Demolition Planning & Analysis
Designing Safer Demolition

Structural Analysis Depicting Displacement
Contours During Stadium Demolition
(Brazil 2011)
When studying a problem, Engineers look for ways to practically and effectively solve a problem in a way that make the study practical to the time allotted, budget, and technology available. The result has been the use of conservative code requirements paired with analysis solutions that sacrifice accuracy through simplified input and analysis.

At Applied Science International, LLC (ASI) we are dedicated to improving the known built world by revolutionizing the way materials and structures are analyzed, configured, assembled, maintained, and demolished. In order to deliver our advanced methods to the world, we develop practical tools & services to improve performance throughout a structure’s lifecycle from design, to maintenance, extreme events, rehabilitation, and eventual demolition or forensics.

As construction methods and materials have grown increasingly complex over the years, so has the need for new and more accurate methods of engineering and designing the demolition of such structures. Utilizing ASI’s unique 3-D Nonlinear Dynamic Structural Analysis Tools based on a new method of structural analysis originally developed at the University of Tokyo, ASI Engineers can simulate and optimize manual deconstruction, controlled collapse and implosion plans in the demolition design phase, before the actual demolition.

With extensive expertise in the design and structural analysis of demolition for buildings, bridges, industrial facilities, sports arenas, and many other complex structures. ASI has designed and analyzed more than 30 controlled collapse demolitions and implosions around the world, with a 100% accurate track record. In addition, four projects that ASI was involved in won the World Demolition Award for Explosive Demolitions in 2011, 2013, 2014, and 2016.

ASI can simulate in full 3-D sequential demolition (mechanical, wrecking ball, excavator) and controlled or induced collapse demolition plans which employ the use of explosives, wrecking ball, high reach excavator, pushing or pulling force, or manual deconstruction.
**Structural Engineering Software, Services, & Training**

*Practical engineering for safer deconstruction, controlled collapse, & implosions*

**Registered Company Name:** Applied Science International, LLC  
**Year Incorporated:** 2004  
**State of Incorporation:** North Carolina  
**Number of Employees:** 85  
**Business Type:** Small Business

**Structural Engineering Capabilities:**
- Structural Vulnerability Assessment
- Seismic, Progressive Collapse, Blast, Impact, High Wind, Hurricane, & Flood.
- Demolition Prediction & Pre-planning
- Complete Glazing Systems
- Historic Structures
- Corrosion & Retrofit
- Forensic Engineering & Expert Witness
- Performance Based Design
- R&D/Product Development

**Structural Analysis Software:**
- Extreme Loading® for Structures

**Structural Design Software:**
- SteelSmart® System
- SteelSmart® Framer

**NAICS Codes:**
- 541330 - Engineering Services
- 511210 - Software Publishers
- 541511 - Custom Computer Programming Services
- 541613 - New product development services
- 541710 - R&D in the physical & engineering sciences
- 611420 - Computer Training

**SIC Codes:**
- 8711 - Engineering Services
- 1795 - Wrecking & Demolition
- 7371 - Computer programming services
- 7372 - Prepackaged software
- 7389 - Business Services, NEC
- 8731 - R&D in the physical, engineering, & life sciences

**Demolition Planning Capabilities**

*Practical engineering for safer deconstruction, controlled collapse, & implosions*

**Demolition Planning Services:**
- Pre-Bid Proof of Concept
- Demolition Design
- Demolition Analysis
- Weakening Analysis
- Seismic Analysis
- Dust Analysis

**Post-Demolition Services:**
- Comparative Analysis
- Forensic Analysis

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**Displacement Contours for Demolition Analysis of a 104m tall Steel Industrial Structure via weakening and pulling with cables (Australia, 2012)**

**Stress Contours for Demolition Analysis of a 650ft Stack Implosion (Canada, 2018)**
Demolition Sequence Design

*Determine explosives timing, cable strength, pull force, collapse direction, & debris spread*

ASI's demolition sequence design will assist you in working out all of the details of your demolition plan out virtually, before placing people or property in harms way. ASI’s engineers will model your complete structure in 3-D, with all its structural details including columns, girders, slabs, masonry, service/transfer floors, detailed reinforcement, pre & post-tensioned tendons, cables, and vessels. They will also include material properties, structural damage, and shoring based on the current condition of the structure. Then evaluate a variety of demolition scenarios and visualize outcomes including direction of collapse and debris spread of the structure to ensure they meet project requirements and leads to the safest outcome. Study the effects of:

- **Weakening & Strengthening**: Evaluate different types weakening cuts, complete removal or addition of structural elements, and the sequence & locations of such structural modifications.
- **Implosion**: Evaluate different scenarios of timing & locations for explosive charges.
- **Pulling by Cable**: Evaluate different scenarios of cable strength, cable location & pulling direction, and required pulling force.

