

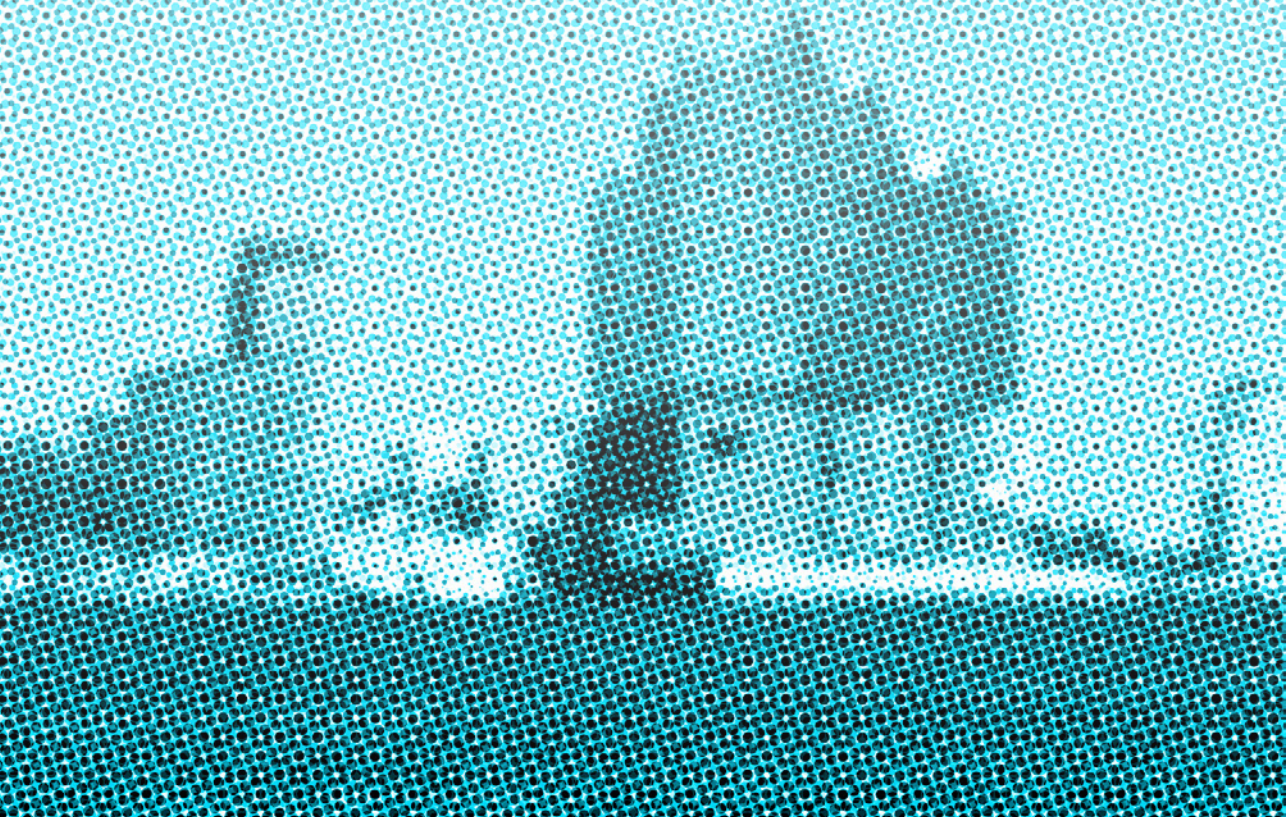
September 25th - 28th, 2017

INTERFACES

architecture . engineering . science **IASS 2017** hamburg

PROGRAM

interactive



INTERFACES

architecture . engineering . science **IASS 2017** hamburg

PROGRAM

Imprint

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THE INTERNATIONAL ASSOCIATION FOR
SHELL & SPATIAL STRUCTURES

HCU | **HafenCity University**
Hamburg

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venues and sights



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- A HafenCity University
- B Cap San Diego
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- D MS Stubnitz

Sights

- 1 Elbphilharmonie
- 2 Großmarkthallen
- 3 Alter Elbtunnel
- 4 Rathaus | Town Hall
- 5 Main Station
- 6 Miniaturwunderland
- 7 Jungfernstieg & Binnenalster

Public Transport

- U1 Meßberg
- U3 Baumwall | Elbphilharmonie
- U4 HafenCity Universität
- CB StadtRad | CityBike stations

Elbphilharmonie



A squat brown-brick former warehouse at the far west of HafenCity is the base for the architecturally bold Elbphilharmonie, a major concert hall and performance space. Pritzker Prize-winning Swiss architects Herzog & de Meuron were responsible for the design, which captivates with its details like the 1096 individually curved glass panes

Fish Market

A legend and a must-see for all visitors to Hamburg: Since 1703, pretty much everything that is not bolted down has been traded here at Hamburg's most traditional market. From dusty porcelain jugs to a chirpy family of ducks, you can find just about anything in the shadow of the 100-year old fish auction hall.

Port of Hamburg



About 13,000 ships from all over the world call at Europe's second largest port. From the cruise ship terminal to the historic 'Speicherstadt' warehouse district and the landing bridges to the modern container port - aromas here redolent of freedom and far-away lands.

Landungsbrücken

Landing Bridges

The floating dock - called the "Landungsbrücken" - is 700 metres long. Harbour tours and the HADAG steamers to Finkenwerder, Övelgönne and Blankenese leave from this water "station". Impressive luxury cruisers also dock here from time to time.

Alter Elbtunnel

Old Elbe Tunnel



In 1911, the old Elbe tunnel was built to provide a new direct route for dock workers from the St. Pauli Piers or 'Landungsbrücken' over to the Southern banks of the Elbe river. Initially a technical innovation, the tunnel became a tourist attraction when the 'new' Elbtunnel and several bridges were built in the 1970s. Now, elevators carry pedestrians and bicyclists into the deep, and cars can use the hydraulically driven lift cages for a small fee.

Elbstrände

Elbe Beaches

In summer, the Elbe beaches (Elbstrände) around Blankenese are a beloved location to spend sunny days sunbathing, barbecuing, or simply enjoying the view of the container port on the other side. Along the beach a small path leads past several cafés and restaurants.

Außenalster

Outer Alster



The 160-hectare lake in the heart of the city is a true paradise for sailors, rowers and paddlers, but has a depth of no more than 2.50 metres. It was created as early as the 13th century by damming the little Alster river and its even smaller feeder rivers. Its opulent grasslands on the edge of the bank offer plenty of opportunities to be close to the water, right in the middle of the city. Just kicking back on a blanket or a deckchair, jogging "all the way round the Alster", taking a walk, playing frisbee and boules - the options are endless for you to enjoy this splendid green oasis on land.

The most famous of Hamburg's many churches, St. Michael's was built in the Baroque style between 1750-62 and is one of the city's most important landmarks. From its 132-meter-high tower, familiarly known as "Michel," and accessible by stairs and an elevator, viewing platforms offer excellent panoramas of the city and port, a particular treat during their regular extended evening openings.

The Reeperbahn is the most famous street in Hamburg. The name "Reeperbahn" comes from the old German word Reep meaning "heavy rope".

In the 18th century, heavy hempen ropes were produced here for sailing ships in the Hamburg harbor.

Today, the area is known for the many great bars, restaurants, theatres like the Operettenhaus, and clubs here, along with sex shops, sex museums, erotic theaters, and strip clubs.

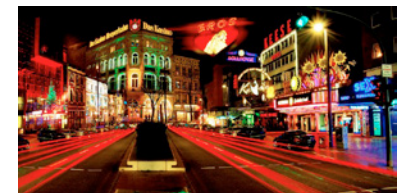
In the heart of central Hamburg, Planten un Blomen park is linking inner city shopping streets with Hamburg convention and exhibition centres, Hamburg University and the bars and pubs of St. Pauli. In other words, it functions as the connector between the Outer Alster lake and the Elbe river. Covering 450,000 sqm of reclaimed medieval fortifications, the park lives up to its name. Planten un Blomen is Low German and translates to 'Plants and Flowers'.

Michel

St. Michaelis Church

Reeperbahn

Reeperbahn Nightlife District



Planten un Blomen

Planten un Blomen Park



HVV Hamburg
24/7 season ticket



>> for more info about 24/7 tickets

You can chose the dates of validity for weekly season tickets, as well as corresponding upgrade tickets for Express bus/1st class RB/RE services to suit your plans, e.g. from Tuesday to the following Monday.

All 24/7 season tickets and supplementary tickets are valid from midnight of the first service day until public transport close down on the last day day. Close of services is at 6 am the following morning.

Area of Validity	€ / week
2 fare zones	17,30
Hamburg AB	34,90

Hamburg Card
your explorer pass



>> for more info about the Hamburg Card

Filled with the finest that Hamburg has to offer, a Hamburg CARD or Hamburg Card plus Region is the practical and inexpensive way to explore the city and its surrounding area.

With these leisure-time passes you are entitled to unlimited travel by bus and train throughout the HVV service area. In addition, you enjoy discounts at more than 150 tourist attractions as well as on other interesting offers. These include:

- City-sightseeing bus tours and boat trips around the port or on the River Alster
- Places of interest and museums
- Musicals and theatre
- Restaurants and souvenirs

The Hamburg CARD leisure-time pass is valid for travel within Hamburg AB, comprising the Hamburg metropolitan area and certain surrounding municipalities and towns.

With a Hamburg CARD plus Region pass you can travel on the entire netwrk (fare rings ABCDE). For a map of our fare zones please click the related link at the bottom of this page.

Tip for Hamburg residents: Why not use a Hamburg CARD to re-discover your home city or show guests around?

Essential information on the Hamburg CARD leisure-time pass:

Both types of pass are valid on all HVV public transport services: U- and S-Bahn rapid-transit rail, regional trains, buses, MetroBuses, SchnellBus limited-stop/Eilbus sprinter services, night buses and harbour ferries. First-class travel is not included.

A individual pass is valid for one adult and up to 3 children (6-14 years inclusive).

A Group Pass is valid for up to 5 persons of any age.

The upgrade required on SchnellBus limited-stop services is included.

Both passes are valid on the days you have selected (see stamp) and expire when public-transport services close down on the last of these days. Close of service is at 6 am the following morning. Only consecutive days of validity are permitted.

How to buy the Hamburg CARD?

You can buy a Hamburg CARD from all ticket machines, at HVV service centres, from the bus driver, at the DB travel agencies and at the Tourist Information Centres (Hauptbahnhof/Central Station, Dammtorbahnhof, Harbour, Airport). Many Hamburg hotels, youth hostels and travel agencies also sell these passes. Or – if you prefer – simply phone 040/300 51 300 or visit the website of hamburg tourismus to get your Hamburg CARD.

Please note that it is not possible to buy the 5-day Pass or Hamburg CARD plus Region on the bus.



>> HVV App for Android



>> HVV App for iOS

StadtRAD Hamburg

on your bike and off you go!

The StadtRAD (city bike) gives you spontaneous, individual mobility. Experience all Hamburg has to offer, whether work, leisure or tourist attractions, in a very special way, right in tune with the pulse of the city. Many hire stations throughout the entire city offer facilities round the clock for hiring and returning a StadtRAD - as simply as cycling itself.

To register you need your bank details or credit card number, together with your HVV season ticket number or BahnCard number, if you have one.

Hiring via terminal

Every StadtRAD Hamburg hire station has a central user terminal:

1. Simply touch the screen to activate it
2. Identify yourself with your bank, credit or customer card.
3. Choose the number of bikes you want to hire, using the displayed bike numbers.
4. Touch the display of the bike lock. The lock opens,
5. pull out the locking bar and off you go.

Hiring by phone

If you don't have a bank, credit or customer card, you can also hire a StadtRAD by phone. Call the phone number encircled in red on the cover of the lock to hire the bike quickly and easily.

Cycling break

If you want to park your StadtRAD while using it, please secure it with the bike lock. Use your personal opening code to unlock the bicycle. The code appears briefly on the lock display when you lock the bike. You can also find it under your personal data on the customer portal and change it online at any time.



>> for more info about StadtRad Hamburg

Return

1. Lock the bike at a vacant parking space.
2. Press the locking button on the right of the bike lock. The lock identifies the parking space and the return procedure is complete.

Hire station full

If all the parking spaces at a hire station are occupied, simply park the bike at the hire station, secure it with the bicycle bolt and press the locking button on the right of the bike lock.

Please note: If the bike is parked next to a hire station - despite free parking spaces - a service fee must be charged according to our price list.

For the first 30 minutes, you can use every StadtRAD Hamburg free of charge; after that, you pay the low price of 6 ct/min.

The 5 € fee charged at registration is held in your credit to the full amount **.

** The registration fee is held in your credit for 12 months after registration. It is not possible for the registration fee to be paid out in cash.



>> for more info and the StadtRAD App
<https://stadtrad.hamburg.de>

HOST

INFO
hafencity university

The architectural and societal challenges of the 21st century coalesce in cities and regions – which must be the starting point for the sustainable development of our built environment. The HCU is located in one of the most dynamic metropolitan regions of Europe. The complex challenges facing cities are its focus.

HafenCity University Hamburg
host for the IASS 2017

Profile of the HCU

A university in dialogue Questions on the future of the built environment and our cities must be answered in dialogue between experts and the public. The HCU sees itself as a laboratory for building and urban development. It invites a broad exchange of ideas on questions of the metropolitan future – a place of research and debate on architecture, building, urban culture and urban development.

Transdisciplinary thinking for new perspectives The complex challenges posed by the metropolitan environment demand new approaches. The HCU works in a transdisciplinary way on the problems of urban living and its spatial, social, cultural, economic and ecological consequences. It confronts traditional disciplines with radically different approaches and ways of thinking.

Specialisation and breadth: the disciplines at the HCU

New solutions for metropolitan problems demand disciplinary excellence as well as an openness to neighbouring disciplines. This disciplinary and professional excellence is based on the five undergraduate programmes, which cover the spectrum from "house to city": Architecture, Civil Engineering, Geomatics, Metropolitan Cultures and Urban Planning.



>> for more info: <http://www.hcu-hamburg.de>



Learn how to continue learning – and to question established ways Our reality is changing more rapidly than ever. The goal at the HCU is to foster lifelong learning and the continual search for new solutions. The Studium Fundamentale and the Study Projects at the HCU encourage students in their ability to reflect and to use their power of judgement – essential skills in the complex and changing challenges of the future.

Interfaces of knowledge Questions on the future of building and metropolitan development occur at the interface of professions. The Masters courses at the HCU are exactly at this interface – where existing professions are challenged and new ones born: Resource Efficiency in Architecture and Planning (REAP) and Urban Design.

The HCU is currently home to roughly 2,400 students learning from around 50 professors.

Research at HCU The HCU is driven by research, encompassing basic research, applied research as well as design research. The fusion of the research areas of architecture, civil engineering, urban planning, geomatics, urban design and metropolitan culture aims to overcome departmental boundaries in order to enable the researchers to exchange openly their methods and approaches.

At HCU we base all of our methods and expertise on the proposition that the complexity of the problems associated with design, building and metropolitan development require interdisciplinary thinking and action.

HCU's current key areas of research are as follows:

- Engineering principles of building.
- Climate, energy and the planned environment.
- Digital cities.
- Economic conditions of urban development.
- Approaches of cultural studies to metropolitan research.
- Resource efficiency in architecture and planning.
- Urban Metamorphoses.

All these core areas of research are characterized by the following criterias:

- Development of solutions to urgent issues in Hamburg at a societal, urban and regional level.
- Novelty of issues to ensure success in publications and third-party funding.
- International perspectives.
- Focus on sustainability to do justice to the social responsibility incumbent on a university engaged with contemporary themes.

The HCU sees part of its mission as the obligation to put the results of research into practice, thereby encouraging new solutions to future tasks in metropolitan development.



If your home university offers Eduroam, you can use it also at the HafenCity University. Eduroam works only if you download the specific certificates. Please install the certificates before you arrive at the venue.

If you are not able to use Eduroam, you can get a guest account at the venue. Please visit therefore the WiFi InfoPoint next to the Registration tables.

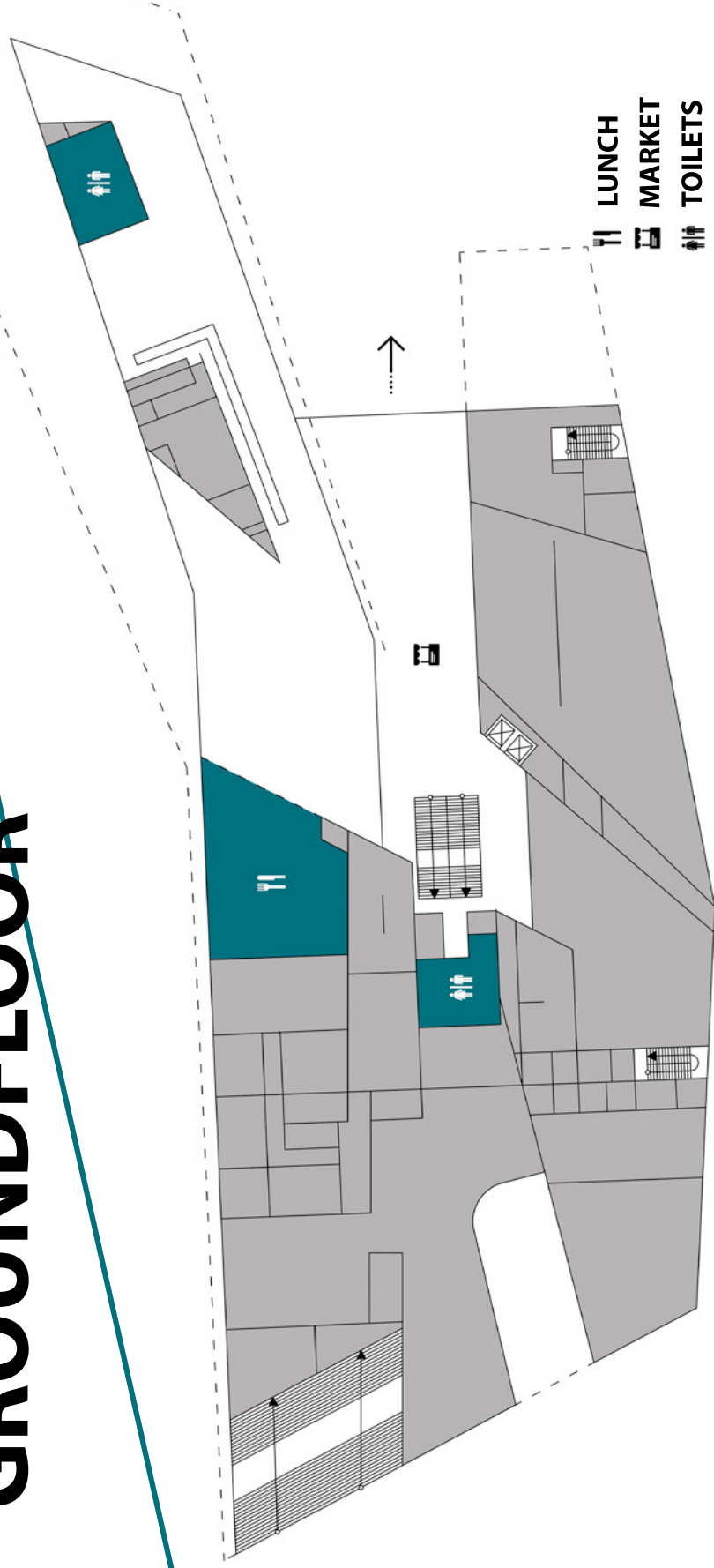
Eduroam & WiFi
stay connected



>> for more info: <https://cat.eduroam.org>

ORIENTATION

GROUND FLOOR

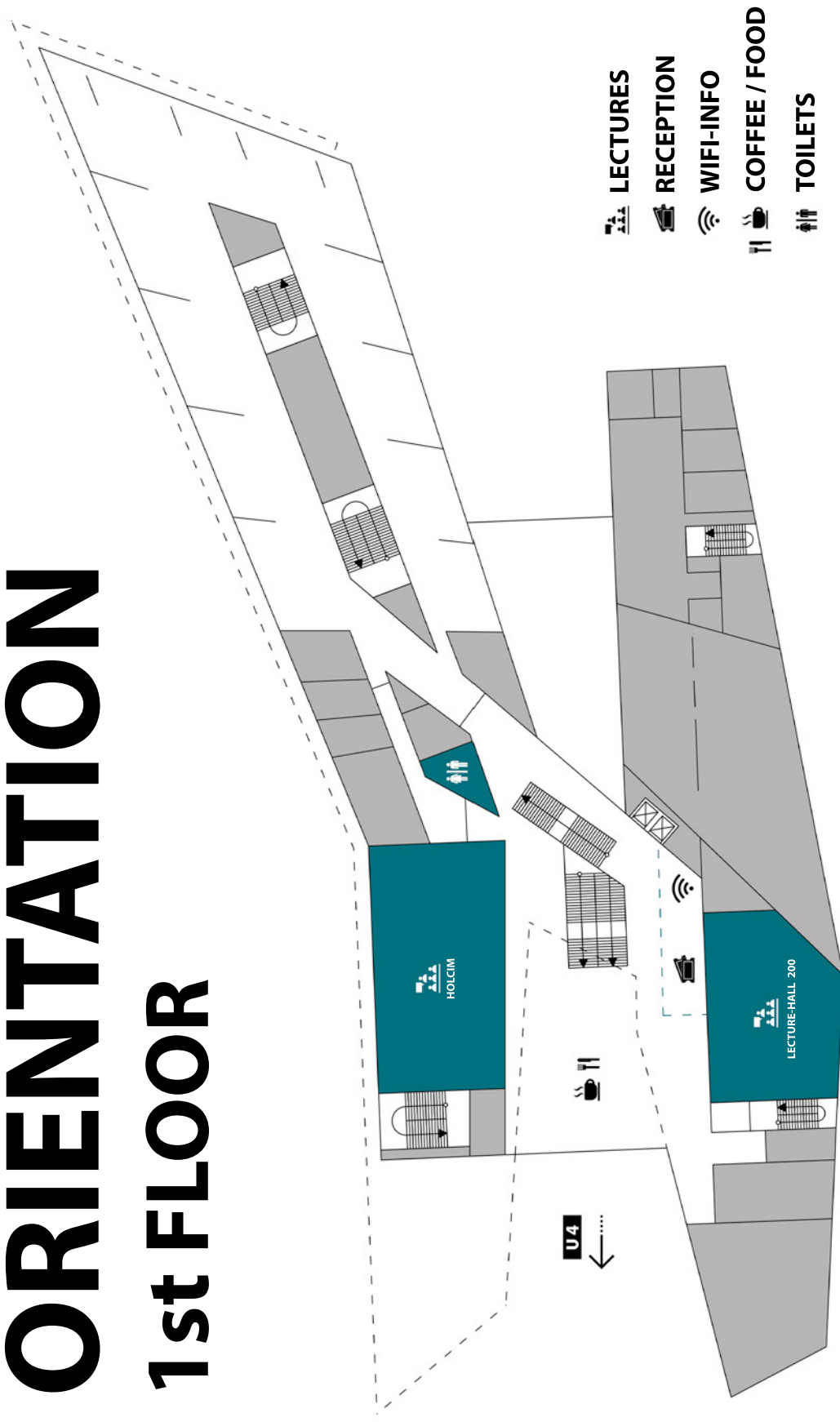


LUNCH
MARKET
TOILETS

U4
←

ORIENTATION

1st FLOOR

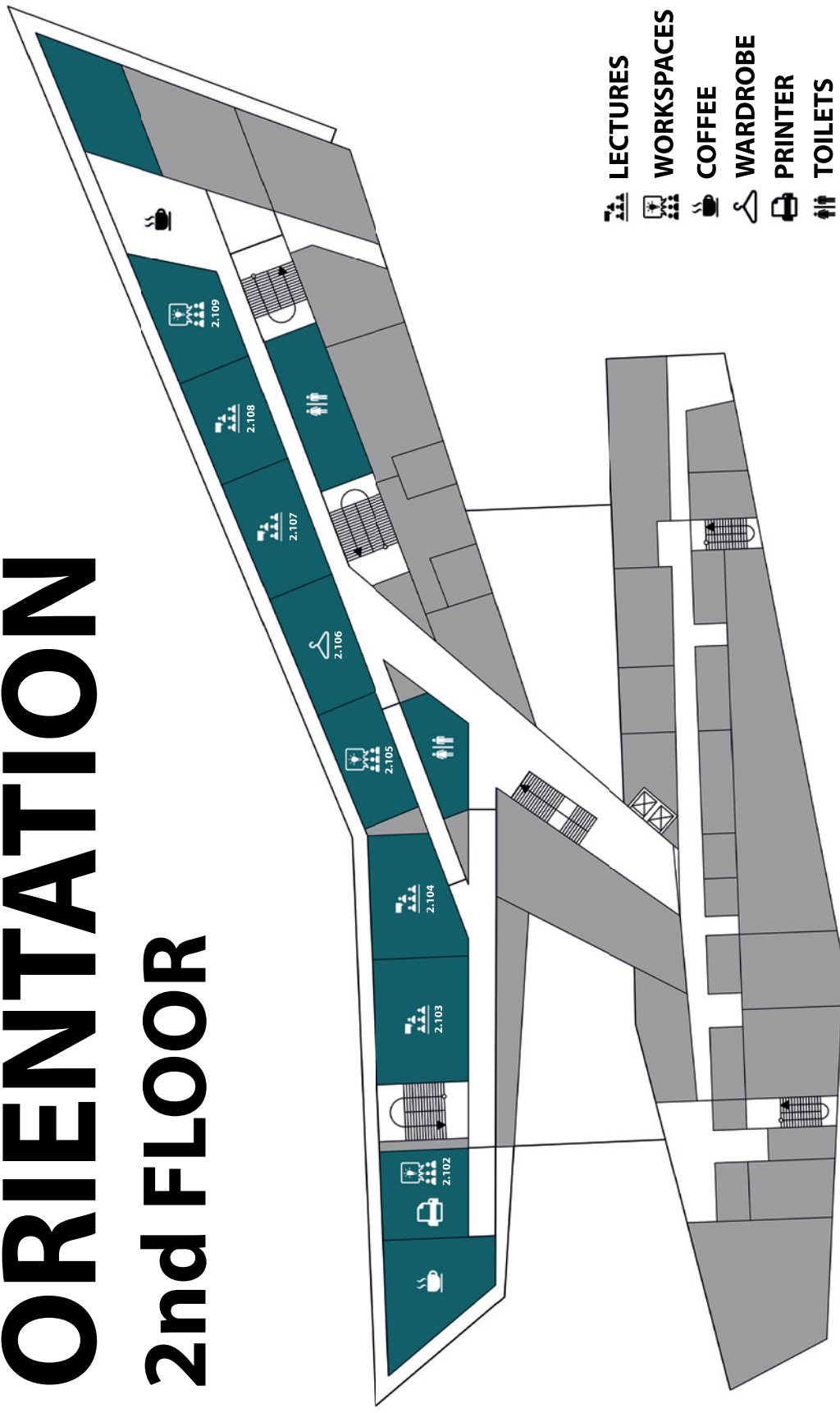
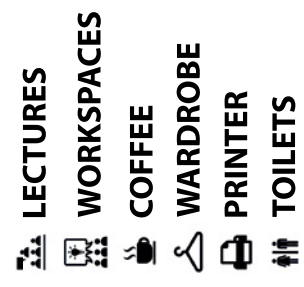


LECTURES
RECEPTION
WIFI-INFO
COFFEE / FOOD
TOILETS

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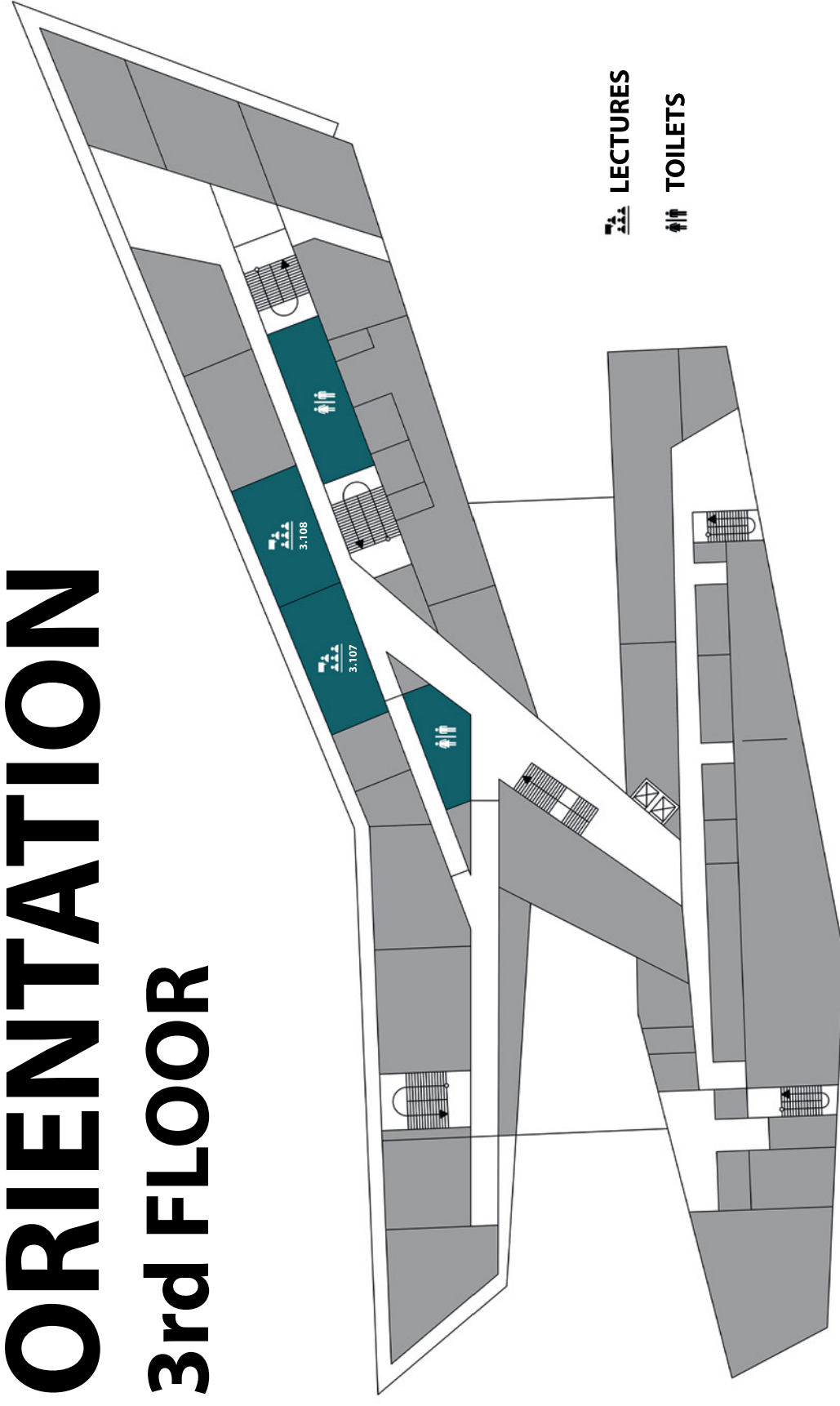
ORIENTATION

2nd FLOOR



ORIENTATION

3rd FLOOR



IASS

INFO
iass

In September 1959, the world-famous structural engineer Eduardo Torroja organized and convened an International Colloquium on Shell Structures in Madrid. During this Colloquium, Professor Torroja proposed the founding of the International Association for Shell Structures (IASS), because at that time shell structures were frequently used all over the world to roof buildings of all sorts, e.g., sports facilities, exhibition halls and industrial plants, as well as to fulfill industrial purposes through such structures as tanks, silos and cooling towers. He wanted to create a platform where the top scientists, designers and constructors of the world would meet and exchange their ideas and experiences. There should be regular meetings, correspondence and a bulletin published regularly. His proposal was enthusiastically accepted by the distinguished group of designers and engineers at the colloquium, and the IASS was born with Prof. Torroja as both the inspiration and the founding president.

