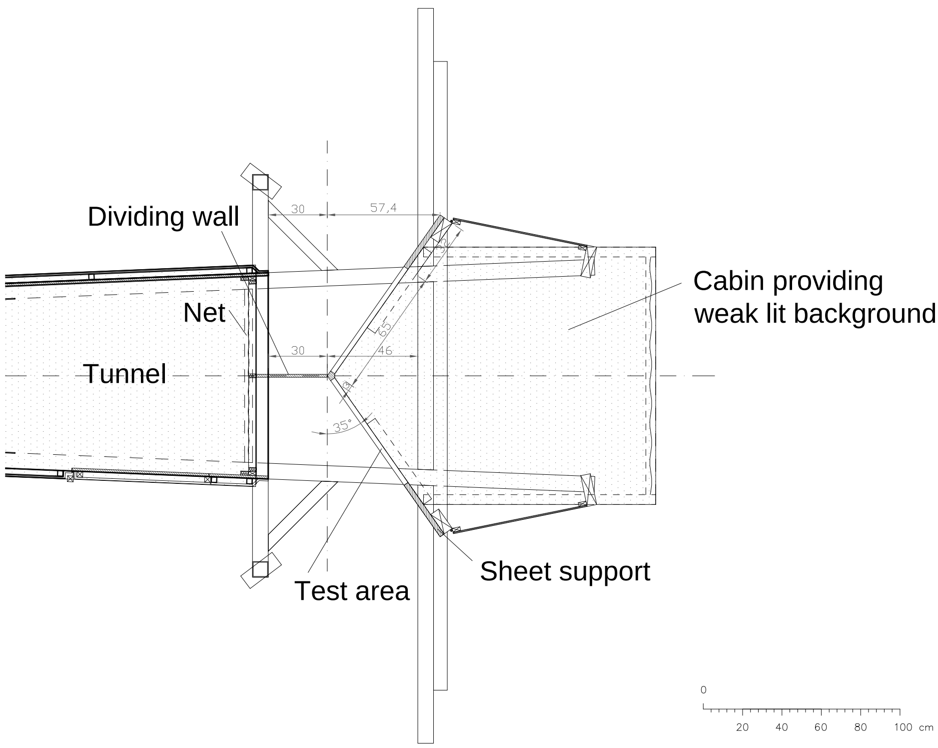

Figure 4: The back end of Flight Tunnel II after modification for the WIN test, as seen from above. The panes in the test area, sidewalls, roof and backdrop form a cabin that creates weak light in the background of the test panes.

The marked and reference panes were placed randomly on the left or right side. After every three consecutive experimental flights, the position of the test panes was changed according to a randomized schedule alternating with candidates from other customers and manufacturers. Homogenous dense natural ruderal vegetation (goosefoots Chenopodium spec. and Atriplex spec.) around the test site served as a background that the birds saw at the end of the tunnel. The birds used in the tests were wild birds caught in the immediate vicinity of the tunnel setup. During testing, the daylight-adapted birds were released at the dark end of the tunnel and then flew to the other (light) end where the test and reference panes were mounted on either the left or right side of the tunnel end. Before the birds could 'escape' through the glass, they were protected from hitting the glass by a mistnet mounted in front of the panes. No birds were harmed in any way during the experiments. Each bird was immediately released back into the wild after a single flight in the tunnel.

1.3 Data basis

280 individual WIN tests were conducted between 26 August and 27 September 2019 (Tab. 2). 187 individual tests could be evaluated. 88 tests (31.4 %) were rejected for various reasons, such as: birds refused to fly or flew hesitantly, the outcome could not be assigned to either of the two sides (e.g. birds approaching the dividing wall) or birds hit the net in angles below 45°, indicating a reaction to the net or detection of a free flight path to the environment.

Table 2: Number of valid and invalid individual tests.

	Total number of tests	valid	not valid	% not valid
SEEN shiny	139	90	46	33.1
SEEN matt	141	97	42	29.8
Total	**280**	**187**	**88**	**31.4**

1.4 Test birds

All birds that were caught at the Bird Banding Station Hohenau-Ringelsdorf during the test period and for whom participation in the test seemed reasonable were included in the test procedure. The resulting test species composition was characterised by the local biodiversity and dependent on the order in which the test birds were given bands at the banding station. 28 bird species were included. Tab. 3 shows the distribution of test birds over the 187 valid individual tests.

