

METS GSF 2007
12-15 November 2007 Amsterdam

GLASS TECHNOLOGIES AND UTILISATION 131107

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Our next session is looking at the utilisation of glass; it's obviously a key issue in the market, there's a lot of it being used. Two people—Jan Rozie we've heard before at various of our conferences is the self proclaimed Dr Glass and Valentina Gizzi from DuPont talking about the new technology. Valentina, please?

Valentina Gizzi DuPont de Nemours (Belgium)

Good afternoon ladies and gentleman. My name is Valentina Gizzi and I'm the global segment leader from Marine Glazing with the DuPont company. And this afternoon I'm going to talk about safety glass for the superyacht segment. The idea really is to have an open conversation and also talk about what are your needs, what your requirements and also to try and address some of your concerns. So I will go through a very short presentation and then Dr Rozie is going to give his view about marine glazing and then hopefully we will have an open debate about glass.

As you can see from my agenda line, I will talk briefly about safety glass in the marine industry. I'm going to talk about existing and incumbent application and I will spend some more time on an innovative solution for this segment and give you some examples. So this is the classification of the marine industry. You have commercial ships, navy, high speed vessels and pleasure boats. We are very interested in the pleasure boat segment and as you can see, as the glass application can go from windows to balustrades to over glazing and so the requirements for the glass is different. So you can have curved glass, flat glass, you want to add functionalities like solar control, acoustic attenuation just to name some of those functionalities. And so how has the glass industry responded to that? So there are two types of safety glass. You have the tempered glass which is safe glass because when it breaks, it breaks into small fragments, as you can see from the picture. But also when the glass breaks, as you can see here, you have a hole in your window and at the same time the tempered glass is quite well known for spontaneous breakage and there are a lot—there is a European legislation where you can limit this phenomenon but according to the statistics you still have 2% of the glass that might present this spontaneous breakage. So the other safety glass you might want to use is laminated glass, which is a safety glass because you have two glass plies and an interlayer in between so when the glass breaks you have the interlayer keeping the fragments together. So you have different types of interlayers you might want to use; you have BVB that is used in this industry already for 7 years; you have ionoplasts—I don't know if you've heard about this polymer structural interlayer and I'm going to talk a little more about that. And also you have polycarbonate and polyurethane because polycarbonate doesn't stick to glass so you need two layers of polyurethane. And so what I said before, you might want to go with laminated glass and you have a lot of advantages but we need to be honest and say that laminated glass especially when