Since that time, the Association has developed and become an internationally renowned institution of high quality, attracting a great number of distinguished members. Regularly, Symposia, Colloquia and Conferences took place all over the world, and a number of Working Groups undertook all kinds of efforts concerning the design, analysis and construction of shells. In the Bulletin of the IASS (the predecessor to the current Journal of the IASS) a wide range of theoretical and practical problems were treated, and both small and important buildings were described.

In the late 1960s, changes were occurring in the building industry. New sorts of construction began to flourish for large spans – spatial structures of steel, timber and fabrics – while shells became less frequent. Consequently, the purpose and scope of the Association were enlarged, as represented by the change in name effective in 1970 to the International Association for Shell and Spatial Structures, although the acronym and logo of the Association remained IASS to help preserve the heritage of the organization. Since that time, the IASS has treated

The International Association of Shell & Spatial Structures

history of the association



>> for more info
<http://www.iass-structures.org>

the design, analysis, construction and research for practically all kinds of buildings and other long-span, light-weight structures. In 1995, to reflect its influence on the fields of shell and spatial structures, the name of the Bulletin of the IASS was changed to the Journal of the IASS; and in 2010, the frequency of publication of the Journal was increased from three to four times per year. A number of well-known specialists in these fields of structures have served as Presidents, and other distinguished architects, engineers and academics have collaborated voluntarily with the Association in the Executive Council and Advisory Board. Hundreds of individuals have contributed to the Bulletin and Journal, belonged to the Working Groups, and attended the Symposia and Colloquia. The IASS has continually recognized both established and young contributors to the field by such awards as Honorary Membership, the Eduardo Torroja Medal, the Tsuboi Awards, and the Hangai Prizes.

Traditionally, the Secretariat headquarters is located in Madrid, Spain, in the same place where the IASS was founded while Eduardo Torroja was its Director, the Laboratorio Central de Estructuras y Materiales, integrated into a wider organization: CEDEX or Centro de Estudios y Experimentación de Obras Públicas. With the launching of this website for the IASS in November 2007, the Journal of the IASS embarked upon a new development, the publication of an electronic version on this site that promises to reach an even wider audience in the current day and age of enhanced communication. In 2009, the IASS celebrated its 50th anniversary at its Jubilee Symposium held in Valencia, Spain. Inspired by this landmark in the life of the Association, a volume, Fifty Years of Progress for Shell and Spatial Structures, was published in 2011.

All those interested in any aspect of the design, analysis, and construction of lattice, tension, membrane, shell, and other light-weight spatial structures, as well as those interested in the research into their behavior, are welcome to become members of the IASS. Join the IASS with over seven hundred others from around the world to enjoy the benefits of an IASS membership. As an IASS member you have e.g. access to the electronic journal and all e-publications of the IASS. You also pay reduced fees for IASS symposia and colloquia.

Membership Categories and Annual Dues:

Individual members: € 85 per year
individuals who share the aims of the IASS

Collective members: € 425 per year
companies, firms, universities or institutes that share the aims of the Association, wish to support it, and wish to extend the benefits of IASS membership to their staff and to their entire organization.

Student members: € 10 per year
individuals who share the aims of the IASS and who are currently undergraduate or postgraduate students at a recognized institution of higher learning.

Go to leaflet ...

**The International Association of
Shell & Spatial Structures**
[become a member](#)



>> for more info about the IASS membership

PROGRAM

SOCIAL PROGRAM

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WELCOME RECEPTION
YOUNG PERSONS EVENT
GALA DINNER
PUBLIC LECTURE

ACCOMPANYING PERSONS PROGRAM

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Welcome Reception

HafenCity University
07:00 pm, canteen & cafeteria



After the first day of this year's international symposium of the IASS, you are invited to enjoy the venue. Enjoy a drink and a snack at the Elbe River, have a kind chat with old and new friends.

Don't miss an impressive sunset accompanied by good music, a view to the Elbphilharmonie, parts of the harbour area and the largest development area of Hamburg.

Young Persons Event

MS Stubnitz
09:00 pm



Last train leaves at 00:28 h from station U HafenCity Universität.

Please wear sturdy shoes!

Since its inception in 1994, Stubnitz has been and remains a unique cross-cultural project of its kind, committed to the research and documentation of the contemporary music and performance art across different European regions, for the benefit of the artists, their audiences and cultural exchange. As the Culture Ark, it is our mission to chronicle the innovation and diversity of contemporary youth culture and communicate it to the present and future generations. Doing so, we keep the maritime cultural heritage of Stubnitz the ship, and the millennia-old tradition of maritime cultural exchange alive and accessible to the people.

For those young in age and at heart: there is a meet & greet on Monday evening after the official reception! Come and join us for a drink and a real Hamburg snack in a nice atmosphere at the MS Stubnitz (former fishing vessel).

The Cap San Diego is the largest seaworthy, civilian museum ship in the world. Its elegant silhouette is part of the Port of Hamburg, such as the Speicherstadt and the Michel. Tourists love the Cap San Diego and its own crew, 45 retired seafarers working in an honorary capacity, they keep the pot boiling and at least once a year it says: Cast off! and the CAP SAN DIEGO drives on the river Elbe to Cuxhaven or through the Kiel ship Canal to Kiel.

The CAP SAN DIEGO is the last remaining ship of a series of six fast general cargo vessels, built in 1961/62 for the shipping company Hamburg South and preferably driven to South America by the end of 1981. Since 1988, Hamburg's unique maritime monument is a museum ship and can be visited every day from 10 am to 6 pm from bridge to hatch and from heart to head.

The CAP SAN DIEGO is not only a living museum ship, it also offers a beautiful setting for company and private celebrations.

Beyond Lightweight - Building the World of Tomorrow

by **Werner Sobek**, Prof. Dr. Dr. E.h. Dr. h.c.

Werner Sobek is an architect and consulting engineer. He heads the Institute for Lightweight Structures and Conceptual Design (ILEK) at the University of Stuttgart. Since 2017 he is chairman of the DFG Collaborative Research Centre "SFB 1244" on "Adaptive Building Skins and Structures". From 2008 until 2014 he was also Mies van der Rohe Professor at the Illinois Institute of Technology in Chicago and guest lecturer at numerous universities in Germany and abroad, e.g. in Austria, Singapore and the USA (Harvard). In 1992, Werner Sobek founded the Werner Sobek Group, offering premium consultancy services for architecture, structures, façades and sustainability. The Werner Sobek Group has offices in Stuttgart, Buenos Aires, Dubai, Frankfurt, Istanbul, London, Moscow, and New York. All its projects are distinguished by high-quality design and sophisticated concepts to minimize the consumption of energy and materials.

Gala Dinner

Cap San Diego
07:00 pm



Please wear sturdy shoes (no high heels) and bring a warm sweater!

Public Lecture

HafenCity University
07:00 pm, Holcim Auditorium



The public lecture is chaired by Sergio Pellegrino & Martin Synold.

ACCOMPANY

	9 am - 11 am	11.30 am - 1 pm	2.30 pm - 4.30 pm	5 pm - 6.30 pm	
				4 pm EARLY REGISTRATION	
sunday 09 24 17				ICEBREAKER HafenCity University	
monday 09 25 17	8 am REGISTRATION Holcim Auditorium Welcome Session Welcome Address Awards Keynote by Jan Knippers	coffee break outside Boat Tour - Harbour and Fleets -	3 pm outside Tea Tasting - historic warehouse district -		WELCOME RECEPTION HafenCity University YOUNG PERSONS EVENT MS stubnitz
tuesday 09 26 17	10 am outside City Tour - inner City, St. Pauli, Planten and Blomen, around the Alster -				GALADINNER Cap San Diego
wednesday 09 27 17	10 am outside Miniaturwunderland additional: Guided Tour for 6 pers. tour				PUBLIC KEYNOTE by Werner Sobek HafenCity University RECEPTION
thursday 09 28 17		11 am outside Guided Tour - City Hall -	Holcim Auditorium Closing Ceremony Hangai Prize Presentation Keynote by Neil Thomas	TECHNICAL TOUR: Structural City Walk	

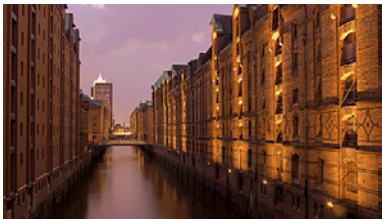
Boat Tour

monday, 11:30 am

Hamburg is really proud of its harbour - it is the second-largest harbour in Europe. The boat tour gives you some insight information and emotions about this special place.

Tea Tasting

historic warehouse district
monday, 03:00 pm



The seven-storey red-brick warehouses lining the Speicherstadt archipelago are a famous Hamburg symbol and the largest continuous warehouse complex in the world, recognised by Unesco as a World Heritage Site. Its distinctive architecture is best appreciated on a leisurely wander or a ride on a flat tour boat (called Barkasse). Many buildings contain shops, cafes and small museums.

City Tour

tuesday, 10:00 am

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Although billed as the world’s largest model railway, Hamburg’s Miniatur Wunderland is really much more than simply a toy train layout. This stunning new attraction is the world’s largest model railway, boasting more than 12,000 meters of track and 890 trains. Built on a truly massive scale, it covers 1,150 square meters with more planned. Even the worst cynics are quickly transformed into fans of this vast miniature world that goes on and on. The model trains wending their way through the Alps are impressive – but slightly predictable. But when you see a model A380 swoop out of the sky and land at the fully functional model of Hamburg’s airport, you can’t help but gasp and say OMG! On weekends and in summer holidays, prepurchase your ticket online to skip the queues.

In the center of Hamburg’s Old Town is the Rathaus or City Hall. This large, sumptuous Neo-Renaissance building adjacent to the Stock Exchange (Börse) was completed in 1897 and consists of 647 rooms, many opened to the public for the city’s annual Long Night of Museums event. With its spectacular coffered ceiling, Hamburg’s baroque Rathaus is one of Europe’s most opulent, and is renowned for its Emperor’s Hall and Great Hall. The 40-minute tours take in only a fraction of this beehive of 647 rooms. A good secret to know about is the inner courtyard, where you can take a break from exploring the Rathaus on comfy chairs with tables.

Miniaturwunderland

wednesday, 10:00 am



City Hall

guided tour
thursday, 11:00 am



OVERVIEW

		9 am - 11 am		11.30 am - 1 pm		2.30 pm - 4.30 pm		5 pm - 6.30 pm		
						4 pm EARLY REGISTRATION				
sunday 09 24 17								ICEBREAKER HafenCity University		
monday 09 25 17	8 am REGISTRATION	Holdcim Auditorium Welcome Session Welcome Address Awards Keynote by Jan Knippers	coffee break	Holdcim Auditorium Plenary Session Hangai Prize Presentation Keynote by Tomás Saraceno		seminar rooms Parallel Sessions		seminar rooms Parallel Sessions	WELCOME RECEPTION HafenCity University YOUNG PERSONS EVENT MS stubnitz	
tuesday 09 26 17	seminar rooms	Parallel Sessions	coffee break	Holdcim Auditorium Plenary Session Hangai Prize Presentation Keynotes by Guy Nordenson & Heike Klusmann	lunch	seminar rooms Parallel Sessions		coffee break	seminar rooms Parallel Sessions	GALADINNER Cap San Diego
wednesday 09 27 17	seminar rooms	Parallel Sessions	coffee break	Holdcim Auditorium Plenary Session Hangai Prize Presentation Keynotes by Tibor Tarnai & Kai-Uwe Bletzinger		Holdcim Auditorium Plenary Session as Pecha Kucha moderation by Peter Schmal & Philippe Block		seminar rooms Parallel Sessions	PUBLIC KEYNOTE by Werner Sobek HafenCity University RECEPTION	
thursday 09 28 17	seminar rooms	Parallel Sessions	coffee break	Holdcim Auditorium Closing Ceremony Hangai Prize Presentation Keynote by Neil Thomas		TECHNICAL TOUR: Structural City Walk				

9 am - 11 am		11.30 am - 1 pm		2.30 pm - 4.30 pm		5 pm - 6.30 pm			
Hörsaal 200				session	Graphic Statics I	session	Graphic Statics II	Hörsaal 200	
				chair	Philippe Block, Corentin Fivet	chair	Philippe Block, Corentin Fivet		
				papers	9986, 9730, 10042, 10231, 10242, 9208	papers	10170, 10087, 9816, 10007, 10236		
2.103		coffee break		session	Memorial Session for Wilfried B. Krätzig	coffee break	session	Cooling and Solar Updraft Towers WG 3	2.103
			chair	Reinhard Harte, Claudio Borri	chair		Reinhard Harte, Claudio Borri		
			papers	10248, 9930, 10359, 9450, 10364, 10527	papers		10335, 9265, 9480		
2.104	Welcome Session chaired by Annette Bögle & Manfred Grohmann Welcome Address Awards Keynote by Jan Knippers Holcim Auditorium	Plenary Session chaired by Caitlin Mueller & Harald Kloft Hangai Prize Presentation by Romain Mesnil Keynote by Tomás Saraceno Presentation of the Technical Activities Committee (TAC) by Carlos Lázaro Holcim Auditorium	lunch	session	Origami WG 15	coffee break	session	Memorial Session for Klaus Linkwitz	2.104
				chair	Tomohiro Tachi, Martin Trautz		chair	Ekkehard Ramm, Kai-Uwe Bletzinger	
				papers	9546, 9567, 9580, 9607, 9696, 10819		papers	9908, 9493, 9968, 9256	
2.107				session	Computational Conceptual (Structural) Design WG 13 & 15	coffee break	session	Computational Conceptual (Structural) Design WG 13 & 15	2.107
		chair	Peter von Bülow, Paul Nicholas	chair	Carlos Lázaro, Jeroen Coenders				
		papers	9552, 9613, 10152, 9848, 9718, 10199	papers	10126, 9637, 10179, 10386, 9568				
2.108				session	Advanced Manufacturing I	coffee break	session	Advanced Manufacturing II	2.108
		chair	Arno Pronk, Patrick Teuffel	chair	Andreas Trummer Arnold Walz				
		papers	10066, 10371, 9759, 10235, 10005, 10140	papers	9250, 9642, 9978, 10133, 10281				
3.107				session	Gridshells I	coffee break	session	Gridshells II	3.107
		chair	Samar Malek, Christopher Williams	chair	Christopher Williams, Samar Malek				
		papers	9247, 9657, 9939, 10195, 10321, 10112	papers	9245, 9664, 9726, 9557, 9504				
3.108				session	21st Century Tension and Membrane Strucutres WG 6	coffee break	session	21st Century Tension and Membrane Strucutres WG 6	3.108
		chair	Sudarshan Krishnan, Martin Synold	chair	Ronald Schaeffer, Seung-Deog Kim				
		papers	9586, 9624, 9588, 9862, 9560, 10230	papers	9891, 9994, 9587, 10540, 9627				

JAN KNIPPERS

Prof. Dr. Ing.
10:25 am



© Julien Lenoir
Elytra Filament Pavilion, Weil am Rhein



© Riccardo La Magna
Thematic Pavilion EXPO 2012, South Korea

Biological Design and Integrative Structure

Jan Knippers specialises in lightweight structures for roofs and façades, as well as the use of innovative materials such as glass-fibre reinforced polymers. He is also partner and co-founder of Knippers Helbig Advanced Engineering with offices in Stuttgart, New York City (since 2009) and Berlin (since 2014). The focus of their work is on efficient structural design for international and architecturally demanding projects. Since 2000 Jan Knippers is head of the Institute for Building Structures and Structural Design (itke) at the faculty for architecture and urban design at the University of Stuttgart and in-volved in many research projects on fiber based materials and biomimetics in architecture. As such he is speaker of the Collaborative Research Centre 'Biological Design and Integrative Structures' funded by the German Research Foundation (DFG) and author of numerous publications such as the 'Construction Manual for Polymers and Membranes'. Jan Knippers completed his studies of civil engineering at the Technical University of Berlin in 1992 with the award of a PhD.

ROMAIN MESNIL

Hangai Prize Awardee
11:30 am



Several optima in the Marionette Design space

Non-standard patterns for gridshell structures: fabrication and structural optimisation

This paper investigates the potential of non-standard patterns for the design of glazed gridshells. We propose an innovative method to generate non-standard patterns with planar facets and perform multi-objective optimisation of gridshells with fabrication constraints.

Why buildings should start to float, or towards the flying architecture

Saraceno studied architecture in Buenos Aires and received post-graduate degrees in Art and Architecture from Escuela Superior de Bellas Artes de la Nación (2000) and Staatliche Hochschule für Bildende Künste in Frankfurt am Main (2003). Participating in the International Space Studies Program at NASA Center Ames in 2009, he was awarded the prestigious Calder Prize. Being well informed by the worlds of art, architecture, natural sciences, astrophysics and engineering, his floating sculptures and interactive installations propose new, sustainable ways of inhabiting the environment. He invites viewers to conceptualize innovative ways of living and interacting with one another, and with their surroundings at large. Throughout the past decade, he has explored the possibility of a future airborne existence as part of his ongoing Aerocene/Cloud Cities project. In 2015, Saraceno achieved the world record for the first and longest certified fully-solar manned flight. He was the first person to scan, reconstruct and reimagine spiders' weaved spatial habitats, and possesses the only three-dimensional spider web collection to existence.

TOMÁS SARACENO

11:45 am



© Studio Tomás Saraceno
In Orbit, 2013



© Studio Tomás Saraceno
On the Roof: Cloud City, 2012

SESSION # 01

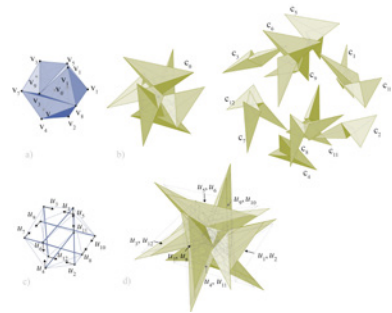
GRAPHIC STATICS I

chaired by Philippe Block & Corentin Fivet

monday, september 25th

02:30 pm until 04:30 pm

Hörsaal 200 | lecture hall 200

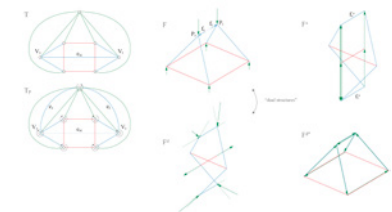


9986

3D Graphic statics and graphic kinematics for trusses

Marina Konstantatou, Allan McRobie

We apply a twofold graphic statics and kinematics analysis to derive the mechanisms and states of self-stress for 3D trusses, tensegrities, and flexible polyhedra, extending the definition to study graphically the redistribution of internal forces in statically balanced tensegrity mechanisms.

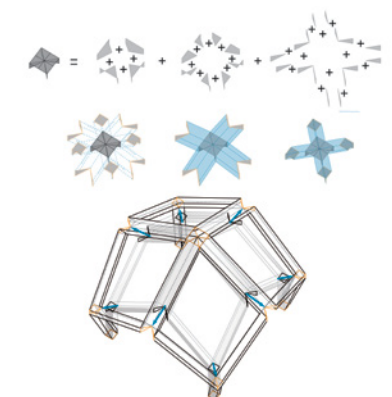


9730

Vector-Based 3D Graphic Statics: Transformations of Force Diagrams

Pierluigi D'Acunto, Jean-Philippe Jasienski, Ole Ohlbrock, Corentin Fivet

The paper describes a series of transformations that can be applied to a vector-based 3D force diagram while allowing the form diagram to be adjusted accordingly. As such, the modification of magnitudes and directions of forces can be used as an active operation in the structural design process.



10042

Graphic statics applied on grid shell roofs

Georgios-Spyridon Athanasopoulos, Allan McRobie

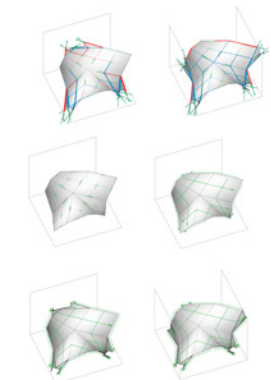
This paper describes a novel method for constructing reciprocal diagrams for gridshell roofs. The procedure involves separating the original form diagram into its constituent polygons. Those are then translated, with the gaps between polygons naturally creating the reciprocal diagrams.

10231

The global equilibrium of hypar-combined shell based on the method of graphic statics

Ting Cao

This PhD research attempts to develop a form-making method based on hypars, which could involve structural thinking from the beginning of design process. This paper only focuses on one type of possible hypar-combined results – shells with continuously varying double curvatures.

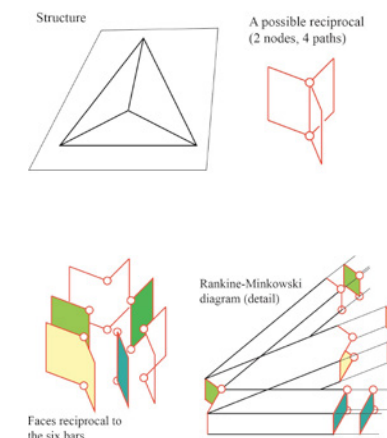


10242

Graphic analysis of 3D frames: Clifford algebra and Rankine Incompleteness

Allan McRobie

This paper presents new perspectives on the Clifford algebra description of generalized Rankine reciprocals for 3D frames, capable of representing all six components of the stress resultant (axial and two shear forces, and torsion and two bending moments) at any point.

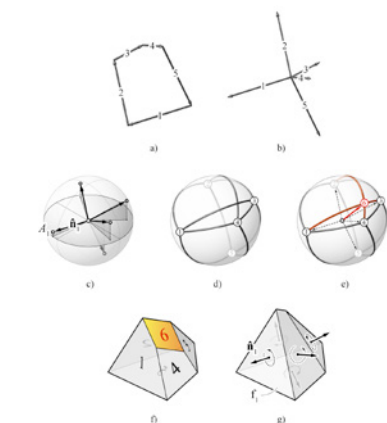


9208

Area-controlled construction of global force polyhedra

Juney Lee, Tom Van Mele, Philippe Block

This paper presents a method for constructing global force polyhedra with target face areas, which extends polyhedral reciprocal diagrams as a viable tool during early stages of design not just for form-finding explorations, but also for addressing more quantitative boundary condition criteria.



SESSION # 02

MEMORIAL SESSION FOR WILFRIED B. KRÄTZIG

chaired by Reinhard Harte & Claudio Borri

monday, september 25th

02:30 pm until 04:30 pm

seminar room 2.103

10248

Large concrete shells for power generation*Reinhard Harte*

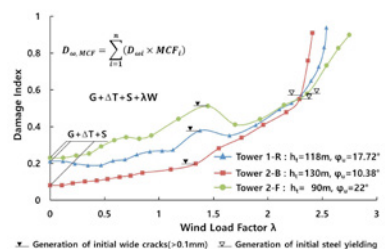
The paper deals with design and construction of Natural Draft Cooling Towers and Solar Updraft Towers, the largest RC shell structures in technology. It is dedicated to Wilfried B. Krätzig, the principal investigator of the German safety concept for cooling towers, who passed away on March 7, 2017.

9930

Examining the resilience of chimneys and cooling towers*Phillip Gould*

The response of a cooling tower structure to an unanticipated extreme loading event is reviewed with the objective of validating design characteristics that may improve resilience of this type of structure, as well as tall chimneys, to extreme loading conditions.

10359

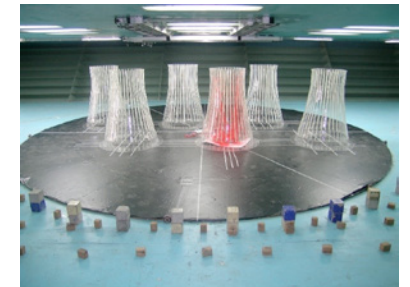
On a form-finding concept of the natural draught cooling tower shell*Sang-Yun Lee, Sam-Young Noh*

The paper evaluates the influences of the geometric parameters of the hyperbolic cooling tower shells on structural behavior. As a result, the cooling tower can be reasonably designed with consideration of the maximum angle of the base lintel and minimum height of the throat.

9450

Structural optimization of large cooling towers considering various distribution patterns of wind loadings*Lin Zhao*

Wind-induced interference is the key control factor in structural design of cooling tower group. The response surface methodology and the gradient search methodology are combined and introduced in the structural optimization to explore the structural optimization rules to different load modes.



10364

Wind Loads for designing Hybrid Cooling Towers*Joachim Meyer, Hans-Jürgen Niemann, Sebastian Höhler, Dr.-Ing. Dieter Lehnen, Norbert Hölscher, Wolfgang Hubert*

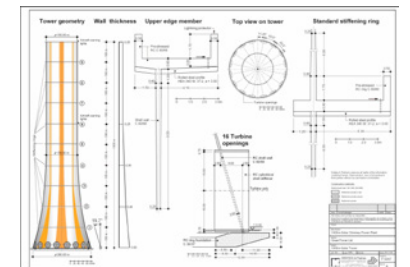
The equivalent static wind load of natural draft cooling towers has been re-inspected regarding applicability to hybrid cooling towers. Modifications are proposed to the pressure distributions as well as to the gust wind pressure, based on the worst gust response.



10527

Solar Updraft Power Plants: beyond structural challenges, towards multi-physical simulations*Francesca Lupi*

The paper addresses the structural challenges of ultra-high towers in Solar Updraft Power Plants. Beside them, the breakthrough is in the concept of the entire plant simulation, modelled as an interaction of multi-physical processes that result in a highly non-linear system of equations.



SESSION # 03

ORIGAMI | WG 15

chaired by Tomohiro Tachi & Martin Trautz

monday, september 25th

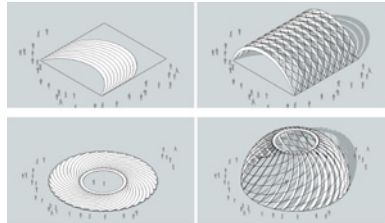
02:30 pm until 04:30 pm

seminar room 2.104

9546

Pop-up origami with thin concrete plates: tilt-up skeleton for vaults and domes

Yoshinobu Miyamoto, Takaaki Itho



We propose a structural system using cable stayed thin UHPC plates with origami pop-up geometry in tilt-up construction. The geometry of skeletons was examined for efficient form layouts. The structural analysis showed that the 19m span vault and the 30m span domes are feasible.

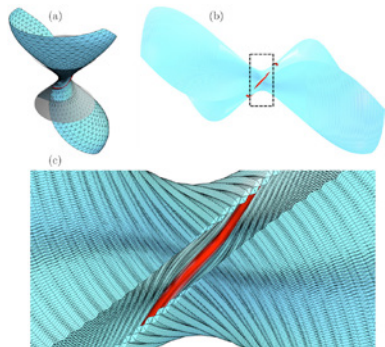
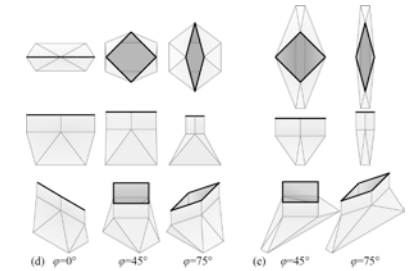
9607

Capping Rigid Origami Tubes

Tomohiro Tachi

We show a parametric design of close-to-rigid-foldable cap that can be attached to rigid foldable tubes.

The proposed structure can act as a component to build bellows or hydraulic actuators, as well as the method for creating a compliant covering of scissors mechanisms.



9567

Macroscopic deformation modes of origami tessellations and periodic pin-jointed trusses: the case of the eggbox

Hussein Nassar, Arthur Lebé, Laurent Monasse

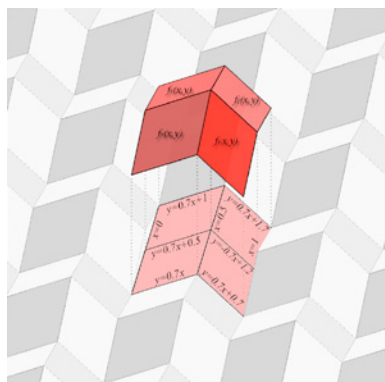
This paper characterizes the parametrization, curvature and metric of smooth surfaces that the eggbox pattern can fit asymptotically. We prove that no finite region of a sphere can be fitted and present a systematic method that allows to fit ruled surfaces.

9696

Interwoven folded stripes

Rupert Maleczek, Gabriel Stern

This work presents the investigation on linear folded interwoven stripes that represent a multilayer variation of linear folded stripes, in order to build spatial configurations. The multilayer arrangement enables new configurations and extends the existing possibilities of this system.



SESSION # 04

**COMPUTATIONAL CONCEPTUAL (STRUCTURAL)
DESIGN | WG 13 & 15**

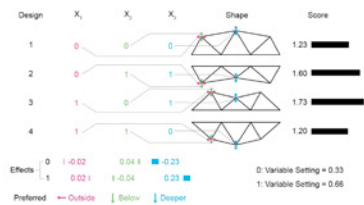
chaired by Peter von Bülow & Paul Nicholas

monday, september 25th

02:30 pm until 04:30 pm

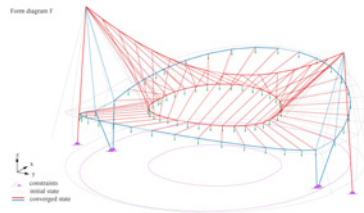
seminar room 2.107

9552

Automated performance-based design space simplification for parametric structural design*Nathan Brown, Caitlin Mueller*

This paper proposes two new applications of traditional optimization methods that can help simplify early-stage architectural or structural parametric design. The first involves analyzing the design variables considered in the problem, and the second clusters designs into families for exploration.

9613

Constraint-driven Design with Combinatorial Equilibrium Modelling*Ole Ohlbrock, Pierluigi D'Acunto, Jean-Philippe Jasienski, Corentin Fivet*

This paper presents an extension to the Combinatorial Equilibrium Modelling (CEM) design framework. In order to solve more specific design problems within the CEM framework, constraints-driven adaptation procedures have been developed. This paper describes interactive and automatic adaptation methods.

10152

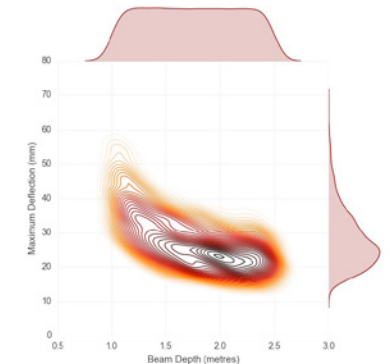
Choosing parents to produce better performing children: a comparison of selection methods used for evolutionary search*Peter von Bülow*

ParaGen, is an exploration method which uses evolutionary methods to select breeding parents in searching a multivariable design space. This paper discusses selection methods used by the NDDP GA in ParaGen: SQL queries and Pareto sets. Each method is described, and the results are compared.

9848

A Knowledge-oriented Approach to Performance-driven design Using Probabilistic Graphical Models*Zack Xuereb Conti, Sawako Kaijima*

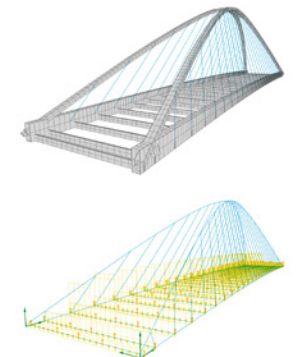
In this paper we propose an approach for designers to utilize engineering simulation with control in the conceptual stages of architectural design. We propose a statistical approach to learn about the cause and effect relationships between inputs and outputs of a design system.



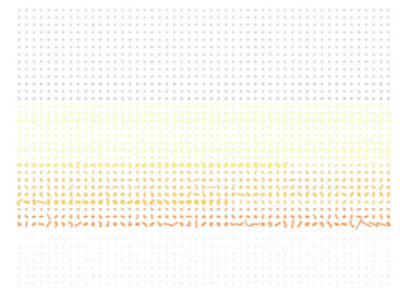
9718

Data visualisation for gaining insight in the behaviour of bow-string bridges under various load cases.*Lennert Loos, Daniel Al Sayegh, Kenny Verbeeck, Lars De Laet*

This paper discusses the use of data visualizations in the conceptual design phase. Structural engineers are increasingly focusing on data-based design and informed decision-making. This is especially useful during the first stages of the design where an exploration of the design space takes place.



10199

Automated building stock data mining and classification using open source data*Alexandros Christodoulou, Anastasios Kokkos, Michele Palmieri*

SESSION # 05

ADVANCED MANUFACTURING I | WG 21

chaired by Arno Pronk & Patrick Teuffel

monday, september 25th

02:30 pm until 04:30 pm

seminar room 2.108



10066

Curved-folding of thin aluminium plates: towards structural multi-panel shells

Philipp Eversmann, Paul Ehret, André Ihde

This study employs computational design and digital fabrication technology in order to structurally connect single and double-layer curved-folded aluminium panels without the need for additional mechanical fasteners. We analyse structural capabilities with custom meshing and FE-Modelling.



10371

Design and Engineering of form-fit steel connections for complex gridshell structures

Julian Lienhard, Arnold Walz

This paper discusses the potentials of form-fit connections in steel structures to generate 'digital details' which are easily adapted to different boundary conditions and organize their manufacturing and assembly.



9759

Prefab, Concrete Polyhedral Frame: materializing 3D graphic statics

Masoud Akbarzadeh, Mehrad Mahnia, Ramtin Taherian, Amir Hossein Tabrizi

This research describes the form finding and structural analysis of a prefabricated, concrete polyhedral structure as the first built prototype designed using the methods of 3D graphical statics based on reciprocal polyhedral diagrams.

10235

A production process for batches of individual, free-formed sheet metal parts

Thorsten Pofahl, Giovanni Della Puppa, Martin Trautz, David Bailly, Roman Schmitz, Gerhard Hirt

Automotive-, ship- and aircraft technologies have been exerting fascination on architects for a long time, not only because of their extraordinary aesthetics but also for their lightweight structural design. These technologies base strongly on customized, complex formed sheet metal parts.

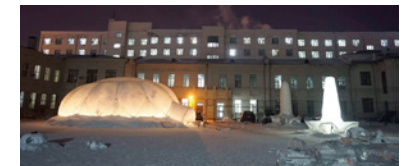


10005

Form-finding and construction of ice composite shell structures

Yue Wu, Xiuming Liu, Qingpeng Li, Boxuan Chen, Peng Luo, Arno Pronk

By using inflatable moulds and then spaying cellulose-water mixture, one ice dome and two ice towers were built in Harbin in December 2016. Form-finding of the inflatable moulds as well as the construction of these ice composite shell structures are discussed in this paper.



10140

Z-Snap Pavilion – advanced fabrication and assembly of self-locking, bending active modules into a semi-double-layer, shell-like structure

Günther H. Filz, Ines Kumrić

This paper describes the research, development and realization of the Z-Snap Pavilion, based on coupled curved and straight-line z-folding of sheet material, which activates a bending active behavior and consequently releases a snap action and self-locking mechanism.



SESSION # 06

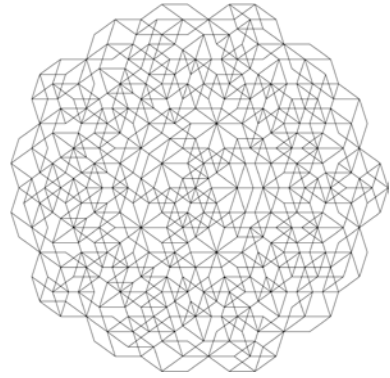
GRIDSHELLS I

chaired by Samar Malek & Christopher Williams

monday, september 25th

02:30 pm until 04:30 pm

seminar room 3.107



9247

Nonlinear Behavior Characteristics of Polyhedron Curved to Large Space Roof Using Quasicrystal System

KyoungSu Lee, Seung-Deog Kim, JeongHyun Lee, HyeWon Jung, Tony Robbin

This paper described form of design grid dome, and showed the analysis conditions. Also, The displacement-load curve is shown through the analysis and we grasped the flow of the load and forces through analysis of design grid dome applied quasicrystal system.

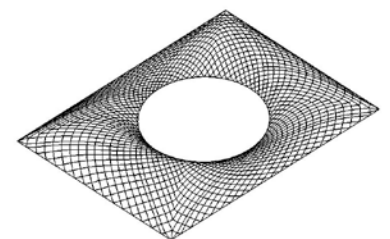


9657

Optimization of Spherical Cap Gridshells using Finite Element Analysis

Samar Malek, Samuel Ciocco

This paper optimizes the design of spherical cap gridshell under uniform from the American Society of Civil Engineers building code. This research gives insight into the effect of the grid density and quantifies the tradeoffs associated with increasing grid density like weight and number of joints.



9939

A grid generation procedure for the design of single-layer free-form structures

Jun Ye, Boqing Gao, Paul Shepherd, Jurgen Becque, Iman Hajira-souliha

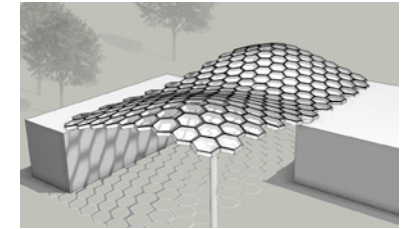
This paper presents an efficient design tool for the synthesis of free-form grid structures based on the concept of a "guide line". The process starts with defining a limited number of "guide lines" on the surface, which are then used to determine the directions of the 'rods' of the grid.

10195

Parametric design of hexagonal frame structures with planar faces

Hendrik Behrens, Annette Bögle, Kai Schramme

The paper explains how to generate a net of planar, convex and regular hexagons on a free formed surface. This can be implemented by computing a new constructive solution. Related work is compared to it in the aspect of efficiency and feasibility.

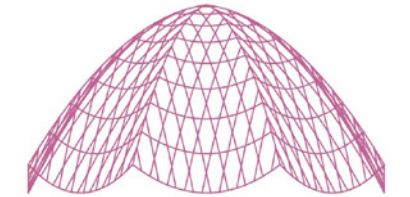


10321

Mallow Domes

Omidali Samavati

The term 'mallow dome' is used to refer to a family of domes because their general shape resembles a 'mallow flower'. There are two main subfamilies of mallow domes. Namely, 'up-curved' mallow domes and 'down-curved' mallow domes.

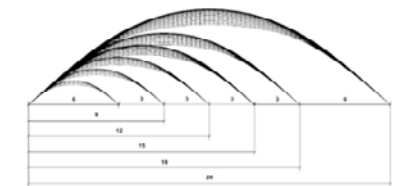


10112

Design and Structural Analysis for a Deployable Gridshell Shelter

Samar Malek, Michael Vassallo

This paper provides the design and structural analysis of a variety of cross-grid shaped gridshell structures for use as deployable shelters in humanitarian assistance and disaster relief (HA/DR).



SESSION # 07

**21st CENTURY TENSION AND MEMBRANE
STRUCUTRES | WG 6**

chaired by Sudarshan Krishnan & Martin Synold

monday, september 25th

02:30 pm until 04:30 pm

seminar room 3.108

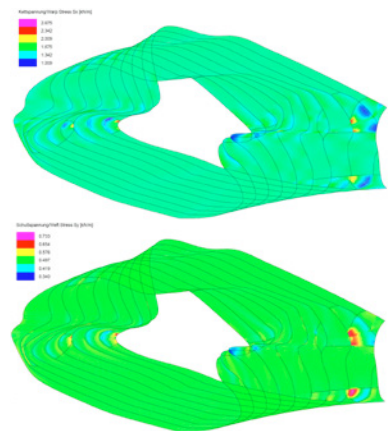


9586

Cable-roof extension for New San Mames Football Stadium. Design.

Javier Llarena, Armando Bilbao, Lourdes Cabezuelo, Asís Gutiérrez, María Besada

This paper describes the design process of the cable-roof extension for the new San Mames football stadium. The roof extension, based on a radial convex cable beam structure with two inner tension rings and an outer compression ring, increases the roof spans by 13 to 23 m (up to a total of 60-75 m).



9624

New Rome Convention Centre, "Nuvola" – Membrane Cladding

Bernd Stimpfle, Christian Würfl

The paper is about this central element, the „Nuvola“ from the geometry driven design process to the installation. It describes the design process, especially the very complex geometric development process in order to achieve the defined geometry derived from a nurbs shape.



9588

The large membrane roof structure of Tokyo station "GranRoof"

Keisuke Yoshie, Toshihiko Kohno, Miwa Sadamoto

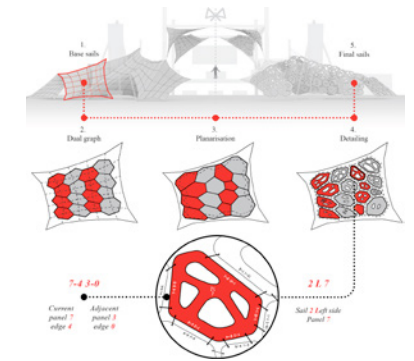
This paper describes the structure of GranRoof which is the new landmark of Tokyo Station's Yaesu Gate area completed in 2014. The vast roof inspired by the concept of "sail of light" gently shelters people as they come and go, forming the public space of this city hub.

9862

Innovation in festival architecture from design to construction

Alessandro Liuti, Ravi Bessabava

In the context of festival architecture, the design and construction of a 45 x 12.5 x 7.5 m installation (for Rainbow Serpent Festival 2017) are illustrated. Innovation is addressed as an emergent interface among computational design tools, manufacturing strategies and intuition of structural behaviour.

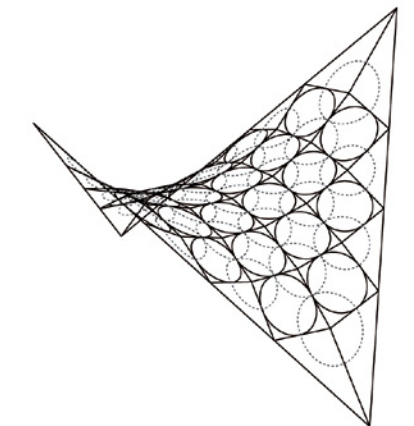


9560

Form-Finding Analysis for Membrane Structures Based on Discrete Differential Geometry : Varification of Unit Stress Distribution

Yohei Yokosuka, Toshio Honma

This paper presents a numerical computation procedure to solve the minimal surface problem by using mean curvature based on discrete differential geometry, and discusses the exactness of uniform stress distribution on discrete surfaces.

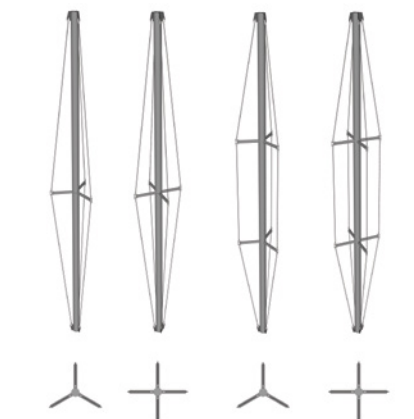


10230

Prestressed Stayed-Columns: Stability Behaviour and Recent Applications

Sudarshan Krishnan

This paper discusses the structural stability of prestressed stayed-columns using recent applications in contemporary architecture. The paper describes the principal parameters that influence the design of stayed-columns and how they fail.



SESSION # 08

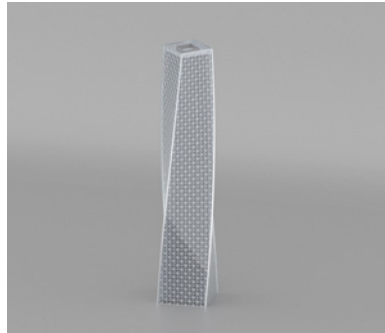
GRAPHIC STATICS II

chaired by Philippe Block & Corentin Fivet

monday, september 25th

05:00 pm until 06:30 pm

Hörsaal 200 | lecture hall 200

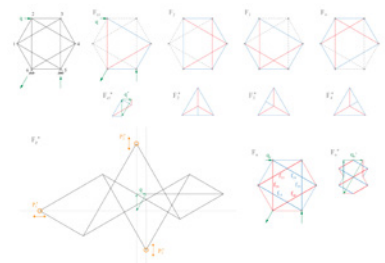


10170

The Application of 2D and 3D Graphic Statics in Design

Christian Hartz, Arek Mazurek, Tomas Zegard, Toby Mitchell, Masaaki Miki, William F. Baker

This paper focuses on the use of Graphic Statics in both the two and three-dimensional layout of load-path-optimized structures, and in the purely geometric panelization of architectural surfaces.



10087

Limit state analysis of 2D statically indeterminate networks using graphic statics

Jean-François Rondeaux, Pierluigi D'Acunto, Denis Zastavni, Joseph Schwartz

The proposed graphical methodology uses an optimization process that operates on the geometric transformation of the force diagram for the structural limit state analysis (collapse mechanism and collapse load factor) of 2D statically indeterminate networks with given geometry and loading condition.



9816

Addressing buckling of compression members using subdivision of force diagrams

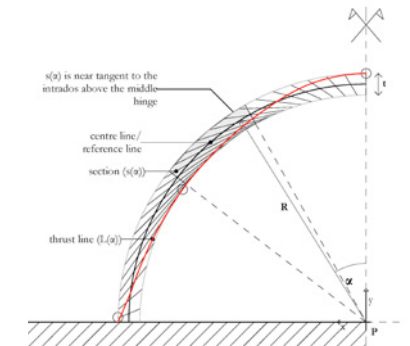
Timo Harboe Nielsen, Masoud Akbarzadeh, Per Goltermann

10007

Lower bound of the minimum thickness values for circular masonry arches based on thrust line analysis considering various stereotomies

Orsolya Gaspar, Istvan Sajtos

The effect of stereotomy on the minimum thickness value of the arch can not be fully exploited unless the stereotomy is treated as a function (not a single value parameter). Numerical optimization searches for the stereotomy resulting in the lower bound of minimum thickness.

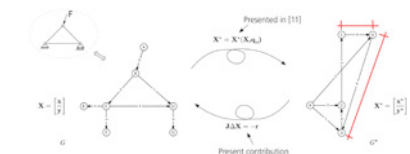


10236

Bi-directional Algebraic Graphic Statics - On Force Diagram Constraints

Vedad Alic, Daniel Åkesson, Kent Persson

The paper presents a study exploring the capabilities of a new method that extends the algebraic graphic statics method by making it bi-directional i.e. allowing for determination of an updated form diagram by making direct interactive manipulations of the force diagram.



SESSION # 09

COOLING AND SOLAR UPDRAFT TOWERS | WG 3 chaired by Reinhard Harte & Claudio Borri

monday, september 25th

05:00 pm until 06:30 pm
seminar room 2.103

MONDAY
05:00 - 06:30 pm

SESSION #09
seminar room 2.103

10335

Design and Construction of a Prototype Solar Updraft Chimney in Aswan/Egypt and Additional Wind Tunnel Tests

Markus Tschersich, Reinhard Harte

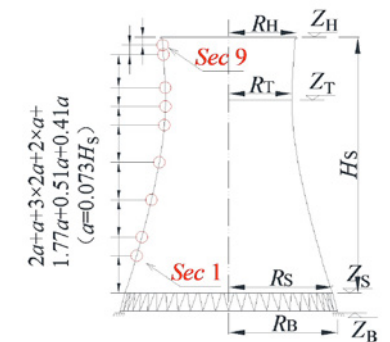
This work is part of a joint project funded by the STDF of Egypt and the BMBF. A Solar Chimney Power Plant is being installed at Aswan City. Wind tunnel tests will be performed to gain some knowledge about the influence of installations inside the transition section to improve the performance.

9265

Wind induced dynamic effects on hyperboloidal cooling tower shells and the Equivalent Static Wind Loads

Jun-Feng Zhang

Characteristics of Wind induced dynamic responses, structure behaviors and structural design principles of HCT are illustrated. Then, the tower shell is degenerated from 2-D structure to 1-D structures along meridian and A new approach for ESWL is proposed targeting at the reinforcement amount.

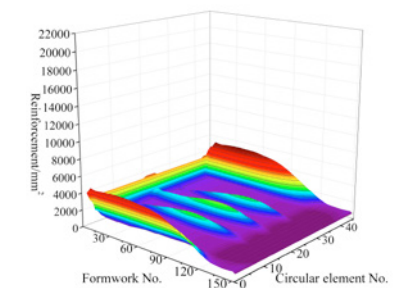


9480

Universal equivalent static wind loads of large cooling towers considering reinforcement envelopes

Yanyan Zhan, Lin Zhao

The paper proposes a equivalent wind distribution considering weighted internal force combinations. Highlights lie in the use of dynamic wind pressure and reinforcement calculation based on time-changing internal force combinations.



SESSION # 10

MEMORIAL SESSION FOR KLAUS LINKWITZ

chaired by Ekkehard Ramm & Kai-Uwe Bletzinger

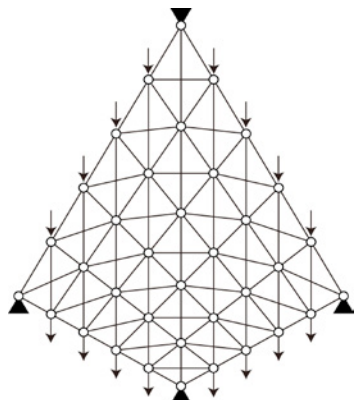
monday, september 25th

05:00 pm until 06:30 pm

seminar room 2.104

Klaus Linkwitz and the invention of the Force Density Method

Kai-Uwe Bletzinger



9493 Force density method for simultaneous optimization of geometry and topology of spatial trusses

Kazuki Hayashi, Makoto Ohsaki, Caitlin Mueller

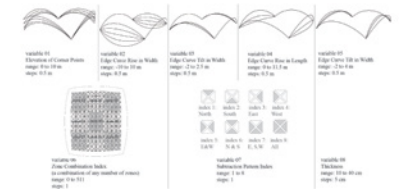
Force density method is applied to simultaneous optimization of geometry and topology of truss structures. The difficulties due to melting nodes are successfully avoided. Various optimal shapes can be obtained from a sparse initial ground structure with small computational cost.

9968

Continuous to discrete: computational performative design and search of shell structures

Niloufar Emami, Harry Giles, Peter von Bülow

This research assesses structural and daylighting performance of perforated shell structures. By employing computational design tools and performance assessment methodologies, an array of generated topologies of perforated shell structures spanning the two extremes is studied.

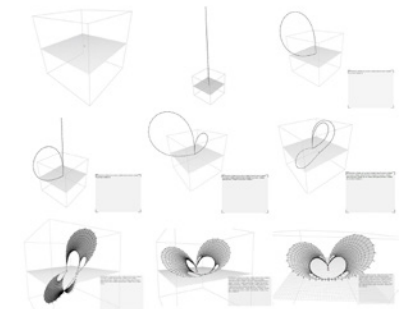


9256

A comparative overview of generative approaches for computational form-finding of bending-active tensile hybrid structures

Seiichi Suzuki, Evy Slabbinck, Jan Knippers

Bending-active tensile hybrid structures demands new ideas about physic-based simulations for increasing the flexibility of design spaces. This paper seeks to contribute to this study by identifying and comparing two main approaches for form-finding defined as geometric-driven and topology-driven.



SESSION # 11

**COMPUTATIONAL CONCEPTUAL (STRUCTURAL)
DESIGN | WG 13 & 15**

chaired by Carlos Lázaro & Jeroen Coenders

monday, september 25th

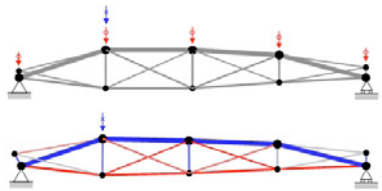
05:00 pm until 06:30 pm

seminar room 2.107

10126

Large and reversible shape changes as a strategy for structural adaptation

Arka Prabhata Reksowardojo, Gennaro Senatore, Ian Smith

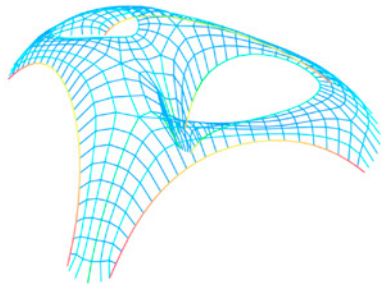


The study explores the effects of large shape change achieved via actuation to minimize the effect of external loads. Results show that with large shape changes considered, material mass reduction is achieved with respect to optimised active and passive structures.

9637

Patterns for Masonry Vault Design

Robin Oval, Matthias Rippmann, Tom Van Mele, Olivier Baverel, Philippe Block



This paper presents a methodology to generate structural patterns for masonry vault design. First, a quad-dominant block decomposition is proposed, that can be meshed and smoothed, before form finding and further optimisation. Second, rules for conversion into a tessellation are proposed.

10179

Minimizing the interface between design, engineering and fabrication for the delivery of a specialty structure

Steve Lewis



In today's age the desire to deliver projects on shorter schedules with greater complexity and smaller budgets requires computational approaches using digital workflow to streamline the interface between design, engineering and fabrication. This paper describes such a project.

10386

A case study on the influence of multi-scale modelling in design and structural analysis

Riccardo La Magna, Paul Nicholas, Mateusz Zwierzycki, Esben Norgaard, Scott Leinweber, Mette Ramsgaard Thomsen

Focusing on the influence that different models have on the analysed performance of the structure, the paper will discuss the advantages and trade-offs of coupling multiple levels of abstraction in terms of design and structure.

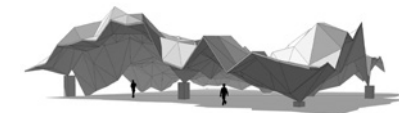


9568

Fractal dimension based computational morphogenesis: An application in designing a randomly folded spatial structure

Iasef Md Rian

This paper applies the concept of fractal dimension as a unique geometric variable for the computational morphogenesis process as a target for finding a new form for architectural structures. A benchmark application of the proposed process is the design of a randomly folded spatial structure.



SESSION # 12

ADVANCED MANUFACTURING II | WG 21

chaired by Andreas Trummer & Arnold Walz

monday, september 25th

05:00 pm until 06:30 pm

seminar room 2.108

9250

Reinforcement of additive manufactured concrete Elements

Asko Fromm, Markus Schein, Manfred Grohmann



This paper summarizes a research project about reinforcement of 3D-printed, powder-coated parts. The goal is to develop foundations for the implementation of an automated reinforcement process for 3D-printed cement materials in combination with according digital modelling techniques.

9642

Precast Elements for Building the Future

Andreas Trummer, Stefan Peters, Gernot Parmann



The submitted paper presents the final results of a 3-year research project "Shell Structures made of UHPC" that investigated the development of an adaptive robot driven fabrication process of thin, highly precise double curved concrete elements connected by a reversible dry-joint technology.

9978

Digital Prefabrication of freeform concrete elements using shotcrete technology

Hendrik Lindemann, Asko Fromm, Joscha Ott, Harald Kloft



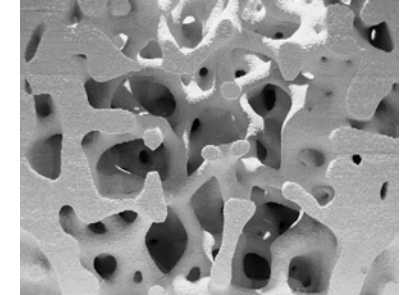
This paper is going to present an overview of the state of the art of 3D printing with concrete, the recent progress of the ongoing research project 'generative manufacturing of concrete', the integration in the just completed DBFL, the benefits of shotcrete 3D printing.

10133

Multifunctional Concrete - Additive Manufacturing by the Use of Lightweight Concrete

Klaudius Henke, Daniel Talke, Stefan Winter

Combining additive manufacturing with lightweight concrete enables the construction of freely formed, fair faced, monolithic building elements that can be optimised regarding building physics and structure.



10281

Design and prototyping of a novel tridimensional panel using coated textiles

Salvatore Viscuso, Alessandra Zanelli



SESSION # 13

GRIDSHELLS II

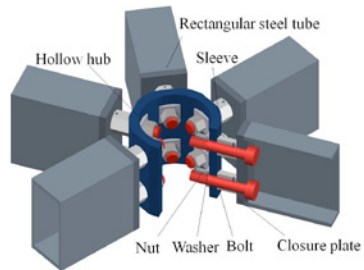
chaired by Christopher Williams & Samar Malek

monday, september 25th

05:00 pm until 06:30 pm

seminar room 3.107

9245

Study on the Assembled Hub joints in single-layer reticulated domes*Qinghua Han, Yiming Liu, Ying Xu*

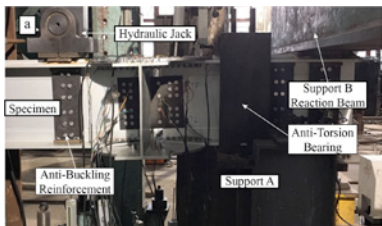
A novel Assembled Hub (AH) joint with two connection types was introduced. A K6 single-layer reticulated dome model with AH joints was established and analysed. The results shows that the AH joints are typical semi-rigid joints and acceptable for engineering application.

9664

Performance Development of Gridshell Connections*Christian Stutzki, John Knowles*

Connections of grid shells, or reticulated metal structures subject to seismic events or blast loads should be designed keeping low-cycle fatigue in mind. The performance of bolted connections can be enhanced with considerations of stable ductility that endures cycling deep into the plastic range.

9726

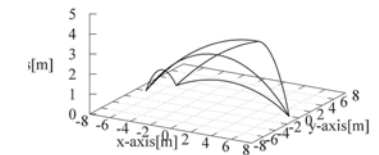
Experimental study on semi-rigid behavior of two-way aluminum alloy gusset joints*Minger Wu, Mingzhe Shi, Ping Xiang*

Two-way aluminum alloy gusset joints (AAGJs) are designed to be used in reticulated shell structures with quadrilateral grids. Both experimental investigations and corresponding FE simulations on AAGJs were carried out to determine their semi-rigid behavior.

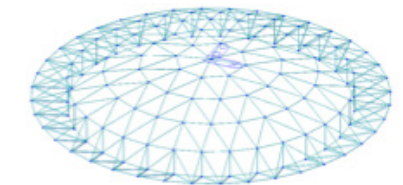
9557

Discrete elastica model for shape design of grid shells*Yusuke Sakai, Makoto Ohsaki*

A grid shell is designed by bending beams connected by hinge joints. This paper presents an approach to designing grid shell structures made of steel or wood, considering them as an assembly of discretized piecewise linear curves, which are called 'discrete elastica'.



9504

Study on Economic Influencing Factors of Long Span Spatial Structure Type Selection*Zaigen Mu, Yuqing Yang, Peng Ge*

SESSION # 14

**21ST CENTURY TENSION AND MEMBRANE
STRUCTURES | WG 6**

chaired by Ronald Schaeffer & Seung-Deog Kim

monday, september 25th

05:00 pm until 06:30 pm

seminar room 3.108

9891

Stress monitoring of steel tension rods of a retractable roof stadium

Xiaokai Xie, Yaozhi Luo



A self-developed health monitoring (SHM) system is established for a retractable roof stadium aiming at measuring stress of steel tension rods. Stress variation during three special stages, including pretension process, unloading process and moving process, will be mainly focused on .

9994

Convertible Architecture with Lightweight Technology

Igor G Siotor



The evolution of the engineering design tools, better understanding of existing materials, development of new materials and new mechanical systems, and the necessary interface within the team of experts committed to the creation of unique solutions made possible for large retractable roofs.

9587

Cable-roof extension for New San Mames Football Stadium. Erection.

Javier Llarena, Armando Bilbao, Lourdes Cabezuelo, Asís Gutiérrez, Rafael Urrutia



This paper describes the main phases of the construction process and focuses on the staged construction simulation carried out by Idom to check the structure stability during the whole erection of the cable-roof extension designed for the new San Mames football stadium.

10540

Cable Erection of Miami Stadium Suspended Roof

David Ward, Mosè Castiglione, Matteo Marchesi, Paolo Ferrante



9627

The Hoisting of Ring Structures

Mathias Kutterer

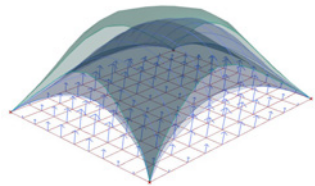
The modern Cable-Ring Roof is being used for stadia since almost 30 years – very successfully thanks to its efficiency and unmatched lightness. Its closed form and the characteristics of high-strength cables led to a special erection method: the so-called Biglift. It comprises the hydraulic lifting of the entire system, which is fast, safe and economic.



9 am - 11 am			11.30 am - 1 pm			2.30 pm - 4.30 pm			5 pm - 6.30 pm		
Hörsaal 200	session	Optimization & Computational Design I	coffee break	Plenary Session	Lunch	session	Optimization & Computational Design II	session	Optimization & Computational Design III	Hörsaal 200	
	chair	Jan Knippers				chair	Ornella Iuorio	chair	Sigrid Adriaessens, Lars De Laet		
	papers	10096, 10292, 9813, 9728, 9533, 10127				papers	9199, 9517, 9724, 9843, 10056, 10240	papers	9190, 9525, 9811, 9841		
2.103	session	Structural Design	coffee break	chaired by Knut Stockhusen & Irmgard Lochner-Aldinger		session	Concepts & Buildings: Collaborative Structural Design	session	Structure as Architecture	2.103	
	chair	Irmgard Lochner-Aldinger, Alberto Domingo				chair	Joseph Schwartz, Mario Rinke	chair	Toni Kotnik, Günther H. Filz		
	papers	9212, 9179, 10238, 10210, 10362, 9932				papers	9688, 10249, 10080, 9604, 10043, 9211	papers	9219, 10307, 9397, 9248, 9510		
2.104	session	Severe Conditions & Disasters WG 5	coffee break	Keynote by Heike Klusmann		session	Learning by Making WG 15 and 20	session	Educational Methods for dealing with complex environments WG 20	2.104	
	chair	Sigrid Adriaenssens, Ruy Marcelo Pauletti				chair	Olga Larsen, S. Alireza Behnejad, Niels De Temmerman	chair	S. Alireza Behnejad, Olga Larsen		
	papers	9198, 9692, 9558, 9825, 9870, 10099				papers	9761, 9916, 10048, 10093, 10150, 10252	papers	9795, 10219, 9668, 9853, 10816		
2.107	session	Computational Design	coffee break	Keynote by Guy Nordenson		session	Deployable Structures I	session	Deployable Structures II	2.107	
	chair	Juan Gerardo Oliva-Salinas, John Abel				chair	Knut Stockhusen	chair	Knut Stockhusen, Niels De Temmerman		
	papers	9184, 9872, 9874, 10180, 9954, 10519				papers	9622, 9670, 10149, 10207, 10182	papers	9793, 9812, 10114, 10192, 9958		
2.108	session	Design and Fabrication of Light and Spatial Constructions	coffee break	Holcim Auditorium		session	Multi-/Meta-Material Digital Fabrication I	session	Multi-/Meta-Material Digital Fabrication II	2.108	
	chair	Fabian Schmid, Stefan Peters				chair	Jeroen Coenders, Caitlin Mueller	chair	Fabian Scheurer, Sandra Manninger		
	papers	10222, 9292, 10339, 9638, 10031, 9223				papers	9494, 9495, 9810, 9858, 10276, 9796	papers	9727, 10125, 9520, 9231, 9496		
3.107	session	Analysis and Design of Reticulated Shells Against Sever External Disturbande WG 8	coffee break			session	Analysis and Design of Reticulated Shells Against Sever External Disturbance WG 8	session	Timber Gridshells	3.107	
	chair	Shiro Kato, Suduo Xue, Toru Takeuchi				chair	Toru Takeuchi, Suduo Xue, Shiro Kato	chair	N N.		
	papers	9621, 9729, 9594, 9531, 10074, 9364				papers	9890, 10054, 10113, 9225, 9205, 9988	papers	9725, 9861, 10008, 10264, 10378		
3.108	session	Concrete light: innovative concrete constructions II	coffee break			session	Concrete light: innovative concrete constructions I	session	Concrete light: innovatice concrete const-ructions III	3.108	
	chair	Harald Kloft, Tine Tysmans				chair	Silke Scheerer, Achim Bleicher	chair	Silke Scheerer, Philipp Eisenbach		
	papers	9194, 9529, 9434, 9883, 9959, 10204				papers	9251, 9253, 9600, 9601, 9868	papers	9575, 9249, 9660, 9659		

TIM MICHIELS

Hangai Prize Awardee
11.30 am, Holcim Auditorium



antifunicular net

Parametric study of masonry shells form-found for seismic loading

A form finding approach is presented that allows for the shape generation of masonry shells in seismic areas. Through a parametric study, this method is illustrated for a wide variety of boundary conditions and leads to a set of shapes for double layer thin shells.

HEIKE KLUSSMANN

Prof.
11.40 am, Holcim Auditorium



DysCrete_Solarbeton

BUILDING ART INVENTION

Research and Development of Innovative Materials at the Convergence of Art, Architecture and New Technologies

Heike Klussmann is an artist and professor at the University of Kassel's School of Architecture, Urban Planning and Landscape Architecture. She has exhibited internationally, among others, at the Berlin State Museum National Gallery, THINK: Material in Toronto, the SCIN Gallery in London, deTour in Hong Kong, and KW Institute for Contemporary Art in Berlin. Heike Klussmann has taught and conducted research at numerous institutions including the ArtCenter College of Design, Pasadena (USA) and at Monash University, Melbourne (Australia). She founded the transdisciplinary research platform BAU KUNST ERFINDEN/BUILDING ART INVENTION at the University of Kassel together with Thorsten Klooster and the Spin-Off Kennwert KW GmbH. Bringing together expertise from the fields of visual art, architecture, urban planning, interaction design, industrial design, computer science, robotics, experimental physics, and construction chemistry, BAU KUNST ERFINDEN/BUILDING ART INVENTION and the Spin Off Kennwert KW GmbH is dedicated to the research and development of new materials at the convergence of art, architecture and new technologies.



Wehrhahnlinie

Engineering the Museum: Structure and Exhibition

Guy Nordenson is a structural engineer and professor at Princeton University. He practiced structural engineering in San Francisco and New York and in 1987 established Arup's New York office. In 1997 he began his independent practice. Nordenson was the structural engineer for the 2004 MoMA expansion in New York, the Jubilee Church in Rome, the Nelson-Atkins Museum of Art in Kansas City and over 200 other projects. Recent and current projects include the expansion of the Kimbell Art Museum in Fort Worth, the National Museum of African American History and Culture in Washington DC and the Menil Drawing Institute in Houston TX.

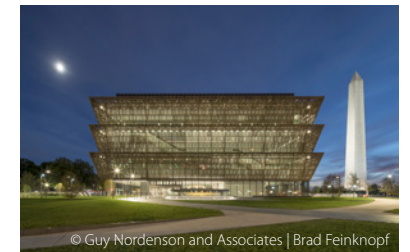
In 2009 Nordenson was the 7th structural engineer awarded the AIA's Institute Honors for Collaborative Achievement Award, and the first practicing structural engineer to be elected to the American Academy of Arts and Sciences. He was Commissioner and Secretary of the NYC Public Design Commission from 2006 to 2015 and is a member of the NYC Panel on Climate Change, both mayoral appointments.

In 2013 his research team at Princeton was awarded a major grant by the Rockefeller Foundation to develop "Structures of Coastal Resilience" in collaboration with the US Army Corps of Engineers. The results of this (www.structuresofcoastalresilience.org) were incorporated in the 2015 North Atlantic Comprehensive Study of the USACE.

In 2016 he published Reading Structures: 39 Projects and Built Works with Lars Müller Publishers, a companion to his 2010 collection of essays Patterns and Structure.

GUY NORDENSON

Prof.
12.20 pm, Holcim Auditorium



National Museum of African American History and Culture, Washington DC



Kimbell Art Museum Expansion

SESSION # 15

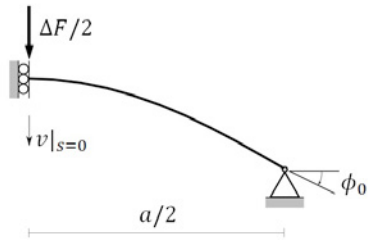
OPTIMIZATION & COMPUTATIONAL DESIGN I

chaired by Jan Knippers

tuesday, september 26th

08:00 am until 11:00 am

Hörsaal 200 | lecture hall 200

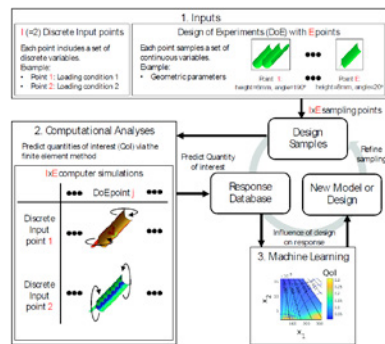


10096

Tangent stiffness in point-loaded elastica arches

Carlos Lázaro, Salvador Monleón, Juan Bessini

This paper analyses the stiffness of elastica-shaped active arches subject to a point load at the centre. The relation between stiffness and the angle at the ends has been quantified for different slenderness. Compressive axial forces in elastica arches produce a loss of stiffness lower than 10%.

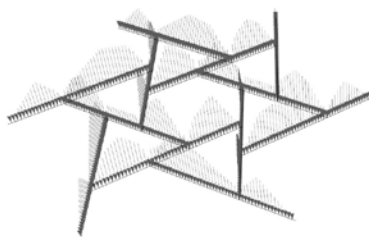


10292

Design of ultra-thin composite deployable shell structures through machine learning

Miguel Bessa, Sergio Pellegrino

A data-driven computational framework is applied for the design of optimal ultra-thin deployable structures with improved buckling behavior. High-fidelity computational analyses and machine learning are used to construct design charts that are shown to guide the structural design.



9813

Geometric Optimization of a Reciprocal Floor-Framing System with Self-Weight and Area-Loading Considerations

Gerry Ip, Corentin Fivet

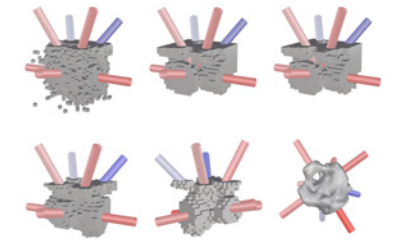
The geometric optimization of a triangulated planar reciprocal frame floor framing structure is explored. Results show that minimum strain energy geometries tend to reduce lever-arms to a minimum, regardless of symmetric or asymmetric floor loading.

9728

An alternative, geometric methodology for topology optimization, applied to nodes of free form space frame structures

Ioannis Mirtsopoulos, Andrew Borgart

Dilation and distortion energies determined by the geometric transformation of all of the elements of a discretized volumetric domain are exploited in a topology optimization methodology that aims to create optimized distribution of material throughout the domain of nodes of space frame structures

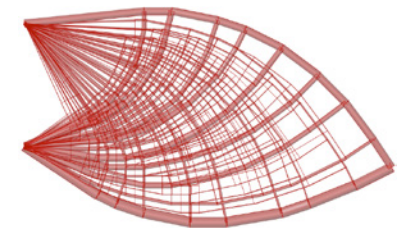


9533

Computational layout design optimization of frame structures

Jun Ye, Paul Shepherd, Linwei He, Matthew Gilbert, Buick Davison, Jacek Gondzio, Helen Fairclough

This paper introduces an interactive design approach in Rhino-Grasshopper that combines parametric modelling and layout optimization, using an adaptive 'member adding' technique to allow large scale problems to be solved on a standard desktop PC.



10127

Evolutionary algorithm for timber shelter design

Javier Petersen, Nayar Gutiérrez, Ximena Aranguren

The present paper describes an approach to wood as an alternative construction material and the formal search of typologies which combine a secure and efficient structure developed with a multi-objective optimization algorithm.

SESSION # 16

STRUCTURAL DESIGN

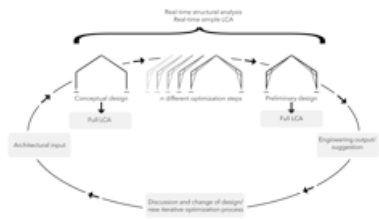
chaired by Irmgard Lochner-Aldinger & Alberto Domingo

tuesday, september 26th

08:00 am until 11:00 am

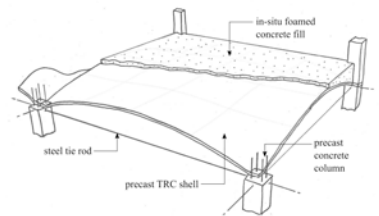
seminar room 2.103

9212

Sustainability Gains from combining LCA and Parametric Design in Early Design Phases of Structural Design*Lotte M.B. Jensen, Christine Collin Hansen, Morten Birkved*

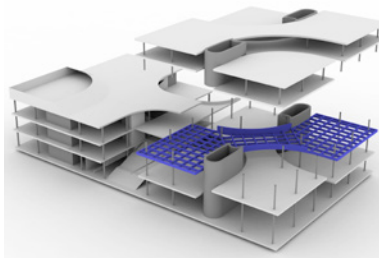
This work investigated the potential to reduce the environmental impact of a structure through an early phase design process informed by LCA and structural behaviour calculations.

9179

Thin-shell textile-reinforced concrete floors for sustainable buildings*Will Hawkins, John Orr, Paul Shepherd, Prof. Tim Ibell, Julie Bregulla*

This project proposes a novel thin-shell concrete flooring system for multi-storey buildings, focusing on structural optimisation as well as construction and practical performance. Savings of over 60% in both self-weight and embodied energy over an equivalent flat concrete slab are demonstrated.

10238

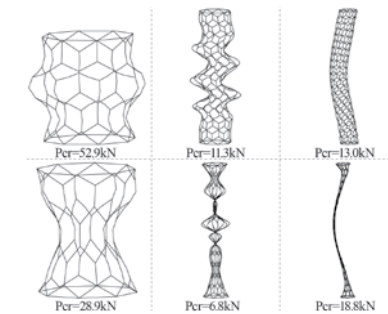
Engineering the new Merck Innovation Center*Stefan Neuhaeuser, Holger Alpermann, Christoph Gengnagel*

The contribution describes some of the structural engineering challenges encountered in the planning of the new Merck Innovation Center. The focus is placed on the large-span composite floor system as well as the design and construction of exposed concrete free-form curved stairs and railing beams.

10210

Basic study on structural property of curved lattice structure having molecular geometry of carbon nanotube*Naoya Miyasato, Akira Okada, Shuzo Hiroishi, Masashi Hishiki, Yuji Hoshino*

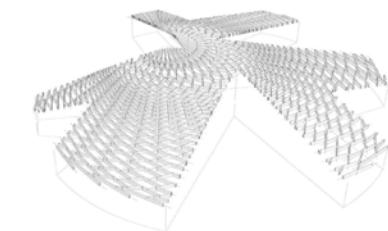
The hyperboloid of one sheet has the feature that it is possible to form the curved surface from a straight member. However, this model has members of different lengths. In response to this, this paper proposes a curved lattice structure conceived from molecular geometry of carbon nanotube.



10362

Reciprocal Frame for the roof of the Franz Masereel Center*Louis Bergis, Klaas De Rycke*

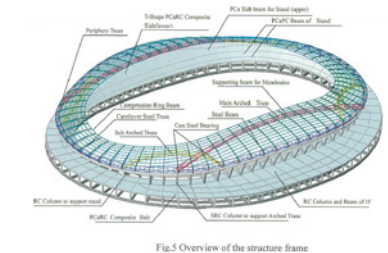
In the context of the extension of the Franz Masereel Centre, a reciprocal frame roof structure has been adapted on an extruded truncated cone. This paper will present the results of this study and their applications and will provide a critical look-back on the processes of optimization.



9932

Dynamic design of Tochigi New Stadium*Chikamasa Okuno, Akira Inoue, Shinsuke Yamazaki, Hiroki Yoda, Hiroaki Oikawa*

Tochigi stadium is an athletic field for The National Athletic Meet 2022 and has an oval shape plan of 210m x 260m and all 25,000 seats is covered with membrane roof. This paper provides a description of the roof and stand substructure design based on the time history response analysis.



SESSION # 17

SEVERE CONDITIONS & DISASTERS | WG 5

chaired by Sigrid Adriaenssens & Ruy Marcelo Pauletti

tuesday, september 26th

08:00 am until 11:00 am

seminar room 2.104

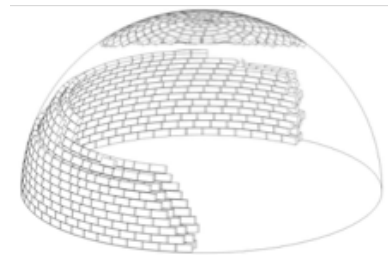


9198

Finite element modelling to predict cracking and seismic collapse of a thin masonry shell structure

Eftychia Dichorou, Matthew DeJong, Giorgia Giardina

This paper investigates the seismic performance of an unreinforced thin masonry shell structure. A nonlinear pushover analysis is performed using FE modelling to predict the crack propagation and failure mechanism. The sensitivity of the results to material and geometric properties is quantified.



9692

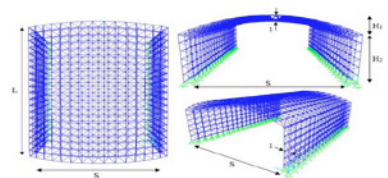
Seismic Design, Detailing, and Construction of the First Catalan Brick Vault and Domes of Istanbul

Ahmet Topbas, Dogan Arslan

9558

Loading patterns for the estimation of seismic response of double-layer barrel vaults with vertical double-layer walls

Mohammad Reza Chenaghloou, Karim Abedi, Mohammad Kheirollahi



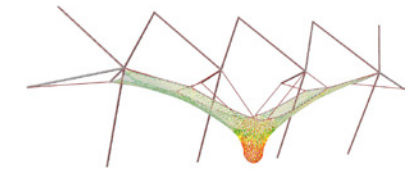
The present study is to propose loading patterns for the estimation of seismic response of double-layer barrel vaults with vertical double-layer walls. The proposed load pattern has well compatible in estimating of mean responses including capacity curves and displacement of space structure.

9825

A sliding cable model for rockfall barrier simulations using dynamic relaxation

Romain Boulaud, Cyril Douthe

Flexible rockfall barriers are protection systems against risks of falling rocks. The behavior of the flexible barriers reveals strong geometric and material nonlinearities, so that their modelling is complex and that calculations are time consuming.

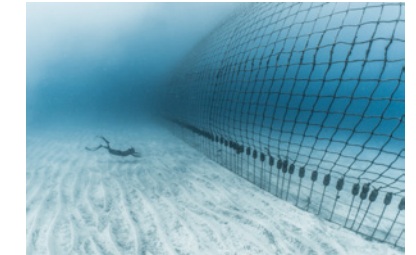


9870

Cable net systems under hydrodynamic loading: an overview of appropriate numerical modeling techniques

Alexander Niewiarowski, Sigrid Adriaenssens, Ruy Marcelo Paulet, Khalid Addi

Motivated by the design problem of a bathing enclosure on La Réunion, France, this paper presents a literature review of numerical modeling techniques for moored cable net structures subject to time-stepped hydrodynamic loads.

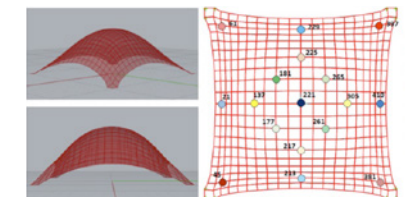


10099

Modal funicularity of shell structures

Stefano Gabriele, Sigrid Adriaenssens, Valerio Varano, Giulia Tomasello, Davide Alfonsi

An effective and easy-to-read method to quantify the funicularity of shell structures is presented and applied to structural "form-finded" shapes under different static loads. The method is applied to modal stress distributions in order to study the intrinsic dynamic funicularity of the structures.



SESSION # 18

COMPUTATIONAL DESIGN

chaired by Juan Gerardo Oliva-Salinas & John Abel

tuesday, september 26th

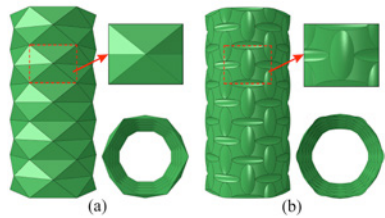
08:00 am until 11:00 am

seminar room 2.107

9184

Icosahedral Roundest Polyhedra*Christopher Kitrick*

This paper provides an approach to solving the complex geometry of roundest icosahedral shells. These unique shells consist of a single uniform circular cap region that repeats to cover the entire surface. A single repetitive region can be utilized to produce a geodesic shell.



9872

Novel designs of tubular structures for energy absorption*Kai Yang, Shanqing Xu, Shiwei Zhou, Mike Xie*

The crushing performance of two novel types of tubes with pre-designed Yoshimura-pattern and ellipsoidal dimples were studied by finite element modelling. The influence of representative structural units and material properties on the mechanical response of full-diamond tubes was identified.

9874

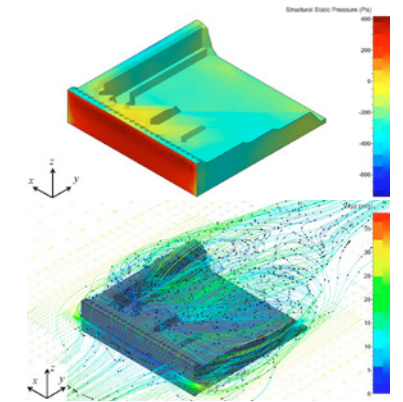
A brief introduction to the computational platform for finite particle method and its applications on structural and mechanism analysis*Jingzhe Tang, Yaozhi Luo*

The basic theory of the finite particle method (FPM) is explained first, based on which a self-programmed computational platform for FPM is developed and briefly introduced in this paper. In addition, applications on structural and mechanism analysis are also provided.

10180

Wind pressure on spatial frame generated by sediment transport phenomena*Toshifumi Mae, Shuichi Asayama*

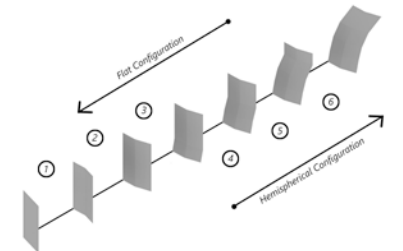
This paper describes the wind pressure distribution and the wind flow to the shape generated based on the theory of riverbed evolution. The generated shape was classified into three. As a result of fluid analysis, the characteristics of wind flow and pressure are different by shapes generated.



9954

Conceptual Development of Single Layer Transformable Structure*Daniel Sang-Hoon Lee, Jianguo Cai, Ruijun Ma*

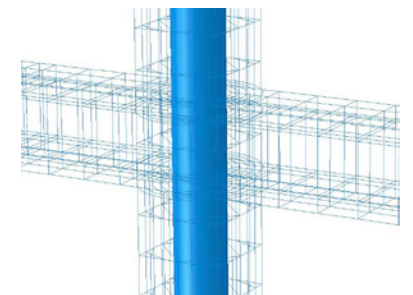
The current paper presents the conceptual development of single layer transformable structure system, which adopts various doubly curved forms. The paper includes information on the adopted components, possible assembly, applications of different actuators, locomotor gait for reduced instability



10519

Numerical simulation study on the seismic behavior of ring beams of joints of concrete fille*Yingying Zhang*

This paper presents the mechanical performances of ring beams of joint of concrete filled steel tubular laminated columns (CF-STLC) to reinforced concrete beam, under low reversed cyclic loading.



SESSION # 19

**DESIGN AND FABRICATION OF LIGHT AND SPATIAL
CONSTRUCTIONS**

chaired by Fabian Schmid & Stefan Peters

tuesday, september 26th

08:00 am until 11:00 am

seminar room 2.108

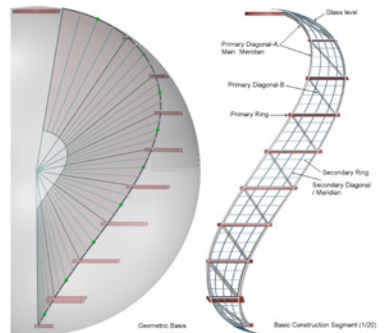


10222

Parametrically designed free form gridshell for Chadstone Shopping Centre, Melbourne

Stefan Peters, Christoph Dengler, Stephan Engelsmann, Christian Fischer

The construction of a geometrically complex steel-glass gridshell roof is part of the extension of the Chadstone Shopping Centre in Melbourne, Australia. This essay describes design and construction of the roof structure, taking into account fabrication and installation processes.



9292

The Sphere: Kazakhstan Pavilion for the Expo 2017 in Astana

Christian Wolkowicz, Jaime Sanchez-Alvarez, Volker Schimmer, Michael Sendelbach

The emblematic entrance pavilion for the Expo 2017 in Astana is the 80-meter "Sphere", which is the largest closed glazed sphere in the world. The present paper gives insight into its geometry optimisation for production, its structural analysis, its glazing and its fabrication and installation.



10339

Double Curvature for Volkswagen

Achim Bleicher, Ron Marten Behnke, Mike Schlaich

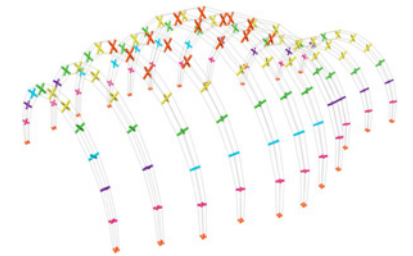
Two double-curved roof structures from schlaich bergmann partner, the 'Porsche Pavilion' and the 'Canopy for exit of customer center' in the "Autostadt" in Wolfsburg Germany will be presented here.

9638

Cases of Lightweight Structures in Polar environments

Jessica Fernandoy-Bak, Julian Christ, Paul Shepherd, Holger Koss

The paper focuses on 'Polar Lightweight Structures'. Firstly, evidence of small-scale lightweight structures (LWS) designed and built for the extreme south is presented. Then, two studies where different computational methods were applied for the design large scale LWS in Polar Areas.



10031

Additive Manufacturing Revolutionizes Lightweight Gridshells

Gregg Pasquarelli, William Sharples, Chris Sharples, Rebecca Cailouet, John Cerone, John Gulliford, Justin Nardone, Robert Otani, Emil Poulsen, Dan Reynolds

This paper presents findings from a research pavilion built by SHoP Architects for the most recent Design Miami fair [November 2016] in order to document and share its success and project its future impact on the field of lightweight gridshells.



9223

Design and fabrication of a small scale vacuum pre-stressed paper structure

Yi-Hsuan Tu, Ya-Chih Chang

A vacuum pre-stressed paper structure using cardboard boxes wrapped in a waterproof envelope was proposed. The boxes were connected by sleeves, locking tabs, and pre-compression. A full-scale model was constructed in an outdoor site to test the performance under natural environmental conditions.



SESSION # 20

**ANALYSIS AND DESIGN OF RETICULATED SHELLS
AGAINST SEVER EXTERNAL DISTURBANCE | WG 8**

chaired by Shiro Kato, Suduo Xue & Toru Takeuchi

tuesday, september 26th

08:00 am until 11:00 am

seminar room 3.107

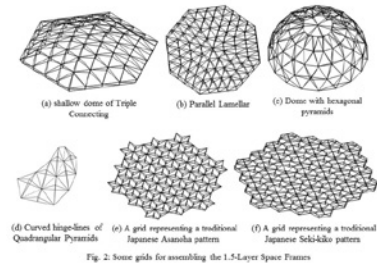


Fig. 2. Source grids for assembling the 1.5-Layer Space Frames

9621

Buckling features of 1.5-layer space frames with crossing units

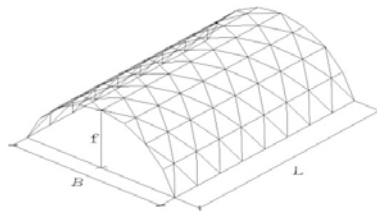
Pei-Shan Chen

A 1.5-Layer Space Frame is a bar-linked structure configured with one-layer of chords and diagonal members. By linear and non-linear buckling analyses, the authors will analyze the relationship between the buckling capacity and the geometrical parameters.

9729

Effects of Initial Geometrical Imperfection on Ultimate load of Single-Layer Cylindrical Reticulated Shells Under Severe Earthquake

WeiJing Zhang

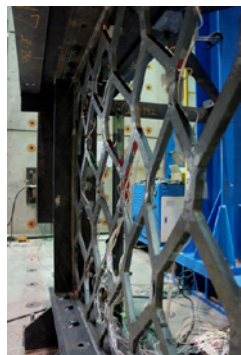


Nonlinear dynamic response analysis was performed for two kinds of single-layer cylindrical reticulated shells with initial imperfections under earthquake using OpenSEES, the effect of initial imperfection on ultimate load of cylindrical shell with different key parameters were studied.

9594

Out-of-plane buckling of steel latticed walls subjected to cyclic shear deformation

Tetsuo Yamashita, Hiroyuki Oyobe, Ryosuke Miyazawa



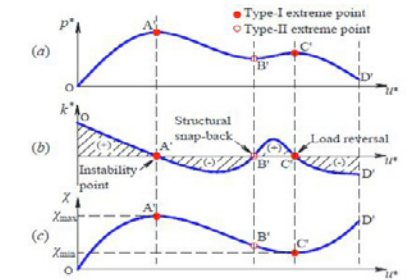
The present paper discusses on inelastic buckling of steel latticed shear walls subjected to cyclic deformation. It is demonstrated that both the buckling strength and the shear strain at the onset of out-of-plane buckling, can be approximated by simple functions of the generalized slenderness.

9531

Static stability analysis of the spatial structure based on the structural Eigen-stiffness

Zhaochen Zhu, Yongfeng Luo, Qinglong Huang, Yang Xiang

In this paper, a scalar parameter denoted by Eigen-stiffness is proposed to characterize the overall structural stiffness. Then, a Eigen-curve based on Eigen-stiffness is proposed to investigate the variation of the overall structural mechanical behavior of spatial structure under static load.



10074

Snap-through and local buckling interaction in a timber dome: Bracing system vs. connection stiffness

Amedeo Manuello Bertetto, Fabio Bazzucchi, Alberto Carpinteri

The stability of an existent single layer timber dome has been studied considering different loadings and increasing the yield-ingness of the nodes. The dome is sensitive to the interaction between different instability phenomena. The effect of the existent bracing system has been evaluated.



9364

Layers in structure and architecture: Design and construction of a 100m span dome in Manila

Catherine Poirriez, Yacine Bouzida

The Okada Manila Dome is a 100m-span and 30m-high steel and glass dome covering a beach club and nightclub. Using a comparison of the linear buckling load of different structural options enabled converging to the solution chosen of a hybrid shell composed of 32 Vierendeel trusses.



SESSION # 21

**CONCRETE LIGHT:
INNOVATIVE CONCRETE CONSTRUCTIONS II**
chaired by Harald Kloft & Tine Tysmans

tuesday, september 26th

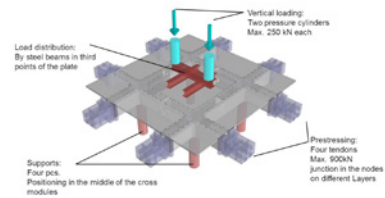
08:00 am until 11:00 am

seminar room 3.108

9194

From digital design to precise production: Dry-jointed coffered ceiling made of UHPFRC-components

Lukas Ledderose, Sven Lehmberg, Franz Wirth, Harald Kloft, Prof. Harald Budelmann



The paper begins with the introduction of the developed design of the coffered ceiling system that consists of dry-jointed UHPFRC-components. Then, the concepts of the formwork are presented, as well as different productions of the coffered ceiling components.

9529

Experimental and computational investigations on shell structures made of carbon reinforced concrete

Tilo Senckpiel, Ulrich Häussler-Combe

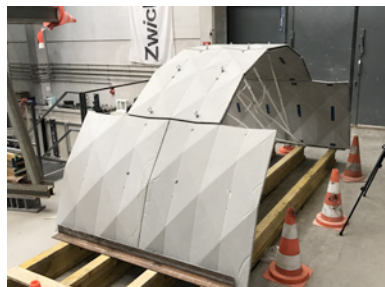


Lightweight, curved ceiling elements made of carbon textiles and concrete soaked nonwovens have been developed by the project partners. The paper presents the investigations of the new material, the manufacturing process, the experimental tests and the numerical calculation model of the elements.

9434

Construction of a vault using folded segments made out of textile reinforced concrete by folding-in-fresh

Jan Dirk van der Woerd, Christian Bonfig, Josef Hegger, Rostislav Chudoba



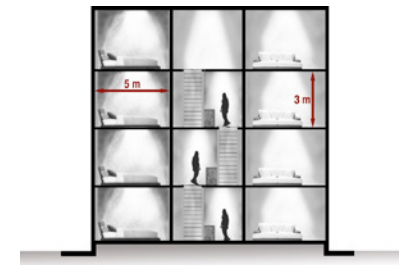
Description of the construction of a vault shell consisting of singly curved folded Yoshimura segments using the oricrete technology, that is applying folding principles to thin plates made of textile reinforced concrete. The segments were folded in the fresh state of the matrix (folding-in-fresh).

9883

Sandwich panels with Textile Reinforced Cementitious skins as new insulating wall system: a case study

Jolien Vervloet, Tine Tysmans, Svetlana Verbruggen, Petra Van Isterbeeck, Jan Wastiels, Danny Van Hemelrijck, Matthias De Munck

In this paper a first feasibility study on TRC sandwich panels as loadbearing wall elements is done by a case study. The loads acting on a wall element at the bottom of a multi storey building are calculated, a numerical model is established and the stresses in the core and the skins are analysed.

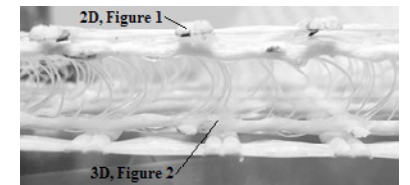


9959

3D fibre textiles as reinforcement for lightweight concrete structures

Michael El Kadi, Tine Tysmans, Jolien Vervloet, Matthias De Munck, Jan Wastiels, Svetlana Verbruggen

This paper presents the comparison between 3D and 2D TRC's in tension and in bending. Their manufacturing process is thoroughly explained and the added value of 3D compared to 2D textile fibre architectures is highlighted.



10204

Properties and applications of polymer concrete for timber constructions

Stephan Arendt, Riccardo La Magna, Gregory Quinn, Michel Schmeck, Christoph Gengnagel, Volker Schmid



SESSION # 22

OPTIMIZATION & COMPUTATIONAL DESIGN II

chaired by Ornella Iuorio

tuesday, september 26th

02:30 pm until 04:30 pm

Hörsaal 200 | lecture hall 200

9199

Shape optimization of concrete shells with ruled surface geometry using line geometry

Juan Pablo Osman Letelier, Arndt Goldack, Mike Schlaich, Daniel Lordick, Jakob Grave



The conceptual design and especially the shape optimization of shell structures with ruled surface geometry are briefly discussed in this paper. In addition, the use of a line-geometry-based parametrization is presented. The proposed methods are implemented in a software module.

9517

Optimization of shape and thickness of continuum shell structures using 2D and 3D shell elements

Shinnosuke Fujita, Yoshihiro Kanno

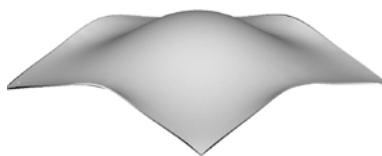


In this paper, while optimizing shape and thickness simultaneously, topology is optimized by deleting the elements for the part where the shell thickness becomes extremely thin. The effectiveness of the present approach are investigated through several numerical examples.