ASI works with clients at various stages of a demolition project:

- **Pre-Bid Proof of Concept**: ASI will work with your team to provide a proof of concept for your demolition to utilize during the bidding process with your client. Analysis output provides engaging visuals early on in the bidding process for encouraging plan approval or for display in public forums.
- **Demolition Plan Design**: If you’re not sure where to start, ASI will work with your team to design a safe and efficient demolition based on your project requirements. Multiple demolition scenarios can be safely and efficiently evaluated virtually without expending resources on the job-site that might result in loss of life or property.
- **Demolition Plan Analysis**: If an initial demolition plan has already been created, ASI can analyze the proposed plan. If the proposed demolition plan indicates the possibility of a mishap or hazard, ASI can suggest alternative scenarios or modifications to the planned approach.
- **Weakening Plan Analysis**: Provided with a weakening plan, ASI can model and analyze the effects of the proposed weakening on the structure to ensure that it does not prematurely collapse during mechanical demolition or preparation for a controlled collapse or implosion.

[www.appliedscienceint.com](http://www.appliedscienceint.com)

*Rio Hospital Implosion (Brazil 2011)*
High Wind & Seismic Events During Demolition

*Prevent premature structural collapse of weakened structures*

Structures are designed to resist varying levels of high winds and seismic activity depending on their location. However, during demolition operations weakening cuts are made in advance of implosion/controlled collapse and structural elements are removed during mechanical demolition removing this safeguard. In addition, once weakened, structures may remain standing for days or weeks, increasing their potential exposure to seasonal high wind or earthquakes, and possible premature collapse.

ASI Engineers can evaluate the weakened structure at various points during demolition preparations against high winds and earthquakes to ensure that it does not risk premature collapse during mechanical demolition or preparation for a controlled collapse or implosion.

*Wind Analysis of the Weakened Hospital Structure (Pittsburg, Pennsylvania, USA 2008)*
Dust generated by demolition is a challenging environmental hazard and common nuisance to the local community. This is especially the case for controlled collapse demolitions that can produce a large amount of particulate all at once. ASI can estimate the size, speed, and direction of dust generated by controlled collapse demolitions so you can reduce environmental impacts. This is based on 3-D models of the structure, in addition to estimation of existing debris and estimation of dust generated due to blast.

Furthermore, ASI utilizes weather data to model different scenarios for dust propagation to ensure the most extreme weather scenarios are taken into consideration during demolition planning. Based on this information ASI provides recommendations for timing and direction for felling the structure as well as location and types of dust control measures to be used. A sample of dust propagation contours created using this technique is shown below. The contours are superimposed on aerial or satellite images of the demolition site to assist with the creation of traffic management plans and exclusion zones to protect the public.
Noise Modeling Capabilities

Reducing sound nuisance impacting neighboring community and property

Noise generated on demolition jobsites is a common discussion between demolition contractors, property owners, and the local community. To ensure public safety and address concerns of extreme noise, ASI Engineers can provide estimates for sound intensity in dB due to the explosive process at the different diameters from the demolition site.

This assessment is started after a detailed plan for implosion sequence and the timing for explosives at different locations so maximum weight of explosives that is detonated at any time instance can be estimated. The relative effectiveness for the chosen type of explosives is taken into consideration to calculate the corresponding TNT equivalent weight. The pressure value at different distance are estimated based on the Unified Facilities Criteria document Structures to Resist the Effects of Accidental Explosions. The sound intensity estimates at different distances are obtained based on blast pressure values and superimposed on aerial or satellite images. The results are then compared to allowable limits based on health and safety regulations to determine exclusion zones.
**Vibration Due to Ground Impact**

*ELS helps to achieve an economical and robust solution when studying complex structural systems with load-bearing, cold-formed steel and composite decking.*

ASI builds a 3-D model of the collapsing structure to estimate the impact with the ground. ASI uses 3-D model of the soil layers to estimate the peak particle velocity at different distances and plot contours for the ground vibration. Comparison to measured data in actual demolition projects shows that the ASI estimates are reliable.