you think about BVB laminates, they don't have the same strength as a monolithic glass so how do you try to solve the problem? You can make, as I said, glass plies stronger so you can use chemically tempered glass and you see quite a lot of chemically tempered glass in the superyacht industry. Or you want to work out on your interlayer and use an ionoplast interlayer or in some cases polycarbonate or you can combine both. So just because I don't know if many of you are very familiar with ionoplast interlayer it is an interlayer that was developed at the end of the 90s for Europe and a zone like Florida and the reason that it was developed they wanted a very stiff interlayer so that when you have a storm or something like that, when the glass is broken you want a stiff interlayer that can still protect you against the wind or a hurricane. And also Florida is the worst country you can imagine for laminated glass because you have very hot and humid climate so you want also to work on the durability of the interlayer as well. And while we kind of exported this interlayer to Europe we saw that when we compared it with BVB it's possible to achieve lighter weight because you have a stiff layer that approximates to tempered glass. Here is just an example of what I was saying so imagine a glass beam and you want to break it, and you want to measure the strength necessary to break the glass beam. And you have 10mm monolithic glass then you have 5plus5 BVB as you can see is not quite the same as the 10mm glass, and then you have 5plus5 ionoplast and with the ionoplast thickness we are about 12.28 so as you can see the ionoplast glass breaks approximately at the same point as a monolithic glass. And just to give you some more effective data about that, and apply it to the marine industry, we have here an example—we have a company in Germany who went through a type approval process with Germanischer Lloyds and they tried to compare the uses as a standard ISO 614—many of you might be familiar with it, but it's really you want to measure the strength of your glass with that type of standard. And as you can see here, imagine that ionoplast interlayer is only 1.52 mm you have a similar behaviour with 10mm glass, you have 11.5 with the laminated glass, and as you increase the thickness we actually saw a quite remarkable phenomenon because you see that you actually gain in terms of weight and you gain also in terms of security so what would have been the same, if you would do the same test with BVB or what does a nav register recommend? Normally they use the square thickness rule with BVB and you would end up with 30-40% higher thickness with a standard interlayer. And concerning ionoplast is quite new because it was developed at the end of the 90s how does it compare with polycarbonate? So there is another company in Italy who went through a series of tests with RINA, the Italian nav register and they tried to compare with the water bath test to simulate the atmospheric pressure, they tried to compare how does the ionoplast laminates compare to polyurethane, polycarbonate laminates. And you can see that the strength is very much the same and in the end RINA made a statement saying that the ionoplast and polyurethane and polycarbonate are really comparable in terms of strength. The other important property that can be very interesting in yacht application is the fast breakage behaviour. As I said before, this interlayer was developed for the European market and so it needed to have exceptional strength and we did a test, this is a chart, as you can see here—the glass was broken and then it was loaded. You imagine—this is the BVB, when it was loaded it was like that, while with the ionoplast layer it could withstand actually 230kgms per sq metre. And just to show you an application of the ionoplast interlayer I think you might be familiar with this one; a lot of these have been shown—quite fantastic applications and the ionoplast interlayer was used because of the fast breakage behaviour properties and also because of the thickness reduction achievable. And then when you are in a marine environment you are always thinking about the durability of the glass and as I said, the interlayer was developed for Florida in the beginning, and we have now 10 years' accelerated natural weathering, and also we have outdoor Arizona weathering and also

accelerated weathering. And coming back to the marine environment we have certification about a salty water environment and the laminate stays unchanged after that. Just to give you an example about the weatherability of these laminates, you know, nowadays they're used for a lot of open edge applications—this is one, if you happen to go to New York and you climb up the Rockefeller Centre there is another open edge balustrade where you can see the whole city. This is a real thing because we have some existing applications with a shipyard in Italy and some others, and also there is a link on the website where you can find also a description of why Yves St Laurent has chosen these laminates for his main series.

So the conclusion is that laminated glass is really the fit for use product for the yacht industry; to overcome the strength problem you have solution with making the glass stronger and using a stiff interlayer and a stiff interlayer really responds to your needs in a way that you can reduce the overall weight with the ISO 614 and also in terms of strength the ionoplast is really similar to a polycarbonate but it has a higher durability and also very good fast breakage behaviour properties. So I'll leave it now to Dr Rozie.

Martin

Jan please?

Dr Jan Rozie Yachtglass GmbH & Co KG

Well that was quite interesting. We also work with a lot of BVB layers, I think this new product for our market should be very interesting to increase the weight of glass. Of course what is the difference is that when you work with chemically toughened glass as we do and with many yards here also is that the breakage pattern is completely different. When the second part is that we use a lot of coloured glass with special layers inside that are BVBs which you use from the car industry so that all our customers have a wide choice of colours. Of course it is a testing phase because many owners want to have a warranty at least of 5 years and the problem is always for the shipyard that when the glassmaker has problems the first one the owners are calling is the shipyards so we like to make some more tests with it and we have a good experience with BVB because we give a very high warranty for all products we make and one of the most interesting tests is the ISO test 614 and that is a steel bullet test, and I also saw that this product had very high failures but I think it will take some good discussions with the classifications because chemically toughened glass is still an issue for many classifications. I think if we start now a discussion with the audience because I think we have a lot of questions. Thank you.

Martin

Jan, thank you very much. The lights should come up in a minute so we can see who's in the audience with their hands raised. My suggestion is that we don't build submarines we build hulls of glass. It might save us a lot of time and effort. Any questions from the floor please?