9724

Research on morphogenesis technique for free-form surface structures considering geometrical nonlinearity

Zhihao Xue, Xiaodong Liang, Guigang Tu, Changyu Cui



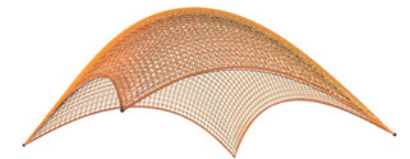
This paper proposes a computational morphogenesis technique for free-form surface structure considering geometrical nonlinearity. And two computational optimization examples with different boundary conditions are provided to illustrate the capabilities of the proposed method.

9843

Prestressed gridshell structures

Mats Ander, Alexander Sehlström, Paul Shepherd, Christopher Williams

A method for the form finding of shell structures composed of both compression and tension members is described. Dynamic relaxation is used and some members are given prescribed force densities while others are given a required length in the form found state. Finally case studies are presented.



10056

Computational morphogenesis of continuum shell structures using Improved ESO method

Koichi Kamimura, Daiji Fujii, Shinya Matsumoto

In this paper, a simple method to find an optimal morphology of shell structure is proposed.



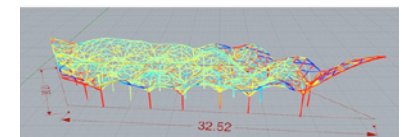
10240

A parametric investigation into the development of cold formed steel free form grid shells

Ornella Iuorio, Hiltred Sanctis

This work explores the possibility to use cold-formed steel sections in free form shells, making advantage of their structural efficiency in realizing light constructions.

Three free form shells having different geometries, configurations and grid topology are investigated through two experiments.



SESSION # 23

**CONCEPTS & BUILDINGS:
COLLABORATIVE STRUCTURAL DESIGN**

chaired by Joseph Schwartz & Mario Rinke

tuesday, september 26th

02:30 pm until 04:30 pm

seminar room 2.103



9688

The structure of Namics Headquarters, St. Gallen (CH)

Andrea Pedrazzini, Eugenio Pedrazzini, Roberto Guidotti

An unusual structural system represents the main feature of the structure of the new headquarters of Namics in St. Gallen, Switzerland. A lightweight folded plate composed of 6 V-shaped concrete waves was conceived in order to realize wide and bright open-spaced floor plans.

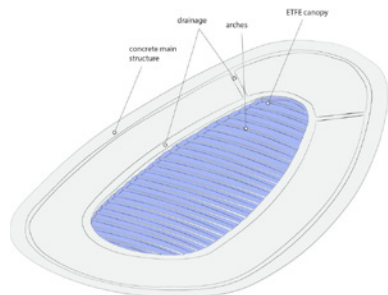


10249

The design and construction of fabric formed ice shells with bending active frames utilizing principle stress patterns

Lancelot Coar, Michael Cox, Sigrid Adriaenssens, Lars De Laet

This paper describes "Ice Bloom", a project that explores the potential of bending active frames to support a fabric formed ice shell. The topology of the frame and resulting shell form follow the principle stress lines of an optimized vault design and is translated into a construction methodology.



10080

Preliminary information flow analysis of a tender project in Southeast Asia: Before clash analysis

André Ihde

The article describes an approach to overcome several clash problems, based on improper information exchange between planners and authorities. Methods from the field of network analysis will be used and further developments for the coordination of complex, lightweight projects will be discussed.

9604

Livio Vacchini and the Problem of the Corner

Toni Kotnik

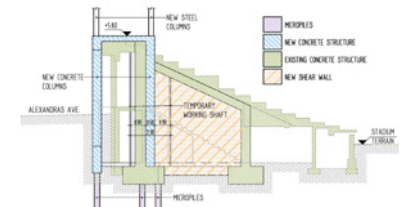
This paper explores the design thinking of the Swiss architect Livio Vacchini in more detail. It can be understood as an active dialogue between architecture and structural engineering in which technical developments enable a constant re-evaluation of recurring problems in architectural design.



10043

Renovation and increase of the capacity of the stadium of Panathinaikos F.C. in Athens

Manos Kyriazis



9211

Four Summer Houses for the Serpentine Gallery

Jon Leach, Amy Koerbel, Michael Orr

The paper provides a brief insight to the design and build processes of the Serpentine Summer Houses, four temporary structures located in Kensington Gardens, London, describing how the team developed the initial concepts into four unique follies that opened to the public in the summer of 2016.



SESSION # 24

LEARNING BY MAKING | WG 15 AND 20

chaired by Olga Larsen, S. Alireza Behnejad & Niels De Temmerman

tuesday, september 26th

02:30 pm until 04:30 pm

seminar room 2.104

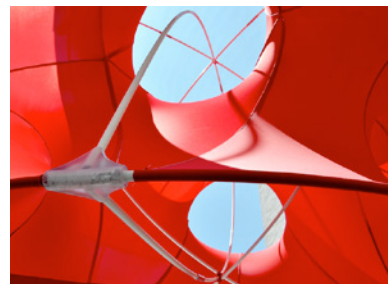


9761

Bending-active reciprocal structures based on equilateral polyhedral geometries

Stijn Brancart, Olga Larsen, Lars De Laet, Niels De Temmerman

Using elastic deformations, bending-active reciprocal frames can lead to structurally efficient systems for rapidly assembled, lightweight structures. We present an approach to develop them from equilateral polyhedral shapes. A full-scale prototype demonstrates the use of double-layered components.

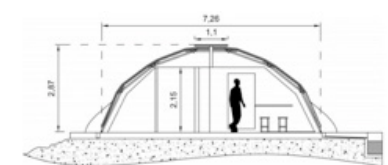


9916

A Minimal Surface Membrane Sculpture

Ruy Marcelo Pauletti, Sigrid Adriaenssens, Alexander Niewiarowski, Victor Charpentier, Max Coar, Tracy Huynh

This paper presents the design, analysis, and fabrication of a membrane sculpture based on a minimal surface. The work was developed during the Spring of 2016 at Princeton University as a pedagogical exercise, combining the mathematics of minimal shapes with the major aspects of membrane design.



10048

Transferring reciprocal frame shelter building technology in emergency situations

Javier Petersen, Nayar Gutiérrez, Paula Arias

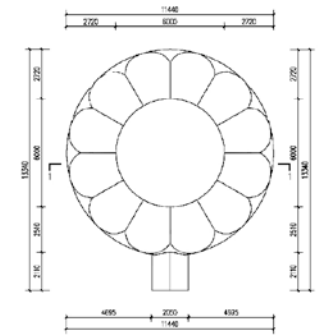
This document describes an academic approach to generate reciprocal frame shelters, which could be assembled immediately after an emergency. Most approaches for generating a cover or a shelter that promote help should come from external resources in form of complete products ready to install.

10093

Ice Architectural Design Teaching by Construction – Review of Sino-Euro Joint Studio of Ice Architecture Construction

Peng Luo, Lu Yuan, Kai Wang, Yue Wu, Arno Pronk

This paper takes the Sino-Euro Joint Studio of ice architecture construction in Harbin China for example and systematically analyzes the relationship between architectural design and the actual construction.



10150

Success factors in the realization of large ice projects in education

Arno Pronk, Fred C. Sanders, Marjolein Overtom, Lancelot Coar, Peng Luo, Qingpeng Li

The design and engineering of ice structures is a relative new field. Most projects were realized by professors in cooperation with their students and researchers. In this paper we will present and compare the motivation and learning experiences of the students.



10252

Algorithmic design for traditional bobbin lace methods

Daniel Nunes Locatelli, Arthur Lara, Ruy Marcelo Pauletti, Thiago Henrique Omena

This paper investigates the potential application of digital tools into the design and fabrication of textile weave through the combined use of form finding and the traditional technique of bobbin lace.



SESSION # 25

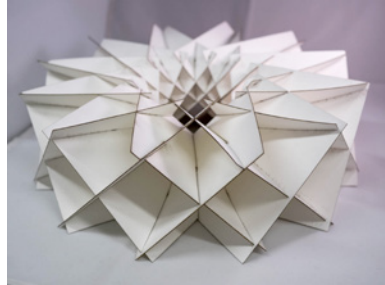
DEPLOYABLE STRUCTURES I

chaired by N. N.

tuesday, september 26th

02:30 pm until 04:30 pm

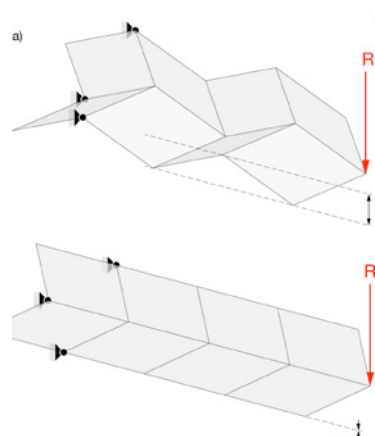
seminar room 2.107



9622

Deployable Rotationally Symmetric Sliceforms*Tim Watson, Keith A. Seffen*

Inspired by papercraft, we introduce a family of rotationally symmetric 'sliceform' structures assembled by slotting together planar slices in a regular symmetrical pattern. These structures exhibit a surprising deployable-locking characteristic which we show to be a compliant transformation.

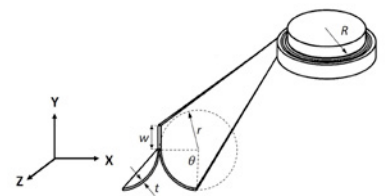


9670

Non-flat folding mechanisms for structural purposes*Henri Buffart, Martin Trautz, Susanne Hoffmann, Jascha Paris, Justus Siebrecht, Burkhard Corves*

Technical origami is always in pursuit of flat foldability, while in a non-flat folded state, rigid-foldable patterns have advantageous structural properties and transformability. This paper introduces a different approach on geometrical design of structurally feasible folding mechanisms.

10149

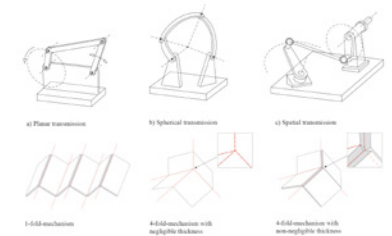
Ultra-Thin Composite Deployable Booms*Christophe Leclerc, Sergio Pellegrino*

Ultra-thin TRAC booms have many applications for spacecraft structures due to their very efficient packaging. A manufacturing process is proposed for composite TRAC booms with a total flange thickness of 71 μm . The mechanical behavior in both bending and torsion is studied through experiments.

10207

Mechanical approach to the design of deployable folding structures with virtually stiff plate elements*Arne K nstler, Martin Trautz*

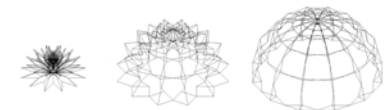
Deployable folding structures are classified as transmissions. It is shown how this choice influences the kinematic DOF and thereby the movability of folding structures as well as which kinds of compound folding structures may be developed out from these 4-fold- and 6-fold basic mechanisms.



10182

Geometric Design and Kinematics of Curvilinear Deployable Structures*Yuan Liao, Sudarshan Krishnan*

This paper describes the geometric design and kinematic behaviour for planar rings and hemispherical grid structures. Position analysis was used to examine the influence of the geometric parameters on the deployment and folding of these structures.



SESSION # 26

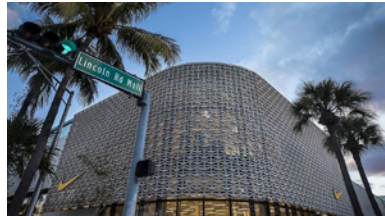
MULTI-/META-MATERIAL DIGITAL FABRICATION I

chaired by Jeroen Coenders & Caitlin Mueller

tuesday, september 26th

02:30 pm until 04:30 pm

seminar room 2.108



9494

Expansion of Spatial Realities - Digital Fabrication Built in the US*Wilfried Laufs*

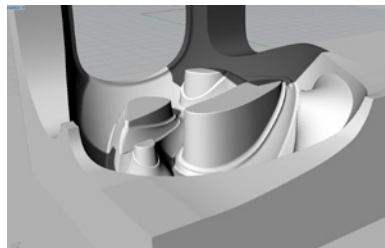
Digitally design-built free-form structures, described in this article by three recently built examples in the US, first a grid shell trellis with 3D structural printed connections, followed by cold-bent riveted metal tent art sculptures and finally a Nike façade application using UHPC Ductal.



9495

Additive Manufacturing for the Built Environment*Ulrich Knaack, Jens Schneider, Paulo Cruz, Paolo Colombo*

This paper targets the potentials of AM for the built environment and the related industry – to identify potentials of the technology in real-world implementation for design and engineering process and construction.



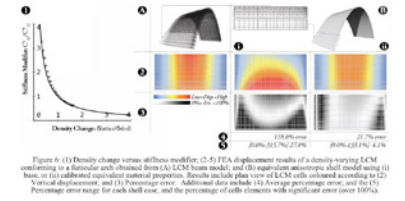
9810

Optimization issues of advanced manufacturing and rapid prototyping processes in architecture and industrial design*Jana Lipkovski*

9858

Equivalent material modelling of complex additive manufactured conformal lattices*Dan Reynolds, Kam-Ming Mark Tam, Emil Poulsen, Robert Otani*

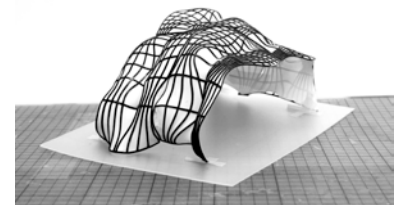
The computationally analysed case studies and results presented here supports the designer's effective capacity to quickly conceive, explore and develop full-scale additive manufactured lattice cellular material.



10276

Towards Active Fabrication - Composite Material Generation Process Where the Structural Performance Arises During the Process of Making.*Cesar Cheng, Yorgos Berdos*

Towards Active Fabrication presents the development of a composite material system consisting of two weak, flexible materials that when put together allow for variable states of stiffness and become structural through the process of fabrication.



9796

Bistable behaviour of creased thin metallic strips*Martin Walker, Keith A. Seffen*

This study investigates the opposite sense bending of a creased thin metallic strip which can exhibit a snap-through instability. We develop a simple analytical model to describe this behaviour, which shows good agreement with experimental and finite element results.



SESSION # 27

**ANALYSIS AND DESIGN OF RETICULATED SHELLS
AGAINST SEVER EXTERNAL DISTURBANCE | WG 8**

chaired by Toru Takeuchi, Suduo Xue & Shiro Kato

tuesday, september 26th

02:30 pm until 04:30 pm

seminar room 3.107

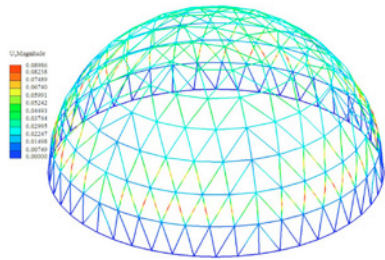


9890

Buckling and Reliability of Cylindrical Lattice Shell under Snow Load*Shiro Kato*

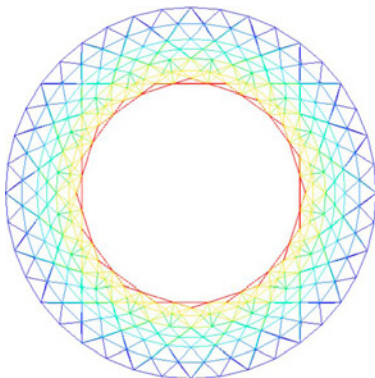
The relationship between global load factor and reliability index. The relationships are important from a view point of design, and the present data can be applied effectively to know the rate of safety of the cylindrical lattice roofs against buckling under heavy snow.

10054

Effect of sleeved compression members on integral stability of reticulated shells*Chenhui Zhang, Changgen Deng*

Sleeved compression members are applied in reticulated shells with large rise-span ratio, the integral stability capacity of which is impaired by edge pre-buckling. The analysis results manifest application of sleeved compression members can improve integral stability capacity of reticulated shells.

10113

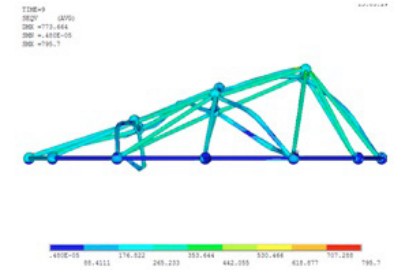
Concept and Feasibility of Crossed Cable Supported Latticed Shell in the View of Preventing Disproportionate Collapse*Suduo Xue, Renjie Liu, Xiongyan Li, Yongqi Lan*

Crossed Cable Supported Lattice Shell (CCSLS) was proposed due to its new configuration which had potential to prevent disproportionate collapse well. The potential of the CCSLS in preventing disproportionate collapse was verified by numerical analysis.

9225

The Influence of Welded Hollow Spherical Joint on Energy Dissipation of Single-layer Reticulated Shell*Lei Gu*

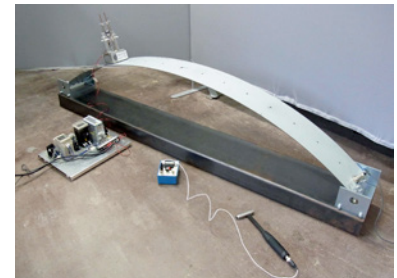
Traditional model of single-layer reticulated shell always ignores the effect of welded hollow spherical joint when researching energy dissipation, and this paper points out the limitation and gives the effect degree. In order to further study, the shell was stimulated by beam element and shell.



9205

Impact test of an arch model using TMDs with initial displacement*Susumu Yoshinaka, Yoshiya Taniguchi*

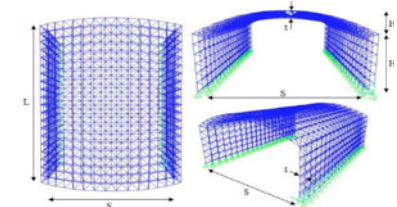
To control transient responses effectively, we propose TMDs with initial displacement. This paper describes a vibration test using an arch model under impulse loading to verify the control performance experimentally. We can see that the TMD model showed high control performance for early responses.



9988

The influence of random geometric imperfections on the dynamic stability behavior of double-layer barrel vault roof with vertical double-layer walls under seismic excitation*Mohammad Kheirollahi, Mohammad Charkhtab Basim, Mohammad Reza Chenaghloou, Karim Abedi*

The influence of random geometric imperfections on the dynamic stability behavior of double-layer barrel vault roof with vertical double-layer walls are investigated under seismic excitation. Monte Carlo simulation is used to calculate the collapse fragility curves and results are compared.



SESSION # 28

**CONCRETE LIGHT:
INNOVATIVE CONCRETE CONSTRUCTIONS I**
chaired by Silke Scheerer & Achim Bleicher

tuesday, september 26th

02:30 pm until 04:30 pm

seminar room 3.108

9251

Application-specific adaptation of concrete formulations using genetic algorithms to optimize a wide range of different fit-functions

Henrik Funke, Lars Ulke-Winter, Sandra Gelbrich, Lothar Kroll

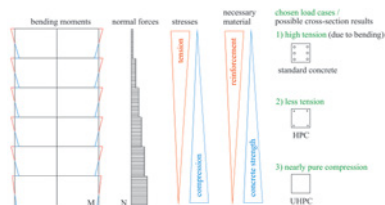


This work reports about a novel approach for an automatic adaptation of concrete formulations based on genetic algorithms to optimize a wide range of different fit-functions. As a result, the new developed procedure can be used for an automatic analysis and specific adaption of concrete mixtures.

9253

Architectural columns as a result of shape optimization

Angela Schmidt, Manfred Curbach



First research results on the engineering optimization of eccentrically loaded columns will be presented. An introduction to the optimization process, the defined criteria and the calculation principles will be provided as well as an outlook on the experimental verification.

9600

Weight-optimized and Mono-material concrete components by the integration of Mineralized Hollow Spheres

Daniel Schmeer, Werner Sobek



The following article provides an overview of the concept of lightweight concrete components by the integration of mineralized hollow spheres. It describes the hollow parts' geometry and their manufacturing process, and approaches for sphere packing with its mass-saving potential for components.

9601

The technology of graded concrete

– Interface between design and manufacturing –

Mark Woerner, Daniel Schmeer, Benjamin Schuler, Oliver Sawodny, Werner Sobek

The paper presents the technology of graded concrete and an in-depth consideration of the interface between design and manufacturing. The design is linked to the constraints imposed by the manufacturing. The result is a digital blueprint of the component and can be forwarded to the production.

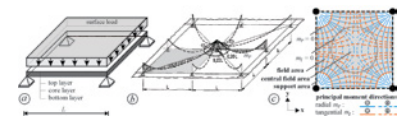


9868

Load-bearing behavior and efficiency of layered two-way slabs

Michael Frenzel, Manfred Curbach

This paper describes the general load bearing behavior of layered two-way concrete slabs on the basis of experiments and theoretical analyses. They show that the chosen slab designs lead to efficiently bearing slabs with a weight reduction of about 15 % in comparison to regular concrete slabs.



SESSION # 29

OPTIMIZATION & COMPUTATIONAL DESIGN III

chaired by Sigrid Adriaenssens & Lars De Laet

tuesday, september 26th

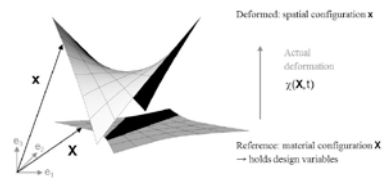
05:00 pm until 06:30 pm

Hörsaal 200 | lecture hall 200

9190

Isogeometric B-Rep Analysis for finding stress-optimized cutting patterns

Ann-Kathrin Goldbach, Kai-Uwe Bletzinger



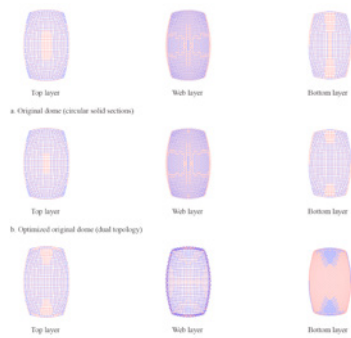
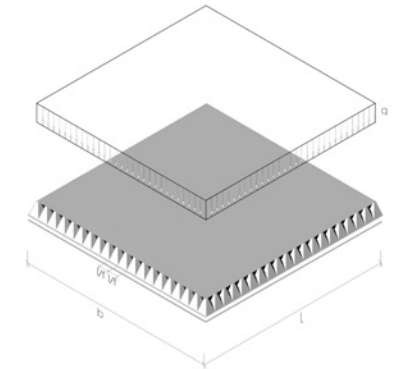
The advantages of performing cutting pattern generation with the Variation of Reference Strategy and Isogeometric B-Rep Analysis are lined out, including a thorough mechanical description of the optimization problem. Selected examples show the applicability and efficiency of the presented procedure.

9841

Stress oriented foldings as an optimized lightweight system

Juan Musto, Martin Trautz

In the framework of this paper, the potential of stress orientated foldings as an optimized light building systems are analyzed. The investigation was made as an example on a simply supported square plate.



9525

Layout optimization of space frame structures

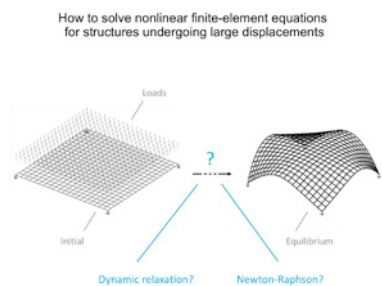
Antiope Koronaki, Paul Shepherd, Mark Evernden

This paper presents a computational workflow for the optimization of double layered grid structures generated using Conway operators. The inherent modularity of such layouts significantly reduces the computational resources required, while at the same time facilitates the fabrication process.

9811

On the equivalence of dynamic relaxation and the Newton-Raphson method: application to the design and analysis of bending-active structures

Jef Rombouts, Geert Lombaert, Lars De Laet, Mattias Schevenels



An accurate and fast-converging dynamic relaxation approach using an optimized fictitious mass matrix based on modal analysis is proposed. The method's equivalence to the Newton-Raphson method is shown and its application to the design and analysis of bending-active structures is discussed.

SESSION # 30

STRUCTURE AS ARCHITECTURE

chaired by Toni Kotnik & Günther H. Filz

tuesday, september 26th

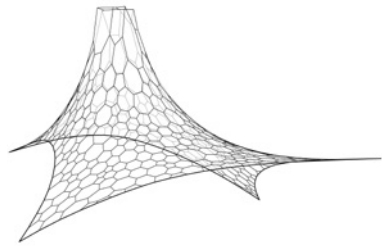
05:00 pm until 06:30 pm

seminar room 2.103

9219

Irregular cable-nets: exploring irregularity as a driver for form and structure

Pedro Augusto Galbiati Silva Giachini, Bahar Al Bahar, Evy L. M. Slabbinck, Jonathan Solly, Jan Knippers



Irregular mesh patterns enable the design of cable net structures with non-directional grids and varying cable concentration. These characteristics are investigated in this paper as a mean of expanding the design space of such systems and for analyzing their structural behavior.

9248

Magnolia: a glass-fibre reinforced polymer gridshell with a novel pattern and deployment concept

Diederik Veenendaal, Edyta Augustynowicz, Gabriel Tang

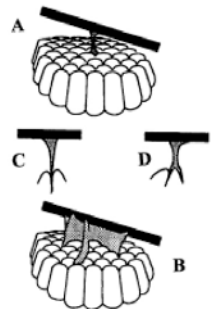
The Magnolia gridshell was built at Sheffield Hallam University during a workshop. The gridshell features a central funnel with a novel pattern and unique deployment concept. A two-stage form-finding process was required in which the pattern was determined first, before arriving at the final shape.



10307

Learning from insects: studies of nest structures

Irmgard Lochner Aldinger, Chrystelle Mavoungou



This paper presents a description of structural, chemical and material characteristics of a hornet nest. It proposes the transfer of design elements and natural conditions into architecture. The results show an approach of constructing buildings using one material for different applications.

9510

Digital Fabrication and Tectonic Space in Interlocking Particle Structures

Markus Hudert, Toni Kotnik

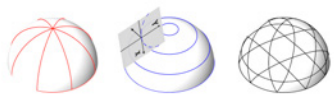
This paper addresses Interlocking Particle Structures (IPS) and the notion of tectonic space, which here refers to the spatial quality and space generating capacities of individual as well as arrays of joints, as they often occur in material systems.



9397

A Weaving Structure for Design & Construction of Organic Geometry

Weixin Huang, Chenglin Wu, Jiankun Huang



Inspired by traditional handicrafts, a new weaving structure system is proposed that can be constructed by continuous elastic rods bearing bending forces. It has a wide range of organic formal representation, adaptive structural performance and convenient construction methodology.

SESSION # 31

**EDUCATIONAL METHODS FOR DEALING WITH
COMPLEX ENVIRONMENTS | WG 20**

chaired by S. Alireza Behnejad & Olga Larsen

tuesday, september 26th

05:00 pm until 06:30 pm

seminar room 2.104

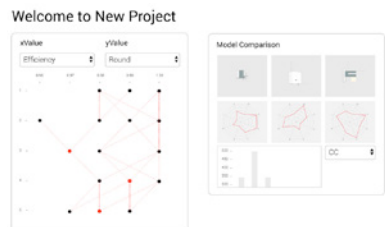


9795

Structural elements and joints - a generator for design explorations

Jesper Thøger Christensen, Lars Damkilde

The paper introduces a methodology for structural elements and joints to become a generator for design explorations in the early conceptual design of buildings.

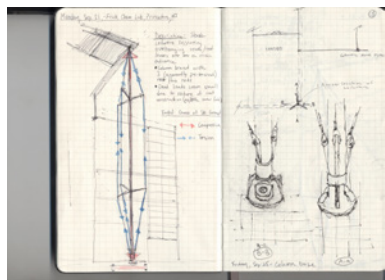


10219

A Web Based Open Infrastructure and Tool for Viewing Parametric Project Development: Towards New Interfaces

Sam Joyce, Nazim Ibrahim

This work looks at interfaces which empower designers by visually providing efficient means to make decisions using web-browser based tool, which records user models passed via JSON. It provides "option comparison", "design history" as well as a "design performance" views of a design exploration.



9668

Elements of Conceptual Design: an Innovative Course

Juan José Jorquera-Lucerga, Maria Garlock

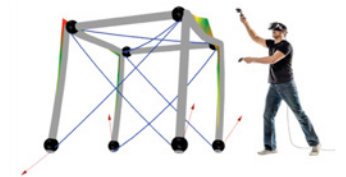
This paper describes an innovative course that illustrates the process of 'conceptual design', meaning how to use and combine the many tools one learns as a structural engineer to find forms and design structures that are efficient, economical, and elegant.

9853

Augmented reality structures

Gregory Quinn, Christoph Gengnagel

This paper presents a prototypical tool in which users interact with physical objects (educational structural systems such as portal frames) which are visually augmented by means of projected images of a synchronous simulation of the same system. The visual augmentation provides the user with immediate insight into the systems' structural performance by displaying internal forces (bending moments, axial forces and shear forces) as well as reactions resulting directly from the user-imposed deflections. This prototype provides an arguably more engaging and intuitive way in which to interact with and learn about structural systems and principals than comparable teaching aids.

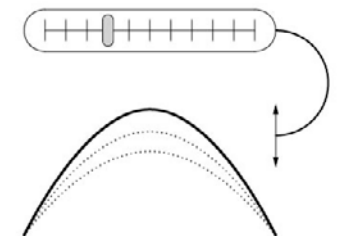


10816

Sending Engineering Students Searching for the Interaction of Form and Structure using Parametric Design

Kai Schramme, Annette Bögle

This paper focuses on teaching engineering students about the design of structures following light weight principles and shares the experience gathered during the course. Besides the form finding of efficient structures, emphasis is also put on the digital methods that are used to explore the design.



SESSION # 32

DEPLOYABLE STRUCTURES II

chaired by Knut Stockhusen & Niels De Temmerman

tuesday, september 26th

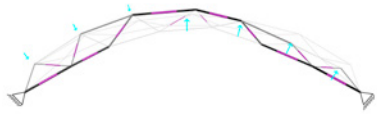
05:00 pm until 06:30 pm

seminar room 2.107

9793

The Use of Variable Stiffness Joints in Adaptive Structures*Gennaro Senatore, Qinyu Wang, Henriette Bier, Patrick Teuffel*

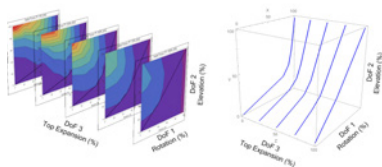
This paper investigates the use of large shape changes achieved via actuation as a structural adaptation strategy to counteract the effect of external loads. Experiments show the potential for application of joints with variable stiffness in adaptive structures for shape and load-path control.



9812

Deployment sequence optimisation of 3 degree of freedom systems*Giulia Fenci, Neil Currie*

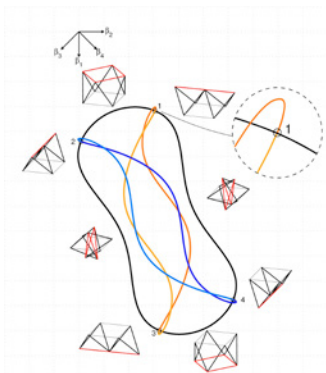
The optimisation methodology proposed can be used for any deployable structure with 3 independent degrees of freedom and allows finding the optimal combination of the DoFs to minimise the stresses and forces within the structure during deployment according to the optimisation parameter selected.



10114

Visualization of compatibility Paths in 4D: The square Antiprism as an Example*András Lengyel, István Hegedűs, Tibor Tarnai*

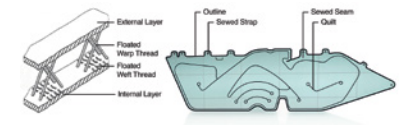
An oblique parallel projection of the 4D parameter space to 2D is applied to visualize compatibility paths of mechanisms. Unlike ordinary orthogonal projections, it is able to display bifurcation points as intersections of the paths. The square antiprism is shown as an example.



10192

Kinetic Lightweight Surface Elements: Composite Actuators*Fabian Schmid, Stefan Marinitsch*

This paper presents experimental developments for composite actuators with a focus on the advantages of the combined production processes. The characteristics of the one piece woven textile materials, extended with production processes used for glass metal composites, are discussed.



9958

Using Adaptable Scissor Structures for Post-Disaster Relief Sheltering*Aushim Koumar, Tine Tysmans, Niels De Temmerman*

The research presented in this paper concerns an optimal deployable adaptable scissor structure that can be used for very fast deployment in a first emergency phase and can later by disassembled and reassembled as a building kit for the second transitional phase of disaster relief.



SESSION # 33

MULTI-/META-MATERIAL DIGITAL FABRICATION II

chaired by Fabian Scheurer & Sandra Manninger

tuesday, september 26th

05:00 pm until 06:30 pm

seminar room 2.108

9727

Study on 3D-Printing reinforced masonry structure

Jie Bai

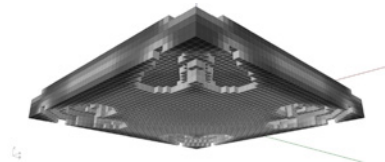


By combining the advantages of 3D-printing and the traditional reinforced masonry structure system, this paper puts forwards a new structure system: 3D-printing reinforced masonry structure system.

10125

Optimising 3D Printed Concrete Structures using Topology Optimisation

Pascal Martens, Maarten Mathot, Jeroen Coenders, Freek Bos

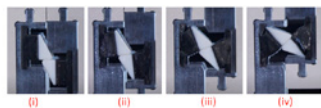
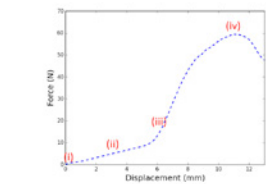


This paper will present a novel topology optimisation method that includes material performance and manufacturing constraints of 3D printed concrete, in order to save material and thus create more sustainable and more cost efficient structures.

9520

Multi-Material Ratchet-like Mechanism for Interlocking Joint Details

Sawako Kajjima, Amir Hosein Sakhaei, Tat Lin Lee



The paper presents the design and physical testing of a bespoke multi-material ratchet-like mechanism for interlocking contact surfaces. Our mechanism allows easy insertion of two or more elements while preventing them to easily dislodge by controlling the material layout and geometry.

9231

Numerical analysis and design of the 3D printed, pre-deformed moulds for small- and medium-scale concrete applications

Pawel Baran, Rob Nijse, Fred A. Veer, Rogier Houtman, Jeroen Coenders

The paper presents and validates the method for finite element modelling and design of the 3D printed moulds used as small- and medium-scale formwork. It explains how to translate the basic property test results into a numerical model and how to use it to fabricate components of complex geometries.



9496

Ceramic 3D printing – The future of brick architecture

Paulo Cruz, Ulrich Knaack, Bruno Figueiredo, Dennis de Witte

This paper presents the main challenges and outcomes of an ongoing research project aiming to explore the integration of digital additive manufacturing techniques in the architectural design and production processes of free-form stoneware bricks for building envelopes.



SESSION # 34

TIMBER GRIDSHELLS

chaired by N. N.

tuesday, september 26th

05:00 pm until 06:30 pm

seminar room 3.107



9725

Timber Grid Shell Exploration using Geodesic Segments

Marc Schultz

This paper discusses (1) explorations of the Geodesic Segments (GS) grid design method that permits architecturally dynamic design with a high degree of curvature; (2) the tools utilized to implement this method; (3) and the experiences of constructing prototypes with student participation.

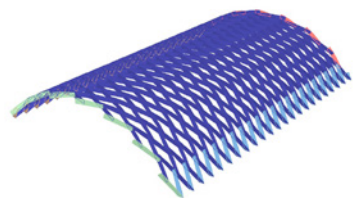


9861

The Airshell prototype: a timber gridshell erected through a pneumatic formwork

Alessandro Liuti, Alberto Pugnale, Sofia Colabella

The construction of a 7.5x7.5x3.3m timber gridshell prototype, erected by means of a pneumatic formwork and monitored via an Arduino board, is described. A comparison on construction speed, form-finding accuracy and precision is made between this erection method and a more conventional one.



10008

Parametric Engineering of a Historic Timber-Grid-shell-System

Cristoph Dijoux, Alexander Stahr, Lukas Franke, Christian Heidenreich

Zollinger-system is a material efficient historic grid-shell-system, based mainly on geometric relationships. A parametric definition and an evolutionary optimisation process are presented, to evaluate the efficiency and to propose improvements.

10264

The UWE Research Pavilion 2016

John Harding, Scott Hills, Stephen Melville, Cecilie Brandt-Olsen

This paper describes the design, fabrication and assembly of a doubly-curved elastic timber gridshell at The University of The West of England, UK. The benefits of both a sequential lath assembly and non-linear structural analysis using the K2Engineering (K2E) Grasshopper plug-in are highlighted.

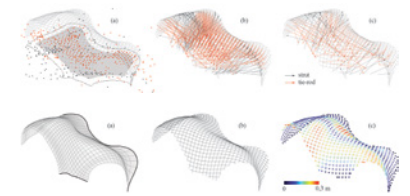


10378

InFormer: designing forming actions in post-formed grid-shells by means of MOGAs

Eduardo Pignatelli, Gabriele Mirra, Sergio Pone

The design of forming actions in a post-formed timber grid-shells has always represented a limit in the real construction of a digitally designed form. InFormer proposes a methodology to generatively design these forces with the aid of multi-objective genetic algorithms.



SESSION # 35

**CONCRETE LIGHT:
INNOVATICE CONCRETE CONSTRUCTIONS III**
chaired by Silke Scheerer & Phillipp Eisenbach

tuesday, september 26th

05:00 pm until 06:30 pm

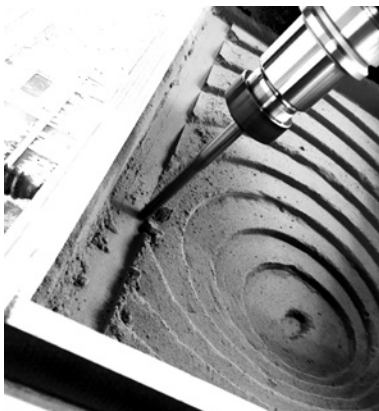
seminar room 3.108



9575

**Non-waste wax formwork-technology:
Innovative precision formwork for concrete members
made of recyclable industrial waxes**

Jeldrik Mainka, Harald Kloft, Elena Stein, Franz Wirth

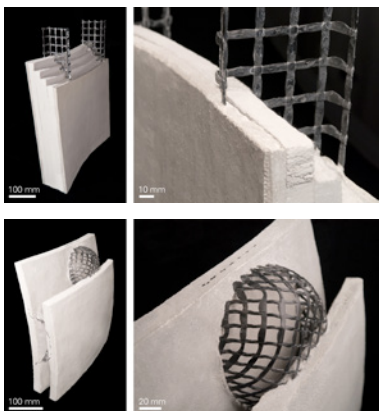


9249

**Reusable concrete formwork systems made of sand and
wax**

Philipp Eisenbach, Anne Liebringshausen, Manfred Grohmann

The paper presents a new sustainability and resource optimized process technology for complex concrete formworks. The complete formwork is produced with re-usable and non-hazardous materials, namely sand and wax, representing a new sustainable approach for the realization of extremely thin and double-sided curved concrete free-form shells.



9660

**Production of Curved Concrete Sandwich Panels Using a
Frozen Sand Formwork**

Oliver Gericke, Walter Haase, Werner Sobek

This paper concerns the production of concrete sandwiches using frozen sand formwork. The method is evaluated using two specimens of concrete sandwiches with components like shear reinforcement or thermal insulation. It will be shown that sandwiches can be produced precisely and with minimum waste.

9659

**Hybrid structural skin - prototype of elastic gridshell
braced with a concrete envelop**

Pierre Cuvilliers, Cyril Douthe, Lionel Du Peloux, Robert Le Roy

The concept of hybrid structural skin consists in an elastic gridshell braced with a concrete envelope. The gridshell serves as formwork for the concrete layer which is mechanically connected to the main grid, so that it assures the bracing of the grid and that its thickness is reduced to a minimum.



9 am - 11 am			11.30 am - 1 pm			2.30 pm - 4.30 pm			5 pm - 6.30 pm		
Hörsaal 200	session	Active Bending Structures I	coffee break						session	Active Bending Structure II	Hörsaal 200
	chair	Christoph Gengnagel, Julian Lienhard							chair	Julian Lienhard, Christoph Gengnagel	
	papers	10370, 9523, 10134, 10239, 9370							papers	10076, 10228, 9945, 9195, 9614	
2.103	session	Environmentally Compatible Structures (ECS) WG 18	coffee break						session		2.103
	chair	Petr Vegh, Andreas Falk							chair		
	papers	10250, 9677, 10350, 10033, 9976, 10138							papers		
2.104	session	Historic Shell and Spatial Structures	coffee break						session	Assessment and Preservation of Historic Spatial Structures WG 17	2.104
	chair	Matthias Ludwig, Maria Garlock							chair	E. Gorun Arun, Ian Smith, Horst Peseke	
	papers	9488, 9998, 10058, 10224, 10337, 10517							papers	9991, 10039, 10258, 9733, 10226	
2.107	session	Architectural Membrane Structures	coffee break						session	Inflatables	2.107
	chair	Jianhui Hu, Alessandra Zanelli, Wujun Chen							chair	Lars De Laet	
	papers	9465, 9805, 9508, 10257, 10002, 9742							papers	10302, 10521, 10289, 9849, 9633	
2.108	session	Glass & FRP & Aluminum	coffee break						session	Natural Engineering Materials	2.108
	chair	Michael Engelmann							chair	Martin Trautz, Patrick Teuffel	
	papers	9840, 10310, 9266, 9571, 9572							papers	9735, 9521, 9643, 10325, 10260	
3.107	session	Analysis and Design of Reticulated Shells Against Sever External Disturbance WG 8	coffee break						session	Optimization approaches to analysis and design I WG 13	3.107
	chair	Shiro Kato, Suduo Xue, Toru Takeuchi							chair	Yoshihiro Kanno, Makoto Ohsaki	
	papers	9948, 9882, 9746, 9591, 9238, 10368							papers	10057, 10171, 10190, 9528, 9576	
3.108	session	Computational Methods: Modeling							session	Computational Methods: Assessment	3.108
	chair	Dieter Dinkler							chair	Ekkehard Ramm	
	papers	10037, 9565, 9880, 9936, 10121, 10367							papers	10075, 10130, 9896, 9873, 9684	

Plenary Session

chaired by
Carlos Lázaro & Manfred Bischoff

Hangai Prize Presentation by Yafeng Wang

Keynote by Kai-Uwe Bletzinger

Keynote by Tibor Tarnai

Holcim Auditorium

Pecha Kucha Session

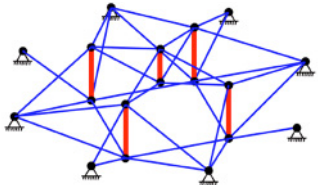
moderated by
Peter Cachola Schmal & Philippe Block

Holcim Auditorium

lunch

YAFENG WANG

Hangai Prize Awardee
11:30 am



Cable-dome form tensegrity systems :
E3-TS-1, without strut buckling constraint

Finding generalized and customized tensegrity systems by MILP-based topology optimization

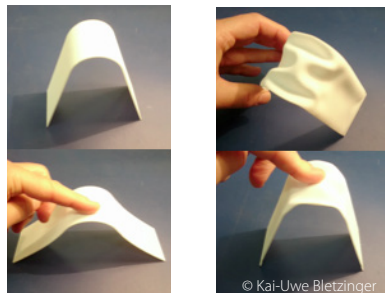
The MILP-based topology-finding approach is extended and improved to be a more general and adaptable scheme which is able to find generalized and customized tensegrity systems towards the engineering and multidisciplinary applications. Examples are given to explain the extensions and improvements.

KAI-UWE BLETZINGER

Prof. Dr.-Ing.
11:40 am



© Kai-Uwe Bletzinger
Norwegian pavilion, Shanghai Expo 2010



© Kai-Uwe Bletzinger
Shape optimization with Vertex Morphing,
3D printed prototype

Form finding by numerical shape optimization and Vertex Morphing – Large, effective and efficient

Kai-Uwe Bletzinger studied Civil Engineering at the Universities of Stuttgart and Calgary. In 1984 he joined the group of Prof. Ekkehard Ramm, placing special emphasis to the analysis and shape design of light weight structures such as shells and membranes. Receiving his PhD in 1990, his thesis topic was "Shape optimization of plate and shell structures" with numerical techniques combining CAD and FEM. Developing this subject ever since, he belongs to the leading experts in the field.

Since 1999 Professor Bletzinger is holding the Chair of Structural Analysis at the Technical University of Munich. His particular research interest includes the merging of analysis and design, where his group is leading in the development of shape optimization methods for large problems and the extension of the isogeometric analysis paradigm for the analysis and optimization of shells, multipatch coupling and consistent B-rep modelling. Besides his various positions for the scientific and professional community, e.g. as senior referee of the German Science Foundation, he has been serving as IASS member for many years.

Structural morphology as I have known it

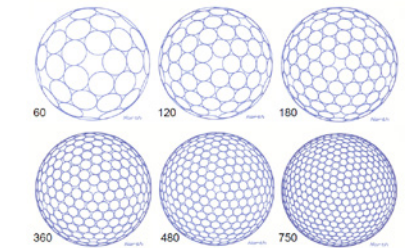
Tibor Tarnai is Emeritus Professor of Structural Mechanics at the Budapest University of Technology and Economics. He graduated in civil engineering and applied mathematics in Budapest, Hungary, where he also got his PhD in 1978. Later he became DSc and member of the Hungarian Academy of Sciences. Before joining the University in 1991 he worked as structural designer at different design and consulting firms in Szeged and Budapest, then as research fellow at the Hungarian Institute for Building Science. He has been a member of IASS since 1992. He is a member of WG 15 Structural Morphology, member of the Editorial Board of the Journal of IASS, and member of the Advisory Board. He is recipient of the Tsuboi Award. He was the vice-chairman of WG 5 Concrete Shell Roofs (1992-2015), member of the Executive Council (2005-2012), and member then chairman of the Tsuboi Award Committee (2009-2016). He was the guest editor of the first special issue of the International Journal of Space Structures. His main field of interest is structural topology including polyhedra, rigidity, and packing problems.

TIBOR TARNAI

Prof. em. Dr.
12:20 pm



© Günther Koller | Tibor Tarnai | Zsolt Gáspár
Icosahedrally symmetric packing



© Tibor Tarnai
Folded prismatic surfaces

SESSION # 36

ACTIVE BENDING STRUCTURES I

chaired by Christoph Gengnagel & Julian Lienhard

wednesday, september 27th

09:00 am until 11:00 am

Hörsaal 200 | lecture hall 200

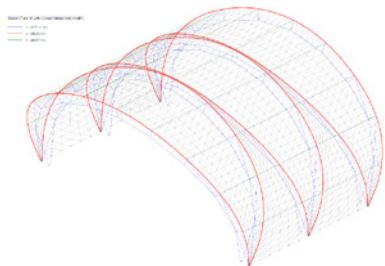


10370

A Collaborative Model for the Design and Engineering of a Textile Hybrid Structure

Julian Lienhard, Christian Bergmann, Riccardo La Magna, Jonas Runberger

A master class at HCU focused on collaborative design and engineering methods using textile hybrid structures as a case study. The paper will discuss the workflow models, including the principles that allowed the iterative development of form finding, detail design and fabrication planning.

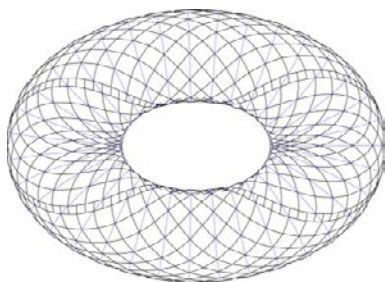


9523

Project development of an ultra-lightweight bending-active temporary structure

Carlotta Mazzola, Alessandra Zanelli, Bernd Stimpfle

This paper investigates the project development of an ultra-lightweight bending active structure. Its challenging design process is to create a lightweight building kit easy to handle and to build-up that guarantees both high resistance to load and high performance during its temporary service life.



10134

Building elastic gridshells from patches

Pierre Marquis, Amandine Cersosimo, Cyril Douthe

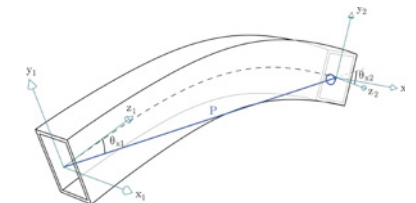
To build elastic gridshells, one must define the flat grids that will be deformed into the final 3D shapes. For complex topologies, this flattening is not possible without splitting the grid into independent sub-grids. This paper investigates such construction from patches.

10239

Sculptural Form finding with bending action

Jens Olsson, Mats Ander, Al Fisher, Christopher Williams

This paper demonstrates a method exploration for integration of bending action into the form finding process. The aim has been to facilitate the designer with means to compromise between structural efficiency and sculptural freedom for grid shell type of structures.

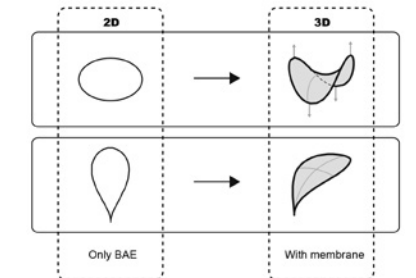


9370

A conceptual framework for analyzing and designing bending-active tensile hybrid structures

Evy Slabbinck, Seiichi Suzuki, Jonathan Solly, Anja Mader, Jan Knippers

In this paper, the core elements of bending-active tensile (BAT) hybrid structures are defined and a classification system is proposed based on the relationship between the active and passive use of the structural elements.



SESSION # 37

**ENVIRONMENTALLY COMPATIBLE
STRUCTURES (ECS) | WG 18**

chaired by Petr Vegh & Andreas Falk

wednesday, september 27th

09:00 am until 11:00 am

seminar room 2.103

Case study A: KAPUZINERARBEIT, Aachen (Germany) - Architects: Ingenieurbüro Overdick + Partner (2002)				Principle 1 [P/A]	Principle 2 [Wu/Wu]
A1- ETFE				FIXING SYSTEM	
				0,45	1:10,35
P (kg)	195,07	A (kg/m²)	390,82		
Wp (kg)	410,16	Wv (kg)	4.247,00		
Wp+wp (kg/m²)	1,05	Wp+wp (kg/m²)	10,37		
Wtot (kg)	4.657,36	Wtot+wp (kg/m²)	11,92		
A2- GLASS				FIXING SYSTEM	
				0,65	9,88:1
P (kg)	252,76	A (kg/m²)	390,82		
Wp (kg)	17.820,00	Wv (kg)	1.809,00		
Wp+wp (kg/m²)	45,00	Wp+wp (kg/m²)	4,63		
Wtot (kg)	19.629,00	Wtot+wp (kg/m²)	50,23		
A3- ETFE				FIXING SYSTEM	
				0,25	1:8,51
P (kg)	97,22	A (kg/m²)	390,82		
Wp (kg)	410,16	Wv (kg)	2.180,65		
Wp+wp (kg/m²)	1,05	Wp+wp (kg/m²)	5,56		
Wtot (kg)	2.591,01	Wtot+wp (kg/m²)	6,63		

10250

Application and validation of eco-efficiency principles to assess the design of lightweight structures: case studies of ETFE building skins

Carol Monticelli, Alessandra Zanelli, Mariangela Centrulli

The paper aims to validate a couple of design principles and sustainability criteria, which the authors stated after past research experiences on membrane structures. The aim is to validate the sustainable design criteria and their repeatability through 5 case studies of ETFE built structures.

10033

Numerical Analysis Method for Vibration Prediction of Proposed Building in Metro Operation Area

Caimin Zhong

Field measurements were made on a newly-built building adjacent to metro line and numerical analysis was carried out through different excitation input ways. Besides, comparison on calculation and measurement results were implemented to find the numerical analysis method for vibration prediction.

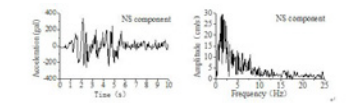


Figure 1: El Centro ground acceleration and frequency spectrum

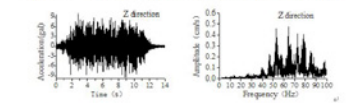


Figure 2: Ground acceleration and frequency spectrum above the subway

9677

How building taller affects environmental compatibility

Petr Vegh

Discussion of selected characteristics of a tightly built up and populated areas which affect the environmental compatibility both in a positive as well as negative way together with some aspects of a structural type which is widely used for high-rise building construction both in Canada and the US.

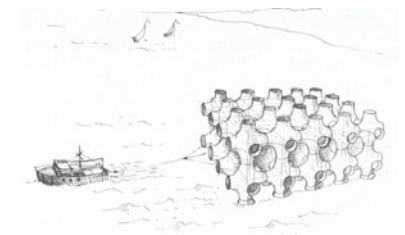


9976

Urban and infrastructures marine development based on 'Fill Material Free' technology

Michael Burt, Yehiel Rosenfeld

To allow City-Port coexistence and reduce their mutual frictions, ports have to expand into deeper waters, and the city has to reclaim most of its sea frontage for its own priorities. An alternative design paradigm is presented, based on the 'fill material free' marine technology.



10350

The limits in generating affordable residential space – a case study in Germany

Kerstin Wolff

In many German cities the housing demand is increasing and so the rental prices. Generating affordable residential space is becoming a major political and social demand, and the key task for the building sector. A project is presented which aims at generating affordable residential space.

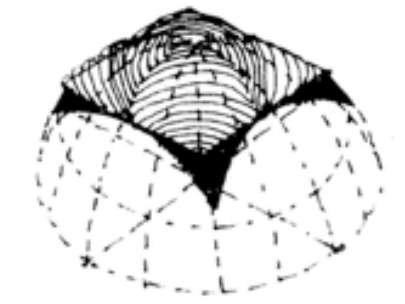


10138

Sustainable materials applicable to the construction of housing for vulnerable groups

Juan Gerardo Oliva-Salinas, Agustin Hernandez, Magdalena Trujillo-Barragan, Jose Alfonso Ramirez-Ponce, Marcos Ontiveros

The aim of this paper is to bring sustainable construction materials and cutting-edge technology closer together in order to impulse the use of these types of materials in the built environment, focusing on sustainable affordable housing for low-income vulnerable groups in Mexico.



SESSION # 38

HISTORIC SHELL AND SPATIAL STRUCTURES

chaired by Matthias Ludwig & Maria Garlock

wednesday, september 27th

09:00 am until 11:00 am

seminar room 2.104



9488

Steps towards a cultural center for structural design – an interface between the engineering profession and the public

Eberhard Möller, Hans Nungesser

This paper researches the circumstances of the foundation of the museums of architecture in Munich and Frankfurt in order to present motivation, inspiration and recommendable steps towards a cultural center for structural design as interface between the engineering profession and the public.

9998

“Formwork Virtuoso” Ulrich Müther (1934-2007): Exploring the Müther-Archive

Matthias Ludwig



Ulrich Müthers buildings stood out not only for their construction, but also for their exceptional spatial and architectural characteristics that were defined by their construction material – concrete.

10058

Setting the Edge Free: Candela’s Shells in San Antonio de las Huertas Church. Geometry and Construction

Juan Ignacio Del Cueto, Agustin Hernandez



This paper presents the evolution of the original design project for the church of San Antonio de las Huertas (De la Mora-Candela, CDMX, 1956), and it explains the building process and current condition, 60 years after its construction, according to two guidelines: geometry and construction

10224

Development and application of precast hyperboloid shells in East and West Germany from the 1950s to the 1980s

Tanja Scheffler

The structural engineer Herbert Müller (GDR) and the architect Wilhelm J. Silberkuhl (FRG) developed comparable roof shells which were mainly used for large industrial and sports facilities, but also for architecturally interesting public buildings like churches and museums.

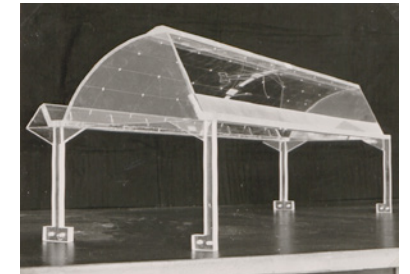


10337

Paths to Form Finding: The formative years of Heinz Isler

Rainer Schützeichel, Matthias Beckh

The paper investigates the formative years of the engineer Heinz Isler. The influence of his time as assistant at Pierre Lardy’s chair at ETH Zurich on his later understanding of concrete structures will be examined. Furthermore, it sheds light on his earliest usage of models as tools for measuring and for designing.



10517

Frontón Recoletos (Madrid, 1935) and Kimbell Museum of Art (Fort Worth/TE, 1972): a Structural Metaphor towards a New Monumentality

Marcos Petrolí, Paul Endres

Analysis of shell structures towards a modern figurative expressionism, and the raise of monumentality as character in universal programs on two iconic buildings: Frontón Recoletos, by Torroja and Zuazo (Madrid, 1935); and Kimbell Museum of Art, by Kahn and Komendant (Forth Worth/TE, 1972).



SESSION # 39

ARCHITECTURAL MEMBRANE STRUCTURES

chaired by Jianhui Hu , Alessandra Zanelli & Wujun Chen

wednesday, september 27th

09:00 am until 11:00 am

seminar room 2.107

9465

Electrical, thermal and mechanical properties of organic photovoltaic cells for buildings integrated photovoltaics (BIPV)

Jianhui Hu, Wujun Chen, Yue Yin, Yipo Li, Jinyu Zhou, Guozhi Qiu

This paper focused on electrical, thermal and mechanical properties and related effects with experimental investigations. An experimental program to obtain simultaneous properties was proposed and performed.

9805

Innovative Cable Net Curved-Glass Photovoltaic Façade

Nebojsa Jakica, Alessandra Zanelli



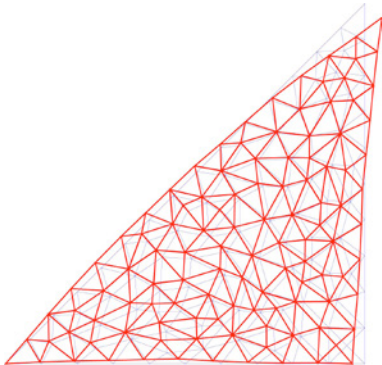
The paper presents a case study concept of curved-glass BIPV façade that is supported by a cable-net structure. The result is a high-performing and high-aesthetic façade that aims to provoke innovative thinking and connecting multidisciplinary realms and objectives in reaching sustainable solutions.

9508

Approximate method for cutting pattern optimization of membrane structures

Makoto Ohsaki, Shun Saburi, Fumiyoshi Takeda

A computationally efficient method is presented for approximate optimization of cutting pattern of membrane structures including ETFE film and PVC sheet. The plane cutting sheet is generated by minimizing the error from the shape obtained by reducing the stress from the desired curved shape.



10257

Retrofitting of ETFE roofs

Paolo Beccarelli, Roberto Maffei

This research paper describes the thermal performance of an existing ETFE roof in Verona and the subsequent retrofitting of the structure in order to meet the targets of solar shading specified by the client.

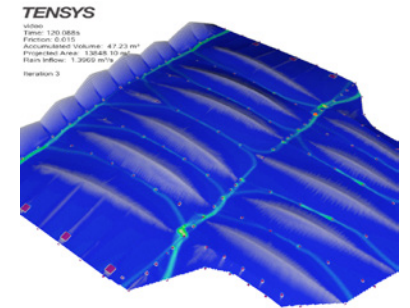


10002

Comparison of membrane structure ponding behaviour; uniformly applied water loads vs. steady state water flow conditions

Adam Bown, Tom Makin

Rainwater ponding is a key consideration in the design of tension structures. This paper reviews how potential for ponding has historically been assessed and introduces a new approach based on flow of rainwater over the membrane surface coupled with a series of time stepped static analyses.

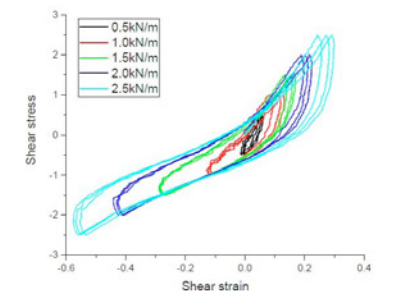


9742

Shear properties of P/G type architectural fabrics under biaxial extension

Wujun Chen, Chenjun Gao, Taibai Shi, Jianhui Hu

A modified biaxial shear test method was proposed for cruciform with 45 degree of yarns with respect to loading axis. Off-axis extension was performed on two common types of architectural fabrics with force control mode. The experimental results show strong nonlinear shear behavior of the fabrics.



SESSION # 40

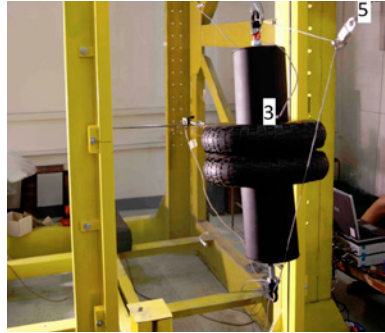
GLASS & FRP & ALUMINUM

chaired by Michael Engelmann

wednesday, september 27th

09:00 am until 11:00 am

seminar room 3.108



9840

Experimental pendulum tests of laminated and float glass plates

Ján Brodniansky, Ľuboš Balcierák, Tomáš Klas

Glass is fragile elastic material. The impact is one of the most important factors in the design of glass load-bearing elements. Safety is the most important element that allows to design any of the glass structures.

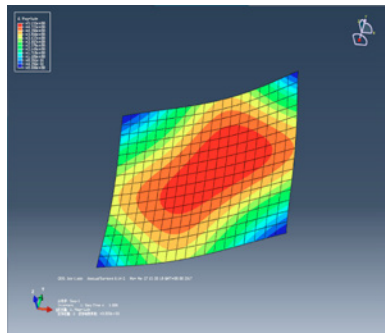


10310

Post-breakage performance of a spherical glass shell

Michael Engelmann

introduction into all-glass shell structures and a case study problem: finding its critical post-breakage scenario stepwise calculation of the eigenmodes of the damaged shell calculation of critical scenarios consecutive calculation exposed critical facets in a "post post-breakage" state



9266

Numerical Simulation of Glass-Fiber-Reinforced Polymer for Curved Facade Screen Panel

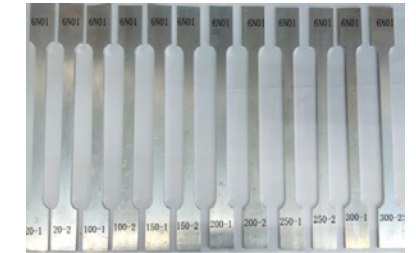
Yuchao Zhao, Xu Jiang, Qilin Zhang, Qi Wang

A common type GFRP panel is adopted to free-form curved facade, numerical simulations are conducted to analyze the deformation and stress of panels under loading with different curvature respectively. The results indicate that GFRP can satisfy the facade demand, but the deformation is large.

9571

Experimental Research on Mechanical Property of Aluminum Alloy at Elevated Temperatures

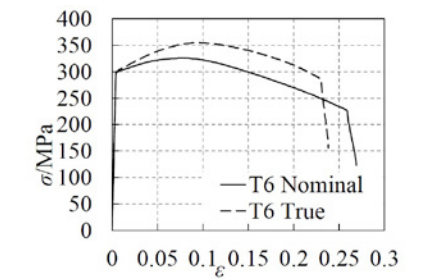
Shaojun Zhu, Xiaonong Guo, Zhipeng Gao, Lei Tao



9572

Cyclic Loading Tests of Structural Aluminum Alloy

Li Wang, Xiaonong Guo, Linlin Liu, Jiamin Zou



SESSION # 41

**ANALYSIS AND DESIGN OF RETICULATED SHELLS
AGAINST SEVER EXTERNAL DISTURBANCE | WG 8**

chaired by Shiro Kato, Sudue Xue & Toru Takeuchi

wednesday, september 25th

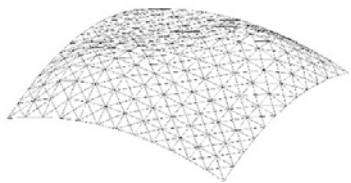
09:00 am until 11:00 am

seminar room 3.107

9948

Dynamic stability analysis of cable-stiffened single-layer latticed shells subjected to seismic loading

Pengcheng Li, Chenglong Zhang

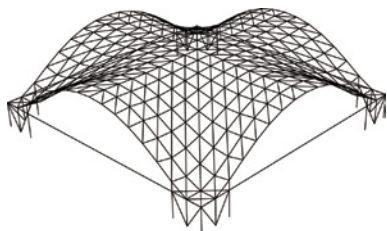


This current work examines the dynamic property of cable-stiffened single-layer latticed shells using finite element analysis. It has been illustrated that the nonlinear seismic behaviour of latticed shell has been significantly improved by the introduction of pre-tensioned cables.

9882

Two-mode based evaluation of seismic loads for free-form single layer reticulated shell structures supported by substructures

Shiro Kato, Yuji Takiuchi, Shoji Nakazawa



The present study proposes a scheme to determine the distribution of static seismic load onto free-form reticulated shells. The accuracy of the proposed seismic loads is proved by comparison between the static analysis and a time history dynamic analysis.

9746

The resilience performance classification of latticed shell structures and the primary research of the evaluation system

Tingting Liu, Zheng He

	Ds_1	Ds_2	Ds_3	Ds_4	Ds_5
Re_1	●	●	●	●	●
Re_2	○	○	○	○	○
Re_3	○	○	○	○	○
Re_4	○	○	○	○	○
Re_5	○	○	○	○	○

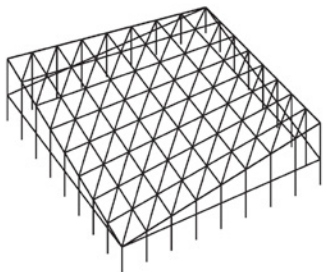
Classification of immediate seismic resilience performance levels. Proposed target performances of global seismic damage and seismic resilience corresponding to different seismic fortification levels.

9591

Seismic response evaluation of HP lattice shells with various natural period ratios between roofs and supporting substructures

Kazuya Nitta, Kumagai Tomohiko, Toshiyuki Ogawa

The response characteristics of the HP lattice shells with various stiffness of the roof or supporting substructures are investigated by numerical analyses. In addition, the seismic response evaluation method for HP lattice shells considering the change of the stiffness is proposed.

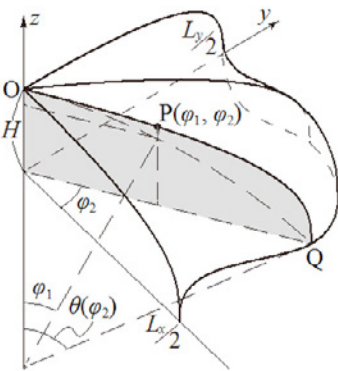


9238

Seismic response evaluation of freeform lattice shell roof using amplification factors

Toru Takeuchi

In this study, seismic response of freeform roof structures using optimization methods and a numeric form-finding process are investigated. The effects of the roof shape, rise-span ratio, and supporting substructures on the seismic response are studied, and the simple evaluation method is proposed.



10368

Effect of strain rate on seismic response of single-layer spherical reticulated domes

Lingling Xu, Jihong Ye, Mingfei Lu, Ruoqiang Feng

A calculation method is proposed to consider strain rate effect in the nonlinear dynamic analysis. The effect of strain rate on the elasto-plastic displacement responses of structures subjected to earthquake action as well as strain rate relevance at different peak accelerations are discussed.



SESSION # 42

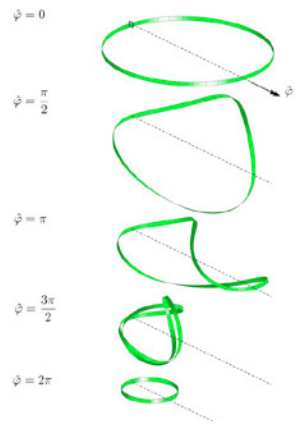
COMPUTATIONAL METHODS: MODELING

chaired by Dieter Dinkler

wednesday, september 27th

09:00 am until 11:00 am

seminar room 3.108

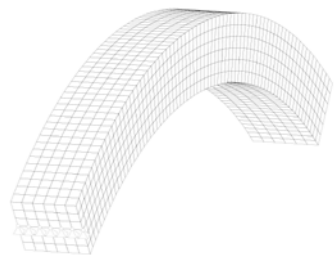


10037

Isogeometric analysis with hierarchic shell elements -intrinsically free from locking by alternative parameterization

Ekkehard Ramm, Bastian Oesterle, Manfred Bischoff

We present shear deformable shell formulations for small and large rotations which are intrinsically free from transverse shear locking, independent of the underlying discretization. An additive strain decomposition dramatically facilitates representation of large rotations in shell analysis.

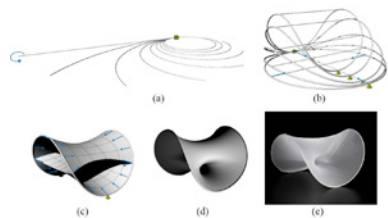


9565

Geometrically Nonlinear Analysis of Three Dimensional Structure Model by Finite Element Technique with Coordinates Assumption

Akinori Honda, Toshio Honma, Yohei Yokosuka

In this paper, the numerical examples of the geometrically nonlinear analysis by a three-dimensional (3D) element adopting a new finite element technique that we developed are shown. We apply to a direct analysis and a shape optimization analysis for an arch structure model using this element.



9880

Isogeometric Analysis for Modeling and Simulation of Building Processes

Anna Bauer, Philipp Längst, Roland Wüchner, Kai-Uwe Bletzinger

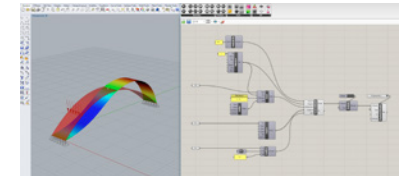
Isogeometric analysis provides the fundamental features for a simple further processing of analysis results within CAD. This contribution presents IGA-based simulation of building processes of slender (bending-active) structures with highly flexible components and several construction stages.

9936

The Potentials of Isogeometric Analysis Methods in Integrated Design Processes

Philipp Längst, Anna Bauer, Alexander Michalski, Julian Lienhard

Isogeometric analysis allows to unify the working environment of architecture and engineering. In this contribution the interface Kiwi3d is presented, which enables to seamlessly link NURBS-based analysis with parametric CAD modelling.



10121

On the calculation of transverse shear stresses of layered plates with a mixed refined zigzag theory

Max Köppler, Werner Wagner

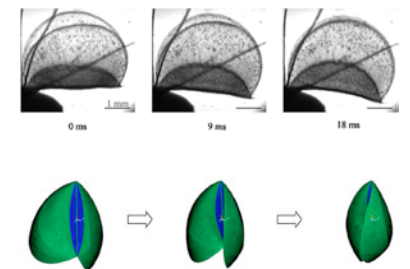
A mixed refined zigzag theory for the modeling of laminated heterogeneous plates and its finite element implementation is presented. The effectiveness of the proposed formulation is demonstrated by means of numerical investigations.

10367

Modeling and analysis of the trapping mechanism of Aldrovanda vesiculosa as biomimetic inspiration for façade elements

Manfred Bischoff, Renate Sachse, Anna Westermeier, Axel Körner, Larissa Born, Simon Poppinga, Götz Gresser, Thomas Speck, Jan Knippers

Mechanical modeling and analysis of the compliant mechanism of the carnivorous plant Aldrovanda vesiculosa is presented. Its abstraction and implementation in a façade element as an example of biomimetic architectural design are briefly described.



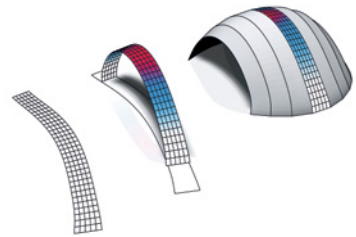
PECHA KUCHA

moderated by Peter Cachola Schmal & Philippe Block

wednesday, september 27th

02:30 pm until 04:30 pm

Holcim Auditorium

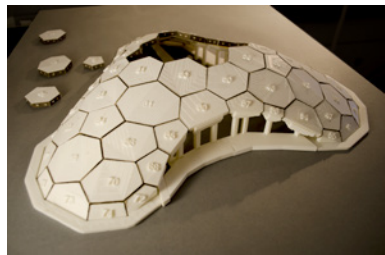


9436

Bending-Active Segmented Shells

Jan Brütting, Axel Körner, Daniel Sonntag, Jan Knippers

A new structural system that combines the benefits of segmented shells and active bending is presented. Initially planar plate elements are bent and connected to freeform surfaces with a very simple construction process, while achieving the structural efficiency of a shell.

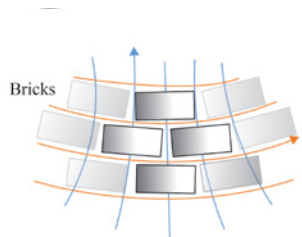


9509

Assembly-aware design of masonry shell structures: a computational approach

Gene Ting-Chun Kao, Axel Körner, Daniel Sonntag, Long Nguyen, Achim Menges, Jan Knippers

This paper proposes a workflow for Assembly-Aware Design (AAD) of masonry shell structure and introduces an interactive tool in a CAD environment to assist the designers in reducing extensive falsework during the construction phase of masonry shell construction.



9647

Brick patterns on shells using geodesic coordinates

Emil Adiels, Mats Ander, Christopher Williams

We present two separate strategies for generating brick patterns on free form shells and vaults using geodesic coordinates. The first strategy integrates structural action and pattern in a form finding procedure, the second strategy enables exploration of multiple patterns on arbitrary surfaces.



9665

Shell Design Considerations for 3D Printing with Drones

Paul Shepherd, Christopher Williams

This paper discusses the structural engineering aspects of a multi-disciplinary research project developing a swarm of autonomous flying drones, capable of 3D printing structures of arbitrary geometry and with no theoretical limit on their size.

9845

Structural Design with Reclaimed Materials: an Elastic Gridshell out of Skis

Sofia Colabella, D'Amico Bernardino, Corentin Fivet, Endrit Hoxha

This paper presents the design and construction of a 62m² gridshell, the rigidity of which is achieved through the bending of an initially flat grid of reclaimed skis.

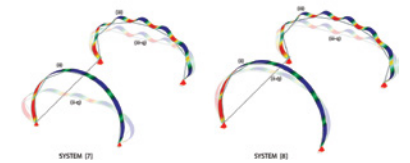


9865

Hybrid bending-active structures with multiple cables

Kristis Alexandrou, Marios C. Phocas

The paper refers to a comparative form-finding and load-deformation Finite-Element Analysis of arch hybrid systems of single planar bending-active strips of continuous length, multiply segmented (two to eight) and respectively coupled with cable elements.

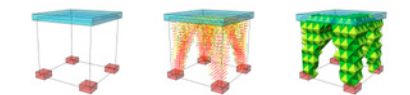


10155

Aggregated Structures: Approximating Topology Optimized Material Distribution with Discrete Building Blocks

Andrea Rossi, Oliver Tessmann

The paper proposes a design and fabrication concept, based on discretization of topology optimized material distributions with modular aggregation of repetitive units. It outlines the discretization process, and proposes a method for evaluation and optimization of stability of resulting assemblies.

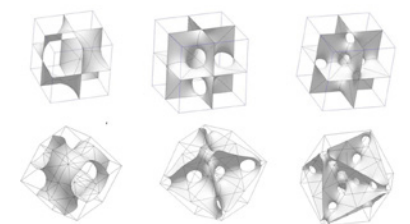


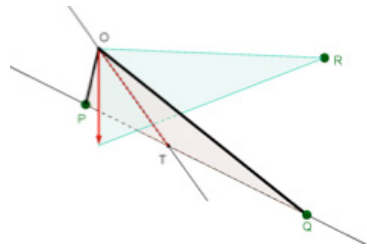
10261

Morphogenesis of continuous, efficient and complex architectural surfaces associated to crystal systems

Andrés Miguel Rodríguez, Prof. Dr.-Ing. Jesús Anaya Díaz

Obtaining architectural surfaces with high degree of reproducibility, based on continuous, complex and efficient solutions, can be defined by the application of parameters that belong to the development of minimal surfaces with crystalline structure associated to crystal systems.



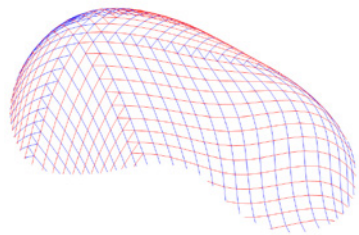


9196

20th Century 3D Graphical Analysis in the 21st Century: Statics and Kinematics

Edmond Saliklis, Sydney Gallion

This paper revisits the Williot-Mohr Diagrams for displacement analysis of 2D and 3D trusses. The statics of 3D trusses are re-visited using a simple two-step process. The kinematic displacement analysis follows the original Williot method and adds a correction analogous to the Mohr correction.



9947

Structural analysis of gridshells designed from singularities

Ricardo M. Avelino, Olivier Baverel

This paper analyzes rigid and elastic gridshells designed from singularities to allow innovative forms and improve the structural behavior. The proposed meshes had their stiffness increased and their stresses due to the shaping reduced encouraging the application of such a design philosophy.

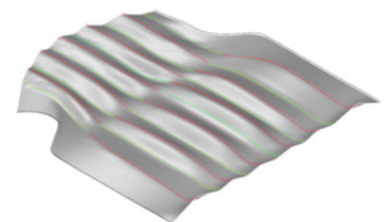


10162

Digital fabrication phasing for monolithic shells

Stephanie Chaltiel, Maite Bravo

Preliminary experiments in 3d printing of clay monolithic shells reveal that one of the most deterministic factors is related to the protocol established in a sequence to complete the process, which has been denominated "phasing". This paper reveals this critical time-based sequence.



10183

Generative geometry workflows – from concept to fabrication

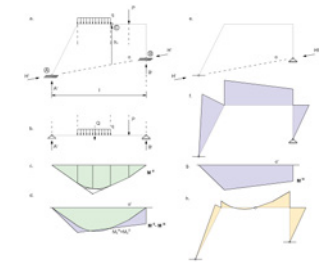
Kais Al-Rawi

9754

Affine transformations of three-hinged arches: reviving an old method

Maja Baniček, Krešimir Fresl, Elizabeta Šamec, Heinrich Werner

Paper revives a graphical procedure for drawing bending moment diagrams for three-hinged systems. The superposition method for drawing bending moments for vertical loads using affine transformation is described and then a generalization of the superposition method for general loading is presented.



10135

House of Cards – design and implementation of a paper house prototype

Jerzy Latka

The House of Cards is a prototype of cardboard house unit designed and implemented as an answer for contemporary and future generations' problems including so called neo-nomads as well as refugees and other people who were forced to leave or lost their homes.



10154

3D printing of ice

Arno Pronk, Yaron Moonen, Masa Ostap, Peng Luo, Yue Wu

In this research a concrete printer has been transformed for the printing of ice composites. The paper will present the first experiments that have been realised. The final goal of this research is to accomplish 3D printing of ice for Mars and Arctic missions.

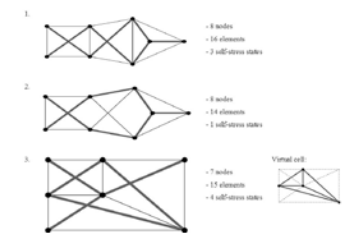


10291

Cellular composition of planar tensegrity structures

Omar Aloui, Landolf Rhode-Barbarigos

This paper presents a novel bio-inspired approach for the combined topology definition and form finding of planar tensegrity structures based on tensegrity units (cells) opening the door to the development of a whole new realm of tensegrity systems with controllable characteristics.



SESSION # 43

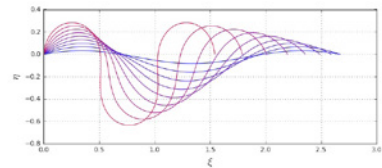
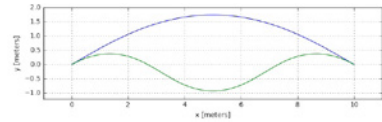
ACTIVE BENDING STRUCTURE II

chaired by Julian Lienhard & Christoph Gengnagel

wednesday, september 27th

05:00 pm until 06:30 pm

Hörsaal 200 | lecture hall 200

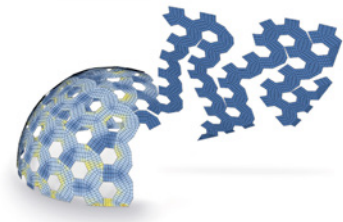


10076

Form-finding of bending-active structures using kinematic constraints

Juan Bessini, Carlos Lázaro, Salvador Monleón

In this paper we explore the possibility of doing form-finding in bending-active structures using kinematic constraints and geometrical design parameters. For that purpose, the problem of the elastica is studied analytically as the elemental solution for a bent rod.



10228

On the behaviour of bending-active plate structures

Riccardo La Magna, Jan Knippers



9945

Torsion as a design driver in plate-bending-active tensile structures

Evy Slabbinck, Axel Körner, Jan Knippers

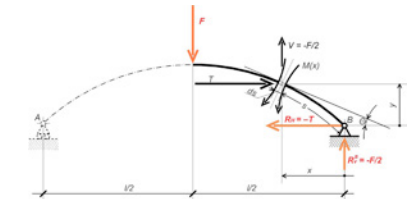
This paper investigates and demonstrates the structural and architectural potentials of torsion in plate elements for bending-active tensile structures and evaluates the limits to which torsion can be employed in plate-hybrid structures.

9195

Extension of elastica methodology to inflated cushions under applied transverse loading

Slade Gellin, Romuald Tarczewski

The behavior of inflated cushion structures under active bending and applied transverse loading is explored. The analytical methodology employed is an extension of that done in a previous study for the elastica problem.

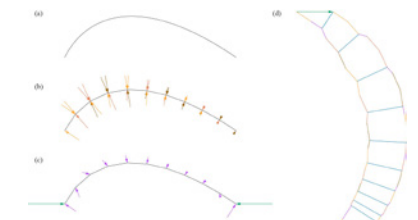


9614

Graphic statics principles for the design of actively bent elements shaped with restraining systems

Léa Boulic, Joseph Schwartz

As an alternative to existing form-finding design methods, and based on graphic statics principles, a novel method for the design of planar actively bent elements shaped with restraining systems into a chosen curved geometry is presented. The method and the different design parameters are shown.



SESSION # 44

**ASSESSMENT AND PRESERVATION OF HISTORIC
SPATIAL STRUCTURES | WG 17**

chaired by E. Gorun Arun, Ian Smith & Horst Peseke

wednesday, september 27th

05:00 pm until 06:30 pm

seminar room 2.104

9991

Structural morphology of a masonry space dome in Historical Tabriz Bazaar Complex

Mohammad Reza Chenaghlou, Ahad Nejad Ebrahimi, Yaser Shahbazi, Mohammad Kheirollahi, Amir Amjad Mohammadi

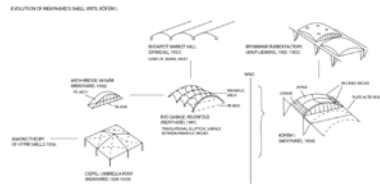
In this paper, structural morphology of a masonry space dome in historical Tabriz bazaar complex has been studied. In this regard, the performance of one of the traditional covered space with complicated configuration of special masonry intersecting arches (Karbandi) was assessed.

10039

Shell roofing of the KÖFÉM Factory – historical case study on the effect of geometrical imperfection

Réka Mándoki, Orsolya Gaspar, Istvan Sajtos

We present a case study on KÖFÉM I. (Menyhárd, 1959), that defined Hungarian post WWII. shell architecture. Despite its impact, the shell's history started with the collapse of the experimental mock-up. We use parametric modelling and FEA seeking for the key factors that resulted in the catastrophe.



10258

Sensor placement strategies with application to the Hall B of Torino Esposizioni by Pier Luigi Nervi

Erica Lenticchia, Rosario Ceravolo, Beatrice Ranaldo Francesco Antonucci

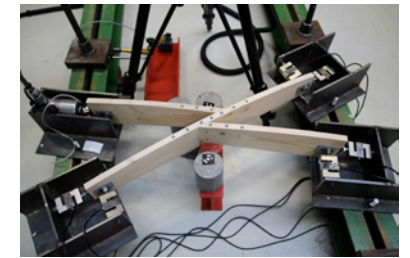
This paper concerns the optimal sensor placement for vibration-based monitoring of one of the vaulted structures built by Pier Luigi Nervi in the Torino Esposizioni complex. The dynamic behavior of the structure is analyzed as well as the effects of non-structural elements on its response.

9733

How does the Zollinger Node really work?

Lukas Franke, Alexander Stahr, Cristoph Dijoux, Christian Heidenreich

It is presented a structural experimental investigation to a better understanding of the nodal behavior. In this, the wooden Zollinger nodal connection from the 1920s and a new developed nodal connection are investigated and compared.



10226

Documentation of Félix Candela's Jamaica Market hyper shells in Mexico City.

Marisela Mendoza, Benachir Medjdoub, Moulay Chalal

The present paper documents the history and architecture of the Old Jamaica Market built by Felix Candela in Mexico City, 1956, and demolished after the 1985 earthquakes.



SESSION # 45

INFLATABLES

chaired by Lars De Laet

wednesday, september 27th

05:00 pm until 06:30 pm

seminar room 2.107

10302

How to inflate a hardened concrete shell with a weight of 80 t

Benjamin Kromoser, Johann Kollegger



A very resource efficient shell construction method called "Pneumatic Forming of Hardened Concrete (PFHC)" was invented at TU Wien. The paper describes a first practical application of the construction method for a concrete shell (event canopy) in Austria on behalf of the Austrian railways (ÖBB).

10521

Ontario Celebration Zone pavilion: a large pneumatic structure

Hauke Jungjohann, Walter Woodington, Viktoria Henriksson



The project is an assembly of two Polyester/PVC-pneumatic structures located at the east coast of Lake Ontario in Toronto/Canada. A form finding exercise for gravity loads and wind loads was performed.

10289

Form finding of deep space exploration surface habitats

Valentina Sumini, Caitlin Mueller



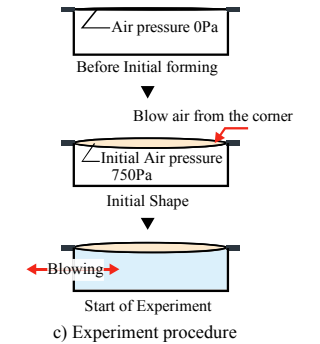
This research aims to explore form finding strategies for deep space exploration habitats on the Moon and Mars. A new sphere packing form finding approach has been studied to optimize the location of different functions inside a space habitat and respond to the high pressure differentials required.

9849

Study on Basic mechanical properties of ETFE sealed Air Cushion - Study of the Behavior under Partial Distributed Snow Load and Progressive Ponding -

Hitoshi Yonamine, Akira Okada, Naoya Miyasato, Shuzo Hiroishi, Kazuma Goto, Jun Miyauchi

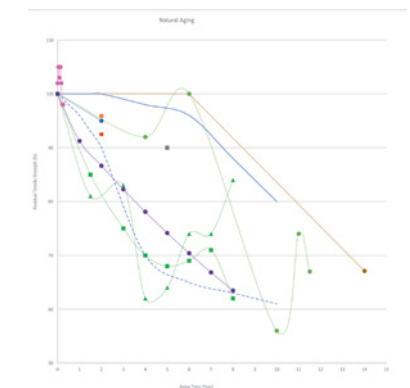
An experiment and a numerical analysis of the ETFE Sealed Air Cushion were conducted, using parameters of different initial shapes and loading patterns. Furthermore, a study of progressive ponding phenomenon was considered under water loading.



9633

A survey on strength deterioration of Polyester-PVC fabrics

Hastia Asadi, Jörg Uhlemann, Natalie Stranghöner



SESSION # 46

NATURAL ENGINEERING MATERIALS

chaired by Martin Trautz & Patrik Teuffel

wednesday, september 27th

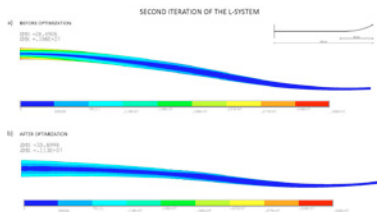
05:00 pm until 06:30 pm

seminar room 2.108

9735

Structural tree growth optimization

Andrija Pranjić, Martin Trautz, M.Sc. Giovanni Della Puppa



It is necessary to observe the trees mechanic and structure together with the environment (gravity, tropism...). For a natural form optimization with the axiom of uniform stresses, shape algorithms are implemented in every growth process increment within the tree simulation.

9521

Fungal mycelium as a building material

Franziska Moser, Martin Trautz, Anna-Lena Beger, Manuel Löwer, Georg Jacobs, Felicitas Hillringhaus, Alexandra Wormit, Björn Usadel, Julia Reimer

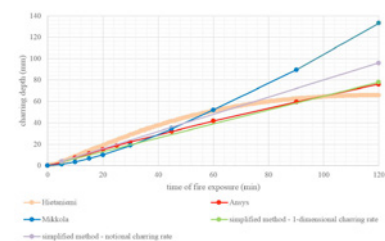


With favorable material characteristics and fast growth, fungal mycelium is a promising natural material. A research project at the RWTH Aachen University examines the possibility of increasing the strength and stiffness of fungal materials with the aim of creating load-bearing building components.

9643

Charring rate of timber structures in fire

Zuzana Kamenická, Jaroslav Sandanus



It is possible to use advanced calculations to analyze different kinds of connections in timber structures, CLT panels, the influence of some defects in timber. This paper presents the advanced design methods for determination of the charring rate depending on the time of fire exposure.

10325

Bio-Based Composite Bridge – Lessons Learned

Rijk Blok, Patrick Teuffel

The world's first bio-based composite pedestrian bridge was realised at the campus of Eindhoven University of Technology. The paper describes the evaluation of material tests, comparison of the FEM analysis with the 1:1 scale load test as well as the monitoring of the bridge after installation.



10260

Timber joints and reinforcements with self-tapping screws – performance and challenges using high bonding lengthss

Christoph Koj, Martin Trautz

This paper gives a summary of the research on timber joints and reinforcements with self-tapping continuously threaded screws (STS), that has been conducted at the Chair of Structures and Structural Design of RWTH Aachen University.



SESSION # 47

OPTIMIZATION APPROACHES TO ANALYSIS AND
DESIGN I | WG 13

chaired by Yoshihiro Kanno & Makoto Ohsaki

wednesday, september 27th

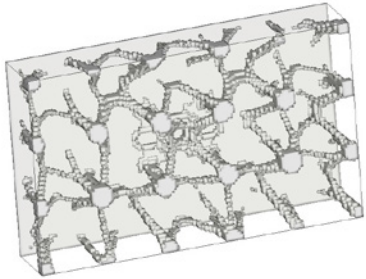
05:00 pm until 06:30 pm

seminar room 3.107

10057

Topology optimization of 3D structures using Hamiltonian MPS method Improved ESO method

Masaki Yamashita, Masatoshi Manabe, Shinya Matsumoto, Daiji Fujii

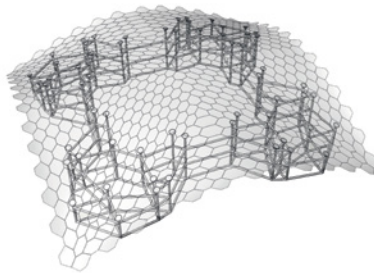


In this paper, we propose a topology optimization method using the Hamiltonian MPS (Moving Particle Simulation) method instead of the voxel finite element method. The improved ESO (IESO) method is used for the topology optimization.

10171

Reversed deconstruction: A method for the optimized assembly of prefab shell structures

Simon Luitse, Peter Eigenraam



This paper presents the preliminary result of an ongoing research into the optimization of shell construction methods. Deconstruction is an analysis method that allows for an optimized assembly of prefab shell structures with a minimal amount of temporary supports; saving both time and money.

10190

Building design using topology optimization method

Momoko Watanabe, Shinya Matsumoto, Daiji Fujii



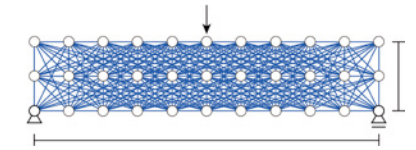
In this paper, we try to design building structure using topology optimization method. Improved Evolutionary Structural Optimization (IESO) method is used for creating the free form building structure. And, 3D printer is used for making architectural model.

9455

A heuristic for truss topology optimization under constraint on number of nodes

Yoshihiro Kanno, Shinnosuke Fujita

Truss topology optimization with the upper bound constraint on the number of nodes is considered. We show that this problem is formulated as a second-order cone programming with a cardinality constraint, and present a heuristic algorithm based on the alternative direction method of multipliers.



9576

An optimization method for generating self-equilibrium shape of curved surface from developable surface

Jinglan Cui, Makoto Ohsaki

In this study, we propose a method to generate a membrane structure from a developable surface. The method consists of generation of developable surface, correction of cutting pattern by adjustment of edge lengths of triangular elements, and reduction of target uniform stress.



SESSION # 48

COMPUTATIONAL METHODS: ASSESSMENT

chaired by Ekkehard Ramm

wednesday, september 27th

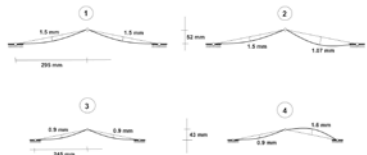
05:00 pm until 06:30 pm

seminar room 3.108

10075

Instability assessment of shallow structures using image capturing

Fabio Bazzucchi, Amedeo Manuello Bertetto, Alberto Carpinteri

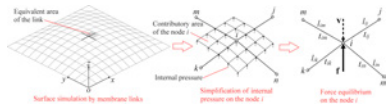


In this paper, the possibility to assess the instability load of a system through image capturing was presented. Several Von Mises arch-like structure were realized, tested and identified by photo capturing.

10130

An in-situ method for numerical simulation of inflatable membrane structure based on photogrammetric measurement

Bing Zhao, Wujun Chen, Guozhi Qiu, Jianhui Hu, Zhongliang Jing

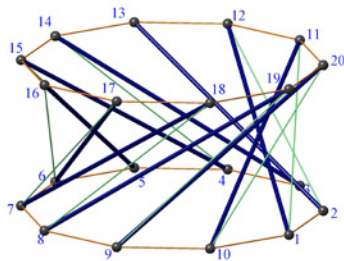


This paper presents a methodology to establish finite element model of inflatable membrane structure from the measurement result of dynamic shape by means of photogrammetry for further numerical simulations and structural estimation.

9896

Automatic and exact symmetry recognition of structures exhibiting high-order symmetries

Yao Chen, Linzi Fan, Jian Feng



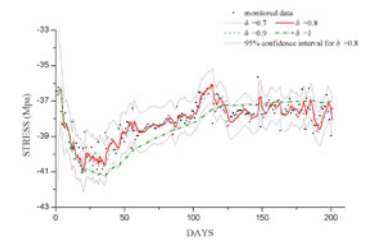
Symmetry is self-evident or manually recognized. Here, we propose an automatic symmetry recognition approach for engineering structures with high-order symmetries. Examples show that the proposed approach can accurately and effectively recognize the symmetries of various engineering structures.