Table 3: List of the 187 test birds (28 species) and their distribution to the experiments.

Species			SEEN shiny	SEEN matt	Summe
Bienenfresser	European Bee-eater	*Merops apiaster*	3	3	6
Wendehals	Eurasian Wryneck	*Jynx torquilla*	5	3	8
Buntspecht	Great Spotted Woodpecker	*Dendrocopos major*	1		1
Rotkehlchen	European Robin	*Erithacus rubecula*	1		1
Blaukehlchen	Bluethroat	*Luscinia svecica*	1	1	2
Feldschwirl	Common Grashopper Warbler	*Locustella naevia*		1	1
Rohrschwirl	Savi's Warbler	*Locustella luscinoides*		1	1
Schilfrohrsänger	Sedge Warbler	*Acrocephalus schoenobaenus*	11	10	21
Sumpfrohrsänger	Marsh Warbler	*Acrocephalus palustris*	11	14	25
Teichrohrsänger	Eurasian Reed Warbler	*Acrocephalus scirpaceus*	3	1	4
Drosselrohrsänger	Great Reed Warbler	*Acrocephalus arundinaceus*	3	2	5
Klappergrasmücke	Lesser Whitethroat	*Sylvia curruca*	1	1	2
Dorngrasmücke	Common Whitethroat	*Sylvia communis*	4	2	6
Gartengrasmücke	Garden Warbler	*Sylvia borin*	2	1	3
Mönchsgrasmücke	Eurasian Blackcap	*Sylvia atricapilla*	2	11	13
Zilpzalp	Common Chiffchaff	*Phylloscopus collybita*	4		4
Fitis	Willow Warbler	*Phylloscopus trochilus*	6	4	10

Heckenbraunelle	Dunnock	*Prunella modularis*	1	1	2
Blaumeise	Blue Tit	*Parus caeruleeus*	2	8	10
Kohlmeise	Great Tit	*Parus major*	3		3
Neuntöter	Red-backed Shrike	*Lanius collurio*	11	9	20
Raubwürger	Great Grey Shrike	*Great Grey Shrike*	1		1
Star	Common Starling	*Sturnus vulgaris*		4	4
Feldsperling	Eurasian Tree Sparrow	*Passer montanus*	4	10	14
Grünling	European Greenfinch	*Carduelis chloris*		2	2
Stieglitz	Goldfinch	*Carduelis carduelis*	9	6	15
Goldammer	Yellowhammer	*Emberiza citrinella*		1	1
Rohrammer	Common Reed Bunting	*Emberiza schoeniclus*	1	1	2
			90	97	187

1.5 Distribution of tests by time of day

Fig. 5 shows how the tests were distributed over the time of day. In relation to the number of birds caught at the bird banding station, with highest bird activity in the morning, 64 individual tests (34 %) were performed before 9:00 a.m., and 69 individual tests (37 %) between 9:00 and 12:00 p.m. All in all, 133 tests (71 %) were performed before noon, and 54 (29 %) in the afternoon until sunset.

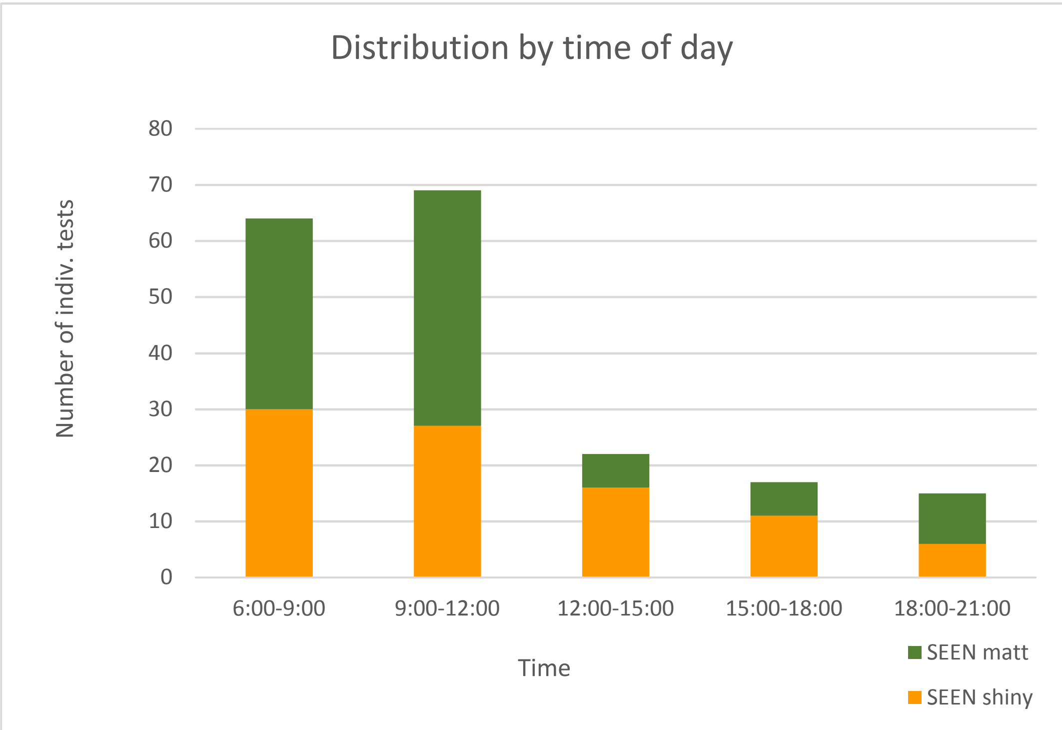

Figure 5: Distribution of valid tests by time of day. Orange: SEEN shiny, green: SEEN matt

2. Test results

In 187 test flights 82 of 90 and 88 of 97 birds flew to the reference pane and 8 (9 %) and 9 (9%) flew to the test specimens "SEEN shiny" and "SEEN matt", respectively (Tab. 4). Neither light intensity (global radiation < / > 400 W m^{-2}) nor the nature of light (sun or clouded sky) showed any observable effect (Tab. 5).

Table 4: Directional flight decisions of test birds within 187 single tests. 'Test sheet [%]' indicates the proportion of "wrong" decisions, e.g. decisions to the marked test sheet instead of to the unmarked reference sheet.

Test specimen	Total Evaluation	Flight to		
		Reference sheet (float glass)	Test sheet	Test sheet [%]
Total	**187**	**170**	**17**	
SEEN shiny	90	82	8	**9**
SEEN matt	97	88	9	**9**

Table 5: Effects of light intensity (global radiation > / < 400 W m^{-2}) and sunny or overcast sky shown by the proportion of flights to the test pane (bold). Two-sided Fisher's exact tests were not significant.

Test specimen	n	Flight to test pane [%]	n	Flight to test pane [%]	Total evaluation	Fisher's exact test
			Global radiation			
	> 400 W m^{-2}		**< 400 W m^{-2}**			
SEEN shiny	25	**8.0**	62	**9.7**	87	n.s.
SEEN matt	33	**9.1**	64	**9.4**	97	n.s.
	Sun		**Clouds**			
SEEN shiny	64	**7.8**	26	**11.5**		n.s.
SEEN matt	79	**10.1**	18	**5.6**		n.s.

3. Discussion and recommendations

The outcome of the WIN tests with SEEN Aluminium reflective and semi-reflective 9mm dots described here as "SEEN shiny" and "SEEN matt", respectively, is very positive and surprising. Considering previous experiments, such a positive result appeared unlikely for three reasons:

1) Where specular reflections occur, highly effective glass markings conventionally require positioning at surface #1.
2) The distances between the dots are larger than required to comply with the 2" / 4" rule; this rule states that

horizontal stripes shouldn't exceed a vertical spacing of two inches and vertical stripes shouldn't exceed four inches of horizontal spacing. In the present case small spots instead of stripes are arranged in distances in both directions of 90mm.

3) The diameter of the spots is less than 10 mm.

However, both tests yielded the same positive result and must be considered as being replicated. Light intensity had no influence on the results, and neither presence nor absence of direct sunlight showed any statistically significant impact. Illumination of the foreground by direct sunlight is decisive for the formation of highly contrasting images on glass surfaces. The results are reinforced by the high sample sizes during sunny conditions of 64 and 79, respectively.

In summary, the SEEN marking pattern and novel technique of application described here ranks among the best collision avoiding solutions tested so far following the WIN test protocol (inclusion of specular reflections on the surface) at the Biological Station Hohenau-Ringelsdorf. Consequently, we recommend the application.