Peter Southgate Cayman Islands Shipping Registry

I have a question for, well two questions actually, one for Valentina regarding the ionoplast. One of the problems with polycarbonate as I understand it, is that after a period of time it tends to craze and that's why it's lost its popularity with a lot of people. How has ionoplast fared in that respect? And the second question is we as regulators are often confronted with proposals to use bullet proof glass particularly in

lieu of storm shutters for example. But we always resist this on the basis that the loading pattern for an impact, as opposed to a lateral bending, is completely different, and most of the glass standards that we use BSMA24, 25, are based on lateral pressure considerations. So we basically say that you'd be comparing apples with oranges. And I was interested in your views on that please.

Valentina

Concerning the ionoplast and the polycarbonate, as I showed, this material the way it was developed it was really to be very durable over time and so even concerning compatibility it doesn't have that problem, we have even tested in our external lab salt water sprays where there's salty water so it doesn't give that phenomenon that you were describing with polycarbonate. So I think this is one of the main advantages of this product, the durability that is shown in architectural application as well as now in superyacht application. And your second question was quite long so could you just repeat it for me please.

Peter

Sorry. We are often confronted with proposals to accept bulletproof glass in lieu of storm shutters, these being the things that people most want to get rid of. And we tend to resist proposals based on that because the loading from impact, as a bullet, for example, is completely different to perhaps the lateral pressure static loading, or dynamic loading, that we would consider. What would your answer be to that?

Valentina

Basically I mean I agree with you in a way that if you think about it, a bullet is really a different type of physics as a lateral pressure and I know the storm shutter, there is a regulation on storm shutters, there is an ISO regulation as well, and I would say that sometimes I would actually consider a proposal putting—you know shutter sometimes have polycarbonate, just a bare piece of polycarbonate and I would kind of consider putting glass and polar resisting glass for that.

Jan

Normally bulletproof glass isn't in the building industry not toughened and in the ship industry it's chemically toughened so that is the difference. You have all the tests what the glass industries make with bulletproof glasses then it is for a yacht or a ship then the glasses will be chemically toughened because it is not allowed to build in on a ship untoughened glass.

Peter

So basically what you're saying is our decision not to accept bulletproof glass in lieu of storm shutters is vindicated.

Jan

Well you can make a combination out of it, you can combine chemically toughened glass and thermally toughened glass. There are some options. You can't destroy them and I think with these new products and new technologies you can reduce weight, weight is energy so it's good for the environment and for your money.

Martin

You have a question over here?

[From the floor] Lloyds Register

Maybe a little difference—what we mostly see is not proposals to consider bulletproof glass but burglar proof glass and that's—we generally use that in addition to the pressure tests as per BSMA 24-25. Burglar proof means that you are actually dropping steel balls from 6 metres height on the pane or alternatively attack it with an axe. And that is of course totally different from bulletproof which is something with a small mass coming in at high velocity—we use big mass small velocity which is much more like the type of pattern that you would have for damaging. As an alternative in association with the pressure tests generally we ask for both. And some additional thickness etc. Thank you.

Jan

Now with the windows there is a difference between, it depends on the tests ISO 614 we make that with steel balls but the difference is that—this is what I wanted to tell—when you have thermally toughened glass and you have chemically toughened glass the breakage pattern after the drop test then mostly only the first window is broken and the rest is still OK because the first one is the breakage pattern of the thermally toughened glass it is all little pieces of glass and absorbing the impact, so then you could normally reduce also weight from that side but that's another issue.

Robert Curry ABS Europe

Jan you had said that you were discussing approval of chemically strengthened laminated glass with class societies and the implication was that it was still ongoing and not completed. In fact ABS has 2 or 3 years ago type approved chemically toughened laminated glass. It was approved by a series of hydrostatic tests that was bonded to the bulkheads and the bonding details used in the test were actually the same that were used in the installation on the yacht, so as far as ABS is concerned we have type approved chemically toughened laminated glass.

Martin

What size of vessel is this for ?