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**Kwinana Boiler Demolition Design & Seismic Analysis (Australia 2010)**

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**Measured Values | ASI Values**

<table>
<thead>
<tr>
<th>Location</th>
<th>Measured</th>
<th>ASI Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Turbine</td>
<td>3.6</td>
<td>6.0</td>
</tr>
<tr>
<td>Water Tank</td>
<td>11.6</td>
<td>9.8</td>
</tr>
<tr>
<td>Alcoa Boundary</td>
<td>2.96</td>
<td>2.6</td>
</tr>
<tr>
<td>Station Stack</td>
<td>3.94</td>
<td>2.76</td>
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<tr>
<td>Boiler</td>
<td>4.19</td>
<td>5.5</td>
</tr>
<tr>
<td>Turbine House</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recent Demolition Design Projects

Below is a listing of past projects in which ASI provided demolition design structural engineering services for controlled collapse & implosion design (chronological order)

- **Crystal Palace Resort, Nassau, Bahamas, September 2018** - Implosion design for one 15-story and two 12-story reinforced concrete hotels on the waterfront. Design included a weakening plan designed for high wind and a seismic analysis of soil vibration due to the proximity of surrounding structures.
  - https://www.youtube.com/watch?v=CIVVF_GeK_8
  - https://www.youtube.com/watch?v=Qg3lh8I0P4c
- **Sulaymniyah Silos, Kurdistan, February 2018** – Implosion design, wind and dust cloud analysis of a pack of 64 reinforced concrete silos.
  - https://www.youtube.com/watch?v=nu_T3DnZDoM
- **Nanticoke Stack Demolition, Ontario Canada - February 2018** – Implosion design of twin 650 foot tall smokestacks demolished at the former Nanticoke Generating Station, Ontario, Canada
  - https://www.youtube.com/watch?v=f6s1BZpcNzE
- **Mosaic Stadium Demolition, October 2017** – Induced collapse design for the steel structure at the Taylor Field, Regina, Saskatchewan
  - https://www.youtube.com/watch?v=nTvTOStJwx4
  - https://www.appliedscienceint.com/project/ambev-silos-implosion/
- **HPX3 Surge Bin, Hay Point, Australia 2015** – Implosion of a structural steel and reinforced concrete surge bin.
- **Preheater Stack – Australia 2014** - Implosion of a 75m, 1,700 tonne structural steel preheater structure.
  - Project Spotlight: https://www.appliedscienceint.com/project/preheater-stack/
  - Case Study PDF: https://www.appliedscienceint.com/wp-content/uploads/2014/08/Case-Study-Preheater-Stack-03opt.pdf
- **Asarco Smelter Stack, El Paso, Texas Stack Demolition, 2013** - Implosion of one 800ft and one 600ft tall stack.
  - Project Spotlight: https://www.appliedscienceint.com/project/asarco-smelter-stack/
- **Implosion of Perimetral Bridge, Rio de Janeiro, Brazil, 2013** – Design of the implosion of a 2-km long bridge section in a densely populated area while preserving the demolished steel beams for recycling.
  - Winner: Explosive Demolition of the year, 2013
  - Project Spotlight: https://www.appliedscienceint.com/project/implosion-of-perimetral-bridge/
  - Phase 1 Case Study PDF: https://www.appliedscienceint.com/wp-content/uploads/2014/08/Case-Study-Perimetral-Phase1-03opt.pdf
  - Phase 2 Case Study PDF: https://www.appliedscienceint.com/wp-content/uploads/2014/08/Case-Study-Perimetral-Phase2-03opt.pdf
- **Manchete Building, Brazil, 2012** – Implosion design and analysis of a reinforced concrete and masonry structure.
- **Santa Mônica Hospital Implosion, Niteroi, Brazil, 2012** – Three reinforced concrete buildings with 7, 6 and 5 floors.
  - Video:
- **HBI Facility - Australia, 2012** – Design for weakening, pulling and implosion analysis for three complex industrial structures constructed from structural steel and reinforced concrete.
  - Noted as the largest structure demolished in the southern hemisphere.
  - Project Spotlight: https://www.appliedscienceint.com/project/hbi-facility/
Recent Demolition Design Projects

(Chronological Order - Continued)

• **Castelão Soccer Stadium, Rio de Janeiro, Brazil, June 2011** – Weakening and implosion of a portion of the cantilevered reinforced concrete and post-tensioned stadium seating while leaving the remaining stadium and nearby structures intact. