



Dr. Hong Zou, ICAO-ACI Aerodrome Seminar, June 2023

RUNWAY **SAFE**

The development, design, and implementation of
Engineered Materials Arresting System (EMAS)



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About me

- Dr. Hong Zou - Head of Engineering at Runway Safe Group
- Worked on aircraft arresting systems for 16 years
- Responsible for Research, product development and system design
- Graduated from University of Iowa and The Ohio State University with research interests in impact dynamics and biomechanics.



Overview

- Development history of EMAS, an aircraft arresting system.
- EMAS design methodology
- EMAS implementation
- Actual overrun saves by EMAS
- Acceptance by aviation authorities





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- Privately held company founded in 2014 and headquartered in Sweden
- Acquired EMASMAX® product from Engineered Arresting Systems Corporation (ESCO) in 2020
- Global presence with installations in North America, South America, Europe, and Asia

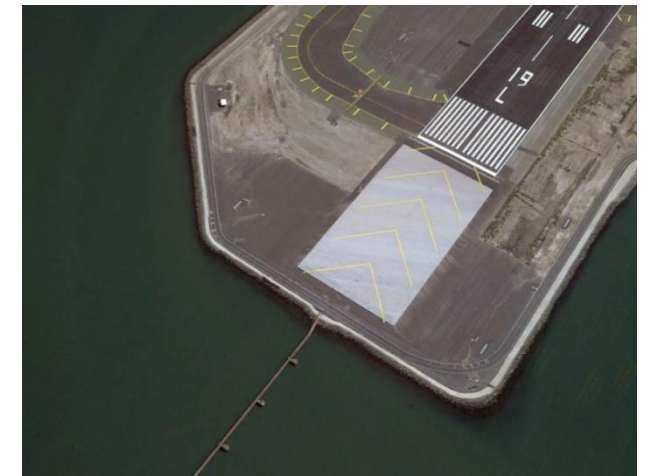
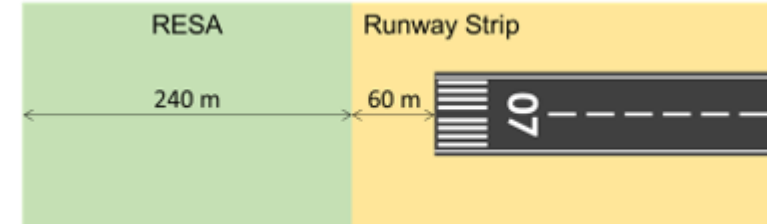
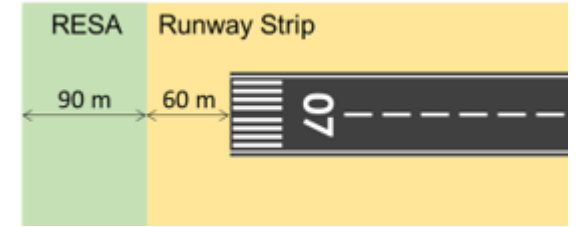


130+ EMASMAX® installations worldwide
14 greenEMAS installations worldwide



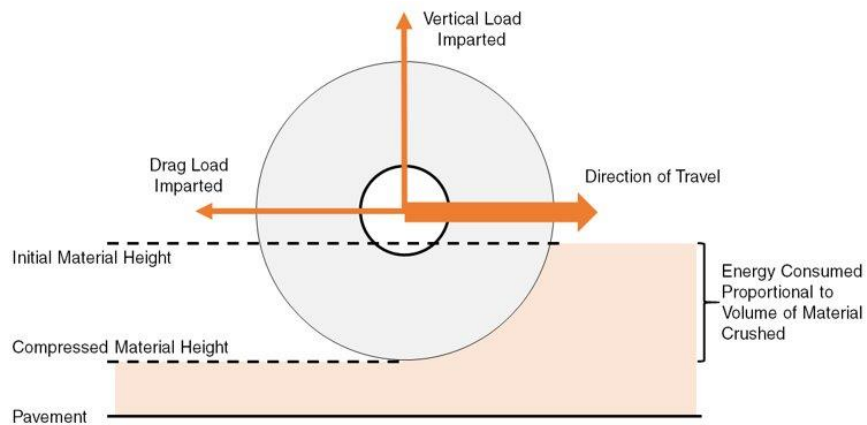
RESA and why do we need EMAS

- RESA (Runway End Safety Area) aims to reduce risks of aircraft overruns.
- ICAO Annex 14 - Aerodromes sets RESA standards:
 - Code 3 & 4 runways and instrumented code 1 & 2 runway
 - Required 90m RESA + 60m strip
 - Recommended 240m RESA + 60m strip
- Difficult to implement RESA standards in constrained environments.
 - Physical constraints due to water bodies, roads, or buildings
- EMAS was developed as an alternative means to meet RESA requirements.
 - RESA length may be reduced if an arresting system is installed.



What is EMAS

- As one type of Aircraft Arresting System, EMAS stands for **Engineered Materials Arresting System**.
- EMAS is made of energy absorption materials designed to crush under the weight of an aircraft, providing gentle and consistent deceleration.
- It is a passive system, the last line of defense to slow down an overrunning aircraft.
- EMAS is designed not to cause control issues in the event of undershoot.
- Runway Safe Group currently offers two FAA certified products, EMASMAX and greenEMAS.



Major historical testing programs leading to EMAS approval by FAA

- **1980s** – FAA started EMAS development
- **1991-1993** – Multiple real aircraft tests for computer model development and validations
- **1994** – ESCO started EMAS development
- **1994-1996** – Full aircraft tests completed on cement-based EMAS
- **1996** – Prototype EMAS installed at JFK
- **1996** – ARFF test and ILS interference test
- **1997** – Fire test and cold weather test
- **1998-2002** – Jet blast test completed at LGA airport and FAA Tech Center
- **1999** – Saab 340 overrun at JFK
- **2002** – FAA released Advisory Circular for EMAS
- **2003** – MD-11F overrun at JFK



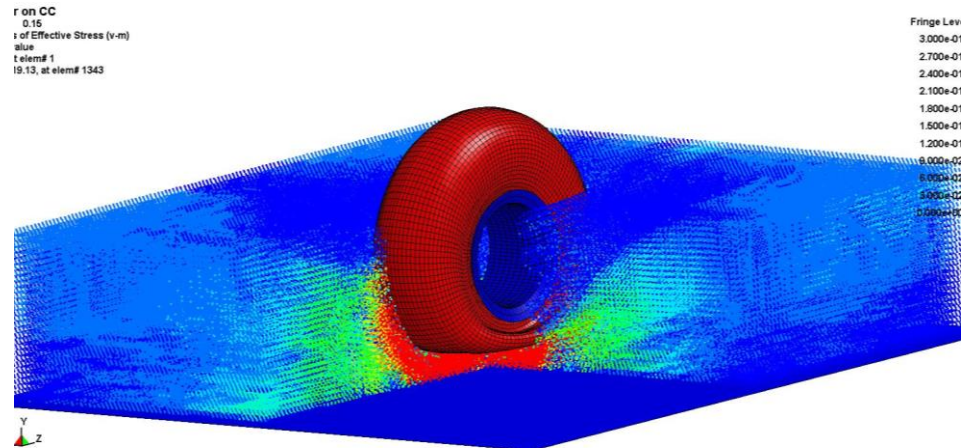
EMAS development testing continues

Continuous testing to improve the prediction accuracy of aircraft arresting performance.

- High-speed overrun test
- Jumbo aircraft wheel test
- Real aircraft arrestments

We continue improving product durability.

- 20 years service life with proper maintenance
- Designed for weather elements
- Designed for airfield environment with heavy jet blast



EMAS performance



- EMAS performance is defined as the maximum speed of an aircraft when it leaves the end of the runway while it still can be safely arrested by the EMAS.
- EMAS comprises setback distance and arrestor bed, both contribute to the resultant “EMAS Performance”.
- A “standard EMAS” provides 70 knots arresting performance with 600 feet undershoot protection (FAA Advisory Circular No: 150/5220-22B for EMAS design).
- The majority of EMAS installed globally are “non-standard EMAS”.



EMAS design

Must use a validated design method to predict the performance for selected aircraft fleet mix

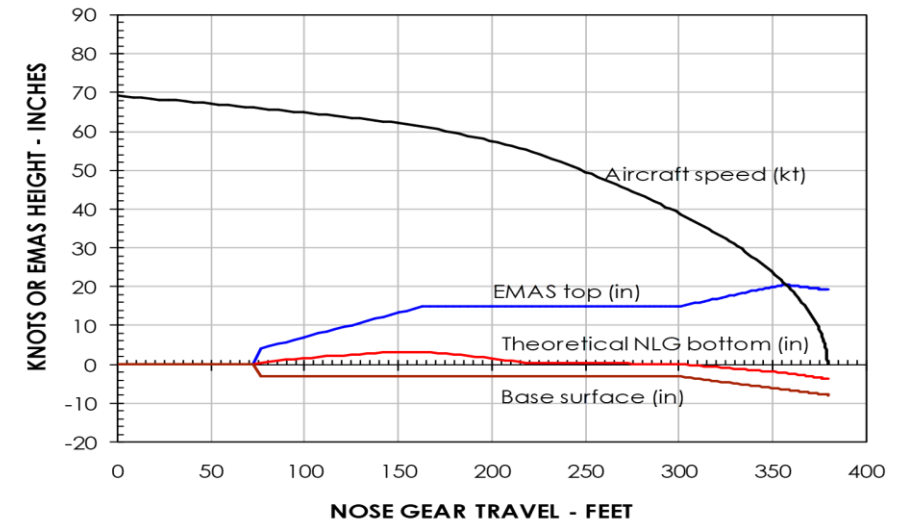
- Based on annual movements and aircraft weight

Design parameters include:

- Aircraft weights (MTOW and 80% of MLW)
- RESA and runway profiles (elevation, dimensions, slopes)
- Setback distance and EMAS profile (size, depth, strength)
- Aircraft parameters (gear configuration, allowable gear load, tire contact pressure, center of gravity, speed)

Computer model outputs

- Aircraft wheel load, deceleration rate, stopping distance



EMAS implementation



 **130+ EMASMAX® installations worldwide**
14 greenEMAS installations worldwide



**Boston Logan International Airport,
USA**



**Haneda Airport,
Japan**



**Kjevik Airport, Kristiansand,
Norway**



**Charleston Yeager Airport,
USA**



Installation of EMASMAX





Installation of greenEMAS



19 actual
overruns saved
by EMAS



Actual overrun arrestment example

- Yeager Airport, Charleston, West Virginia, USA
- Aborted take-off on January 19, 2011
- Exit speed: 50+ knots
- 31 passengers and 3 crew members



EMAS acceptance by aviation authorities

ICAO

- Aircraft arresting system included in Annex 14 vol 1 Aerodrome Design and Operations.
- Guidance on performance and compatibility requirements is provided in Doc 9157 Aerodrome Design Manual.

FAA

- Advisory Circular 150/5220-22B Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns.

Other aviation authorities that have approved EMAS technology. Some of these CAAs have developed their own guidance on EMAS requirements and evaluation process.

- USA, EASA, France, Japan, Italy, Brazil, China, Canada, UK
- Switzerland, Germany, Taiwan, India, Norway, Spain



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Thank you for your attention!

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