Bob

You mean thickness?

Martin

No what size of vessel was this class on ?

Bob

35-40metres.

Valentina

I have a comment here because there is a new standard, it's going to be worked out by RINA and is the ISO commission on the new specification for superyacht industry and they are thinking of including the chemically tempered glass in this standard. This is the commission 81.

Bob

I think they have to. I think one of the problems that we've had to date is that the standards for glass have only been for monolithic heat tempered glass and we really badly need standards for chemically toughened laminated glass.

Valentina

I agreed with you because all the standards are just on tempered glass for the marine industry, all the other variation you want to make you always need to do a type approval procedure with the register.

Peter

I just wanted to come back on that because in LY2 we did actually introduce some standards for chemically strengthened glass because in the early days we were reluctant to accept this because of if you like the long term properties, but we understand because it is actually a case hardening, or a case strengthening process it can be eroded or damaged and therefore in LY2 we put a minimum treatment thickness of 30 microns based on manufacturers' recommendations but also we insisted that it would be in a laminated form because obviously chemically strengthened glass in a monolithic form doesn't afford the same load characteristics but also if it breaks it's pretty hazardous to personnel inside the vessel. So there is provision within LY2 already to accept chemically strengthened glass. But I just also wanted to come back to a point on the ionoplast— I noticed you're using that with conventional toughened safety glass as opposed to chemically strengthened glass?

Valentina

The example I gave was with heat tempered glass but the application I showed with St Lorenzo was most of the window are chemically toughened glass with the ionoplast.

Peter

My understanding is that obviously with the square of thickness rule which you mentioned we found that using laminated glass and using chemically strengthened glass the square of thickness rule grossly underestimated the capability of the glass. But I was interested to see the example you showed on the screen with two layers of 5mm glass with was it 5mm ionoplast?

Valentina

No it was like, yes 2.28mm ionoplast.

Peter

So that was effectively a total thickness of 12 mm effectively equivalent to 15mm of monolithic glass.

Valentina

No it's very close to 12mm. So I don't know if I can put it back to the slide but that was some of our internal results and we also had the complementary data from 614 where we had a 10mm thermally tempered equivalent to 11.5, so you have 1.5mm ionoplast in it. So it's like very similar, you add just 1.5mm in the laminated glass then you end up with a very similar behaviour, so I would say that a ionoplast laminate would approximate a tempered glass laminate.

Peter

Thank you.

Martin

OK. Frans ?

[From the floor]

Just thank you for raising the chemical glass issues. I can't really remember having—well when I saw last proposals for thermally glass on yachts. In the last years I've seen only chemically toughened laminated glass. It's very good.

Jan

I think the biggest problem is that in the specification from the shipyards, from the owners' representatives, the failures in glass, rubber marks, distortions, there are very good systems in thermally toughened glass. We work with many colours, very high quality ovens, but the chemically toughened glass has a nicer surface, the laminated is better because during the toughening procedure you have no distortions on your surface or you have BVB inside from 152, it's a perfect solution really. And I think it is much stronger because we have a lot of people who visit us and where we can explain to them by testing the breakage and that is, which we've said, a chemically toughened glass has the same breakage pattern as a normal glass, so it is very very sharp, so you've always got to use it in a laminated system. And what is also very good with chemically toughened glass is that you have the double curved windows and the curvatures which have been inside, you have no distortion, and that is the biggest problem with thermally toughened glass. That's why we only make thermally toughened glass flat and everything that's bent, and that is at most yachts, that you have the front windows which are curved, they are chemically toughened and 80% of the rest is thermally toughened.

Martin

Any further questions from the floor? Yes, thank you, in the middle there?

Christof Weissenborn Germanischer Lloyd

I have a question beside all the issues of strength and stability of the glass but with regard to the comfort of noise and vibration issues. All the BVB layers have been introduced and have been explicitly pointed out as being able to increase the strength and so to minimise any of the acoustical ingress of whether it is airborne or structure borne noise. When I see the—ionoplast layer? —as being stiffer and leading to smaller thickness, that is counterproductive from the acoustical point of view. Has any investigation been made or calculation with regard to this issue?