9873

An application of Bayesian dynamic model for Structural degradation estimation based on health monitoring data

Zhi Ma, Yaozhi Luo

The main purpose of this paper is to present an efficient method with Bayesian dynamic model about assessment and prediction in real time for structural local degradation. And an existing revolving structure is used to validate the effectiveness of the proposed Bayesian method.

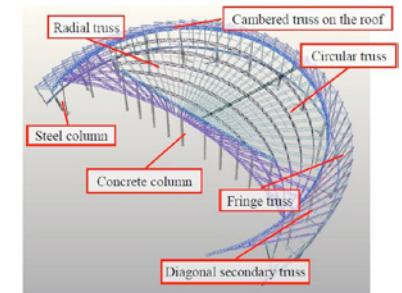


9684

A Monitoring Data Processing Method for Steel Structures during the Unloading Process of Temporary Supports

Xixin Gao, Yongfeng Luo, Lei Wang

In this paper, a monitoring data processing method for large-span and complicated structures during the unloading process of temporary supports was proposed. In this method, the effective representative stress and displacement are defined, and the curves of them with unloading steps was developed.



	9 am - 11 am	11.30 am - 1 pm	2.30 pm - 4.30 pm	5 pm - 6.30 pm	
Hörsaal 200	session Digital Design				Hörsaal 200
	chair Kim Boris Löffler, Moritz Heimrath				
	papers 9752, 9985, 10227, 10457, 10026				
2.103	session Tensegrity				2.103
	chair Ken'ichi Kawaguchi				
	papers 10153, 10274, 10253, 9679, 9537, 10817				
2.104	session Identification and Documentation of Historic Spatial Structures WG 17				2.104
	chair E. Gorun Arun, Alberto Domingo				
	papers 9666, 10157, 10198, 10251, 10324, 9974				
2.107	session Education at the Intersection of Architecture and Structural Engineering				2.107
	chair Michael Staffa, Annette Bögle				
	papers 9221, 9522, 9548, 9562, 10818				
2.108	session Cross-disciplinary design and production of bio-based structures WG 12				2.108
	chair Andreas Falk, John Chilton				
	papers 9589, 9871, 10268, 10377, 10285, 9979				
3.107	session Optimization approaches to analysis and design II WG 13				3.107
	chair Makoto Ohsaki				
	papers 9455, 9524, 9554, 9820, 9993, 10052				
3.108	session Computational Methods: Application				3.108
	chair Manfred Bischoff, Jens Schneider				
	papers 9459, 10197, 10330, 10103, 9236, 10290				

Closing Ceremony

chaired by
Julian Lienhard & Stefan Peters

impressions of the IASS 2017
Hangai Prize Presentation
by Hiromi Yasuma

Keynote by Neil Thomas

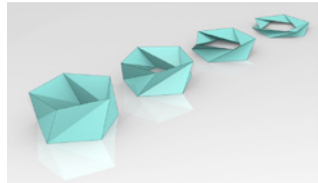
Holcim Auditorium

lunch

Technical Tour:
Structural City Walks

HIROMI YASUDA

Hangai Prize Awardee
11.30 am, Holcim Auditorium



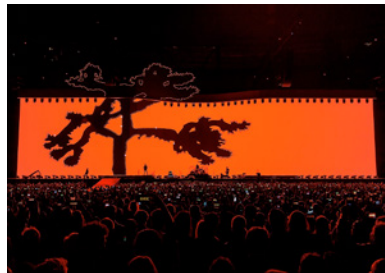
Folding motion of the Triangulated Cylindrical Origami (TCO)

Tunable frequency band structure of origami-based mechanical metamaterials

We study origami-based mechanical metamaterials composed of the Triangulated Cylindrical Origami (TCO). Our analysis on a 1D chain of TCO units demonstrates the formation of tunable frequency band structures, which can be manipulated by the arrangement of the units and their initial configurations.

NEIL THOMAS

Prof. MBE
11.45 am, Holcim Auditorium



People who need People

Neil Thomas is the Founder & Director of Atelier One, which has been described as 'the most innovative Engineering Practice in the UK'.

Atelier One has gained an international reputation as a Structural Engineering Practice specializing in challenging projects. Collaborations with Architects, Artists, and Designers have resulted in many interesting built projects such as Gardens by the Bay with Grant Associates & Wilkinson Eyre, London 2012 & Sochi 2014 Olympics Opening Ceremonies, Cloud Gate with Anish Kapoor and 'The Claw' Stage for U2's 360 Degree World Tour, with Mark Fisher.

Neil holds a number of high profile posts in the UK & US educational service, most recently being a Visiting Professor to Yale and MIT, and has co-written a book titled 'Liquid Threshold' which gives insight to the complex challenges of a number of extraordinary projects. Most recently Neil has been appointed by Leeds University as a member of a Steering Group to develop a new Architectural Engineering course.

SESSION # 49

DIGITAL DESIGN

chaired by Kim Boris Löffler & Moritz Heimrath

thursday, september 28th

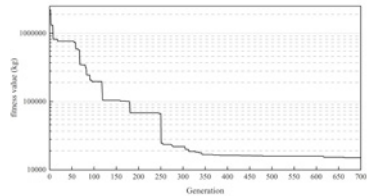
09:00 am until 11:00 am

Hörsaal 200 | lecture 200

9752

Parametric Structural Dynamic Optimization of Steel Frame Using Rhino3D

Xiao Lai, Jiayi Li, Zheng He



A structural dynamic optimization method using parametric modeling technique is proposed for aseismic steel frame structures, in which an interactive interface package is provided.

10457

Design optimization of glued-laminated timber freeform structures with multi-objective constraints

Frank Wellershoff, Roman Baudisch, Matija Posavec

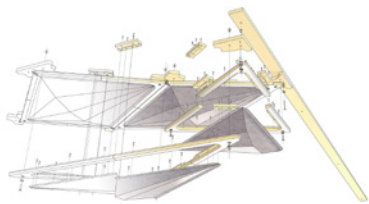
This paper presents a novel approach for the design of spatial structures with curved glued-laminated timber girders and their connections, within a multi-objective platform.



9985

Adaptable acoustic structures – design, detailing and fabrication of a fully parametric acoustic ceiling

Moritz Rumpf, Markus Schein, Johannes Kuhn, Manfred Grohmann



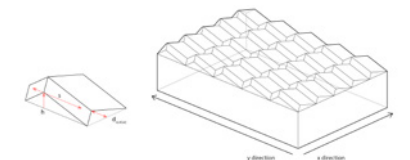
This paper presents the design and fabrication of an adaptable acoustic ceiling with the intention, to close the gap between individual and serial parts. A parametric design model comprises adaption to different acoustic and spatial situations as well as production geometry and assembly information.

10026

Multi-objective room acoustics optimization of timber folded plate structure

Rasmus Skov, Dario Parigi, Lars Damkilde

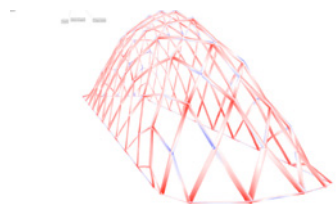
This paper investigates the application of multi-objective optimisation in the design of timber folded plate structures. Considering contrasting objectives the methodology discussed encompasses both structural and acoustic performance when determining the design of a timber folded plate structure.



10227

Capturing And Visualising Parametric Design Flow Through Interactive Web Versioning Snapshots

Verina Cristie, Sam Joyce



A grasshopper plugin is developed to send multiple design states in the form of 3D model, parametric data, and user notes to the server upon will. This information is visualised in the web and could be explored interactively to help the team understand the design flow and collaborate better.

SESSION # 50

TENSEGRITY

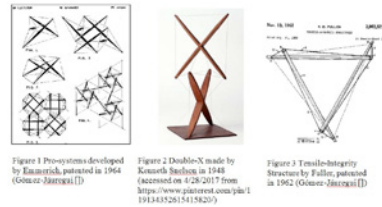
chaired by Ken'ichi Kawaguchi

thursday, september 28th

09:00 am until 11:00 am

seminar room 2.103

10153

Resilience: Lessons from Tensegrity Structures*Rui Liu*

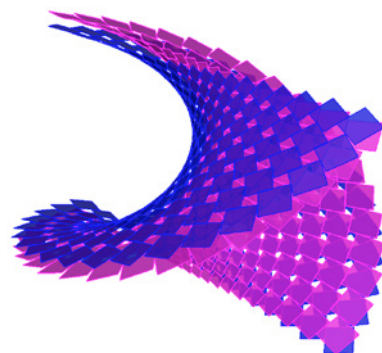
This study examines the history of tensegrity structures, reviews their applications in architecture, and reflects their advantages over other structural systems. Minimum material consumption, stable structure, and adaption to changes, are lessons learned by investigating tensegrity structures.

10274

Preliminary report of design and construction of a tensegrity tower and a pentagonal skeleton supporting a membrane roof*Ken'ichi Kawaguchi, Keisuke Mizutani*

A summary of design and construction of two tensegrity skeletons supporting a membrane roof is reported. One is a tower and the other is a pentagonal pyramid type tensegrities. Prestress distribution and its introduction have been carefully designed so that we can adjust them manually at the site.

10253

Morphological exploration of curved tensegrity networks: towards minimal surface double-layer configurations*Katherine Liapi, Andreana Papantoniou, Chrysostomos Noursias*

This study focuses on the development of tensegrity configurations the two layers of which are minimal surfaces. Specifically tensegrity networks the two layers of which are catenoid and helicoidal surfaces, have been examined and the developed geometric processes are presented.

9679

Study of a novel design for self-standing tensegrity domes*Andres Gonzalez, Ani Luo, Heping Liu*

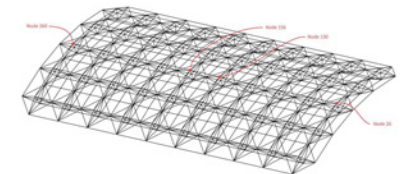
This paper proposes a novel design for a self-standing tensegrity dome. A formulation for the prototype topology is established along with stability equations. Rank deficiency conditions and the form finding algorithm are presented. Finally, a numerical example and a real model are given.



9537

Investigation into the instability behavior of cable-strut barrel vault space structures with DP simplex*Karim Abedi, Kamal Mirzaaghaazadeh, Behzad Shekastehband*

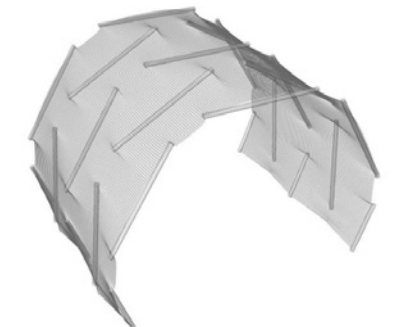
In the present paper, the instability behavior of cable-strut barrel vault space structures based on square di-pyramid (DP) simplex has been studied. Also the effects of selfstress levels, selfstress distribution, the slenderness ratios and loading conditions are evaluated.



10817

Parametric Analysis of Tensegrity-Membrane-Structures*Nils Ratschke, Annette Bögle, Jon Lindenberg*

This research project deals with parametric analysis of tensegrity-membrane-structures. A reference model was created to investigate the influence of geometric parameters. Based on it, an exemplary geometric more optimized pavilion structure for the combination with textile membranes was worked out.



SESSION # 51

**IDENTIFICATION AND DOCUMENTATION OF HISTORIC
SPATIAL STRUCTURES | WG 17**

chaired by E. Gorun Arun & Alberto Domingo

thursday, september 28th

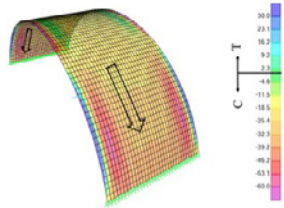
09:00 am until 11:00 am

seminar room 2.104

9666

Structural Analysis of Havana's Historic Tropicana Night Club Shells: Arcos de Cristal

Veronica Boyce, Annie Levine, Maria Garlock, Branko Glisic



The Arcos de Cristal, in the Tropicana Night Club, is a Cuban architectural icon composed of five slender reinforced concrete cylindrical shells, which narrow in telescopic form towards the stage. This paper examines the history of the design and presents a structural analysis of the shells.

10157

Cable roof types built in former Czechoslovakia toward the end of 20th century

Jana Ďurejová, Miloš Slivanský



The paper gives an overview of cable roof structures realized in former Czechoslovakia by structural engineers around Poštulka, who were given an opportunity to design and supervise construction of more than 100 cable roofs. Particular systems are compared with regard to their structural behavior.

10198

Structural Folding as a Source of Research for Sergio Musmeci

Lukas Ingold, Pierluigi D'Acunto



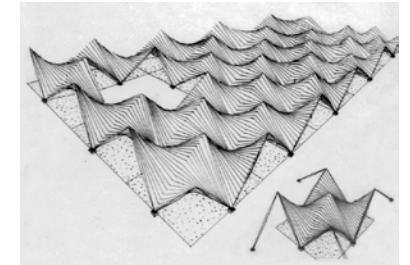
At the beginning of his career, the Italian engineer Sergio Musmeci (1926-1981) experimented widely with folded plate structures. The studies on structural folding led the way to his further search for novel structural forms, which eventually branched out into two independent lines of investigation.

10251

Robert Le Ricolais and Lech Tomaszewski: little-known records of engineering inspiration

Romuald Tarczewski

The paper presents history of engineering collaboration between Robert Le Ricolais and Lech Tomaszewski, especially the unknown latter's book on Le Ricolais ideas in structural morphology.



10324

The spiral staircases of Pier Luigi Nervi in the interwar period

Satoru Kimura

P.L.Nervi designed some spiral staircases of Berta Stadium in Florence with R.Nebbiosi and G.Bartoli, however the more marvelous one was inserted in the apartment in Rome. This paper compared both spiral staircase.

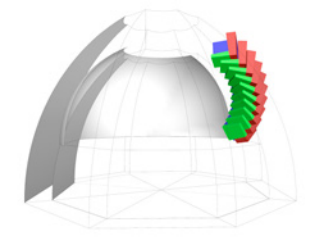


9974

Brunelleschi's herringbone hidden reciprocal structure and the form finding of its self-supporting bricks

Attilio Pizzigoni, Giuseppe Ruscica, Vittorio Paris

This research wants to give a possible interpretation of the realization of the Dome of Florence Cathedral. This study has led to the identification of a self-supporting structure, composed by bricks, arranged in a reciprocal three-dimensional scheme together with a system of mutually supporting ribs.



SESSION # 52

**EDUCATION AT THE INTERSECTION OF ARCHITECTURE
AND STRUCTURAL ENGINEERING**

chaired by Michael Staffa & Annette Bögle

thursday, september 28th

09:00 am until 11:00 am

seminar room 2.107

9221

ArchitecTours – A close look on structures around us

Jan Dirk van der Woerd, *Carolin Stapenhorst*, Stephan Geßner



Architects and civil engineers work together but use different methodic approaches. In order to overcome the differences and to enhance their communication, “ArchitecTours” developed a didactic interface that analyzes and illustrates structures in a way permitting both students of architecture and civil engineering an intuitive understanding of their functioning.

9522

Industrial building design studios - an effective tool for the structural education of architects

Franziska Moser, Juan Musto, Martin Trautz



Architectural studios with a structural focus respond to a growing demand for structural designers. Industrial buildings combine many aspects of structural design and are suited as topics in these studios. The paper reflects on studio examples from the Master’s program of the RWTH Aachen University.

9548

The Use of Physical Models to Teach Structures in Architecture School: A Pedagogical Approach

Mauricio Soto-Rubio



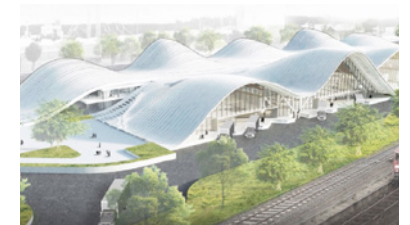
This paper examines different teaching methodologies implemented in architecture schools in North America to teach courses related with structures. The study focuses on content, approach, and highlights the value of using physical models to understand the relationship between structures and design.

9562

IDFP - interdisciplinary factory planning: the RWTH Aachen University model

Susanne Hoffmann, Franziska Moser, Alexander Marks, Dipl.-Ing. Arch. Tanja Osterhage, Katrin Ansorge, Henryk Wolisz, René Huppertz, Martin Trautz, Peter Burggräf, Dirk Müller, Rainard Osebold, Matthias Dannapfel

A course at the RWTH Aachen University broaches the issue of interdisciplinary factory planning. The task for the interdisciplinary student teams is the design of a factory in its entirety. This paper is about the implementation, optimizations, evaluations, the assignments and results are presented.



10818

Beyond the Cube - The Spirit of Frei Otto

Michael Balz

SESSION # 53

**CROSS-DICIPLINAARY DESIGN AND PRODUCTION OF
BIO-BASED STRUCTURES | WG 12**

chaired by Andreas Falk & John Chilton

thursday, september 28th

09:00 am until 11:00 am

seminar room 2.108

9589

Comparison of Plate and Shell Timber-Composite Sandwich Structures

Yousef Al-Qaryouti, Ye Wen, Joseph Gattas, Dilum Fernando

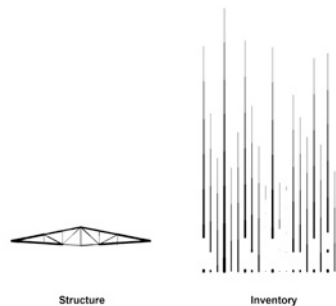


This paper aims to compare two digital fabrication strategies for timber-composite sandwich structures. This first strategy produces modular plate components which form a kit-of-parts system. The second strategy produces continuous shell components which can form any target curvilinear profile.

9871

Form-Fitting Strategies for Diversity-Tolerant Design

Aurimas Bukauskas, Paul Shepherd, Pete Walker, Bhavna Sharma, Julie Bregulla



This paper proposes new computational design strategies to help designers match finite sets of diverse structural elements with desired structural forms. The methods proposed build on algorithms developed for the Bin-Packing Problem. Applications include steel reuse and round-timber structures.

10268

Layered Fabric Materiality in Architectural FRP Surface Elements

Arielle Blonder



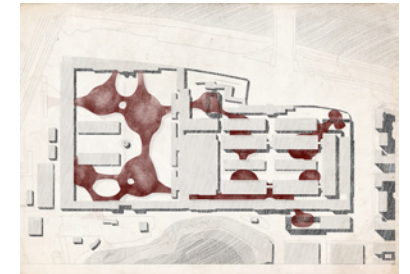
The research develops a fabric based alternative approach to design and fabrication of architectural FRP, as Fabric Materiality. Following the implementation in linear elements, here surface elements are developed by self-organisation and fabric manipulations, to form a resilient matter-structure.

10377

Timber post-formed gridshells as multi-purpose infrastructure for the design of urban public spaces

Sergio Pone, Maria Pone

This paper discusses a new possible interpretation for some structures derived from active bending: the post-formed timber gridshells. This new interpretation concerns possible uses for this type of structure as forms of "soft infrastructure" in urban or natural environments.

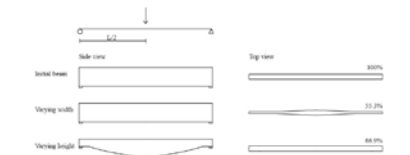


10285

Digital Fabrication of Structurally Optimized Timber Beams

Paul Mayencourt, Joaquin Giraldo, Eric Wong, Caitlin Mueller

This paper focuses on optimizing beams made of solid timber sections through a CNC subtractive milling process. An optimization algorithm shapes beams and reduces the material quantities by up to 50% of their initial weight. A series of these beams are then fabricated and load tested.



9979

A few aspects of UAV-based timber construction

Sébastien Goessens, Tassilo de Furstenberg, Charline Manderlier, Caitlin Mueller, Pierre Latteur

This paper is related to a research project about on the construction of real scale structures with drones. First studies were already presented in previous IASS congresses, focused on masonry and general concepts. This paper this time focuses on "drone compatible" timber connections.



SESSION # 54

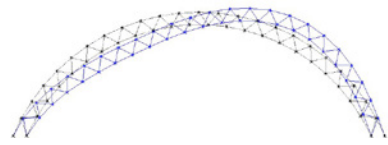
OPTIMIZATION APPROACHES TO ANALYSIS AND
DESIGN II | WG 13

chaired by Makoto Ohsaki

thursday, september 28th

09:00 am until 11:00 am

seminar room 3.107



9528

Applicability of an EMPA procedure for calculating the seismic responses of planar latticed arches

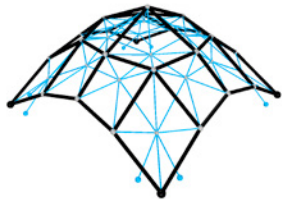
Qinglong Huang, Yongfeng Luo, Yang Xiang, Zhaochen Zhu

The seismic responses of four latticed arches with different rise-span ratios are calculated by an extended modal pushover analysis (EMPA) and the nonlinear response history analysis (RHA). Based on the numerical results, the applicability of the EMPA is examined and further conclusions are drawn.

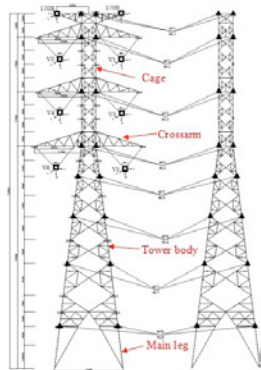
9524

Structural Optimization for Hybrid Structure with Cable and Strut Member: Analysis Using Finite Element Technique with Coordinates Assumption

Shingo Komikado, Yohei Yokosuka, Toshio Honma



In this paper, we present the structural optimization for a hybrid structure with cable and strut member. The finite element technique with coordinates assumption is applied in the form-finding analysis. From results, we show the possibilities of the hybrid structure with cable and strut member.



9554

Optimization of large-scale transmission tower using simulated annealing

Jingyao Zhang, Makoto Ohsaki, Zhengliang Li

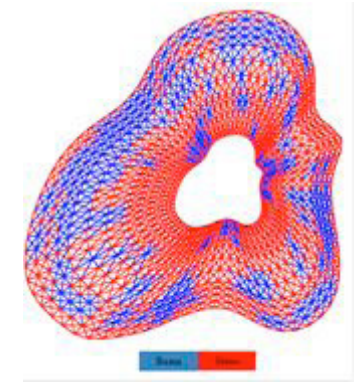
In this study, a size optimization problem is formulated for structural design of large-scale transmission towers, subjected to gravitational loads and wind loads. The list of available cross-sections is given a priori, and the optimal combination of sections is found by using simulated annealing.

9820

Global buckling algorithmic optimization in grid shell design

Maura Imbimbo

The optimization of grid shell structures is a process finalized to obtain efficient and light weight solutions that meet architectural and structural requirements. The paper proposes a new approach that combines different phases of sizing and shape and accounts for the global buckling behavior.

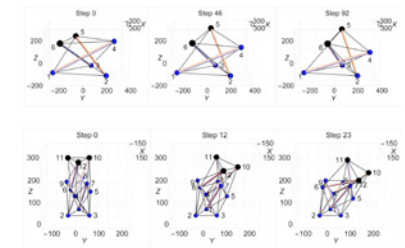


9993

Shape Change Analysis of Tensegrity Structure

Chai Lian Oh, Kok Keong Choong, Toku Nishimura, Jae-Yeol Kim

A computational method for the shape change of tensegrity is presented. Shape change of the tensegrity via application of forced elongation of cables is introduced. Convergent characteristic of the proposed method for a simplex and a two-stage tensegrity model are presented.

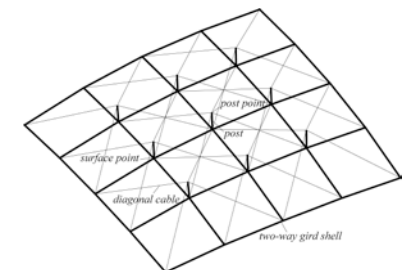


10052

Study on local minimum shape in shape optimization of free-form cable-stiffened single-layer latticed shell

Hao Wang, Minger Wu

A shape optimization method is proposed for one kind of cable-stiffened single-layer latticed shell and a numerical test is carried out to confirm local minimum shape exists. then a modified optimization equation is proposed. Approximate global minimum shapes can be obtained.



SESSION # 55

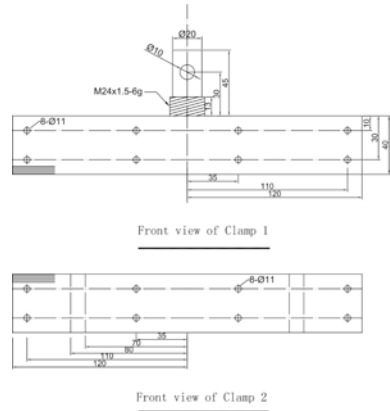
COMPUTATIONAL METHODS: APPLICATION

chaired by Manfred Bischoff & Jens Schneider

thursday, september 28th

09:00 am until 11:00 am

seminar room 3.108

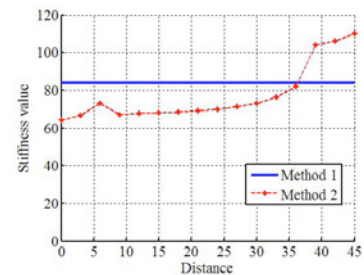


9459

Research on the multi-support response spectrum for large span structures

Pengfei Zhao, Feng Liu, Limin Zhu, Rongwei Tang, Qiang Zhang, Changjie Ye

The characteristic of dynamic displacement coherency coefficient and pseudo static displacement coherency coefficient is researched. The absolute value of decreases with increasing. The peak ground displacement (PGD) corresponding to different seismic precautionary intensity is presented.



10197

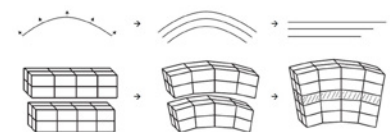
Effect of Differential Foundation Settlement on Outrigger System of Super Tall Steel Buildings in Soft Soil

Baoyi Fang, Xin Zhao, Juyun Yuan

10330

Cold-bent thin glass laminates for architectural applications

Jens Schneider



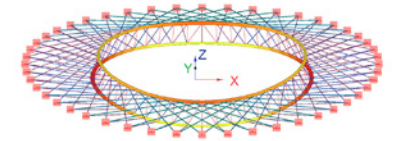
The paper addresses new ideas for applications of thin glass laminates in the built environment. The creation process of a FE-Model accounting the springback-effekt and the time/temperature dependency of the polymeric interlayer is shown. Furthermore, new test scenarios for thin glass are proposed.

10103

Initial force design of a large-span stadium in Zaozhuang

Jinyu Zhou, Wujun Chen, Jinghai Gong, Jianhui Hu, Bing Zhao, Chengjun Gao

Possessing a saddle-shaped roof structure composed of cables and struts, a large-span stadium was investigated for its initial force design by means of a symmetry-based technique. A marked variation was noticed in the pretension values of hoop cables with a coefficient of variation (CV) up to 17.5%.

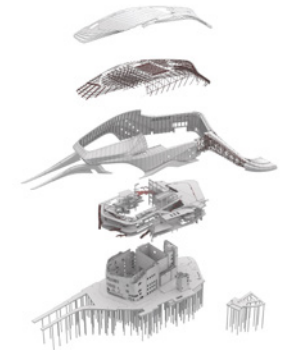


9236

The structure of the "Grand Théâtre de Rabat": from digital design to local fabrication

Nicolas Sterling, Jeroen Janssen, Peter Hind

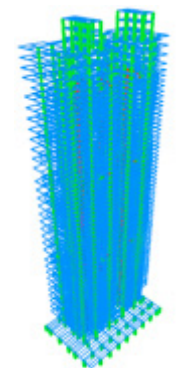
This paper describes the structural design from concept to delivery of the Grand Théâtre de Rabat in Morocco. The complex nature of the programme and the form demanded an advanced digital design process for the structural design, bridging a local traditional and analogue construction process.



10290

Comparative Study between Reversely and Forwardly Constrained Optimal Design Methods for Super Tall building Structure

Xin Zhao, Zhuang Ma





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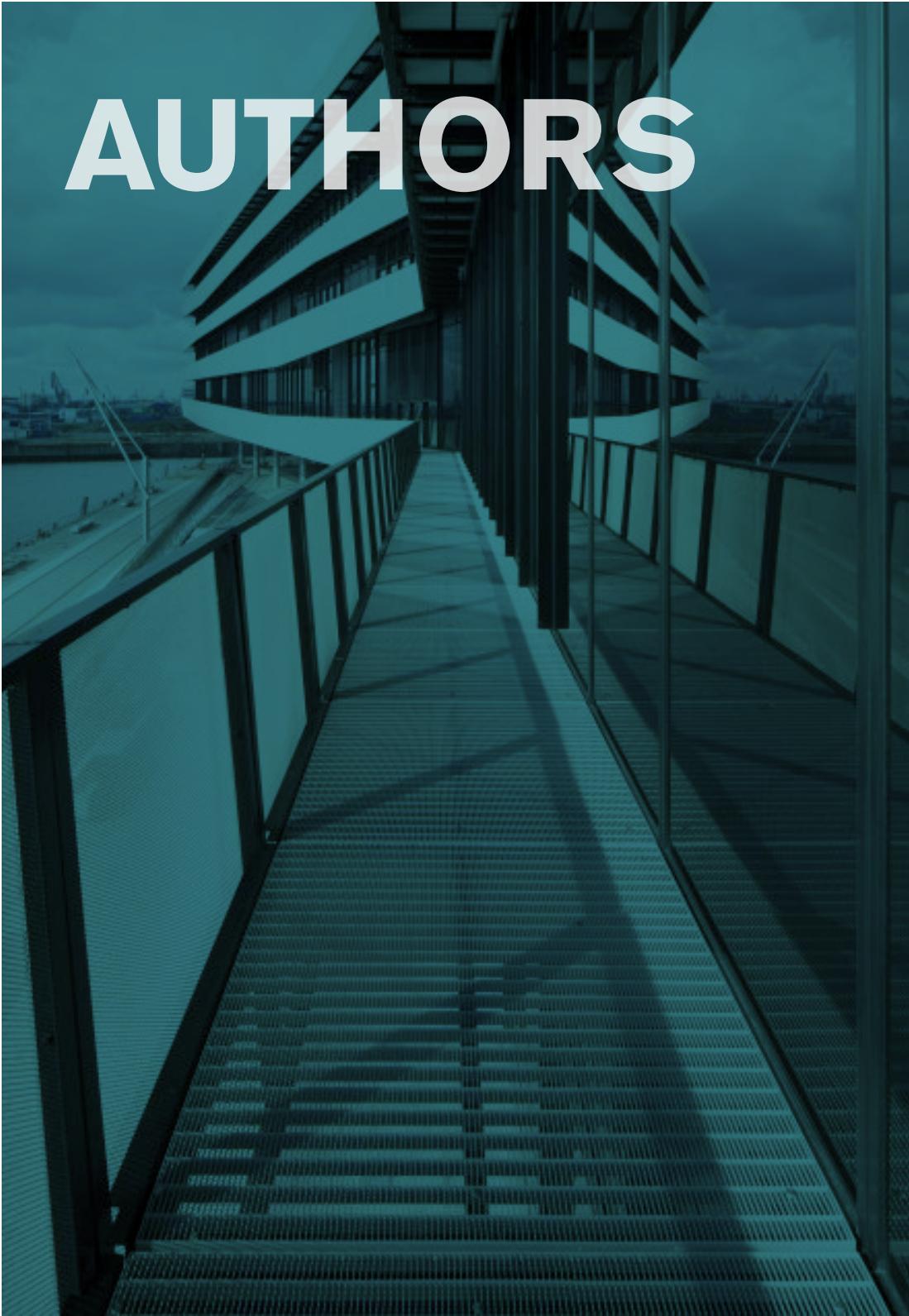
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Sandra Manninger, USA	Qilin Zhang, China
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