Valentina

Always you know you need to have a trade off because if you want a smaller, a boat, if you want to use better your engine, if you want a smaller glass then you need to compromise but if you think about the most effective solution for acoustic is the actual unit. I agree with you that BVB being soft, the dampening effect of the acoustic waves but normally if you want to reduce the overall thickness then also you would say OK I want a thicker glass because then I have a better acoustic. So I would say that the solution might be to go to a larger unit and still have a less weight on your final solution.

Christof

So basically this special side issue has not been considered with regard to the ionoplast?

Valentina

Yes it has been considered but it doesn't really add to the BVB behaviour. The BVB has acoustic attenuation but normally you would use it in a larger unit and the ionoplast layer being stiffer is like similar yacht owner BVB but not quite the same, I would say.

Christof

OK, thank you.

Martin

OK I have one over there please?

Joerg Jonas Saint Gobain Marine Application

I have one question. What would you reply if the market is telling that the chemical reinforced glass' strength is washed out after some years? So if you go and make a test, on the first day it's OK but after some years you will test again the performance of the chemical reinforce?

Jan

We test when we repair ships or make some refits we always test windows to make and the most windows which are chemically toughened and laminated are mostly 10 or 12 years old. And we make then our home tests, because for us it's the most important thing what happens after 5 or 6 years. Because after one day testing it's like everything's perfect. But we have seen no problems with it washing out, or something like that. That is absolutely never have we seen that. When there are problems then it was the trouble that glass is built in shapes without toughening it. That is the greatest problem with chemically toughened glass because it is very hard to check if it's really toughened. That's a very very hard procedure. So when you are on board and the surveyor wants to see—the only thing which you can do is really in the bath we have a system and we also have my colleagues where you can see OK, it has to be in the bath of course, but that is what you can see. But we have no problems with washing out, absolutely not.

Joerg

But even the supplier of chemical reinforced glass are telling it.

Jan

Yes but I think that is part of the procedure because there are at the moment we have systems that you really really can test the quality of that part—it is a very complicated process absolutely but we have no problem and especially when you have a laminated glass. Even when you would clean it and polish it, that is what happens sometimes, that people polish chemically toughened windows, every year, with serum, then you polishing surface of it so that is why we always say you've got to treat your window, normally when you buy shoes you polish them also. So in glass you can polish and clean it, you can protect it, there are all kinds of very good products on the market. And in the inside of the layer you have always two surfaces plus the interior one which are perfectly in capable to carry the waste.

Joerg

OK thank you.

Martin

Any more questions?

Tork

On the example you showed us, Valentina, where there was a gentleman standing on an already broken sheet of glass and it was 300kgs per sq metre, how does that compare to the unbroken weightloading?

Valentina

Well it depends. You need to combine the basically the unbroken in that case I think it was like twice as much, like 500, almost twice as much.

Tork

So it's only lost 50% of its strength ?

Martin

Jan, in your experience, what are the biggest problems that you face with glass? That you think the market should be changing in the way they do things? Does it make your life harder when designers get involved?

Jan

Yes of course because the problem is this. The windows are every year they are larger and larger and always they ask if it's possible 10mm more, 20cm more, so the problem is that we need some new materials, BVB is OK and those products are really incoming because the problem is how thicker the glass is, it is completely stiff, so when you have a construction where there is movement inside and you have glass on board which cannot follow that movement, then you have all your forces on the glue, so that is what we're testing a lot of. We make it every month, 10 or 15

different windows. And so yes, we've got to discuss with the classifications of course. But it is absolutely a product for the future.

Martin

Alright. Any further comments? I can see this is a subject you don't really have a clear understanding of. Sorry, that's a terrible pun.

Right we're going to break for a coffee break. We'll come back here at 4.30 for a design workshop.

Ladies and gentlemen thank you very much. See you later on.
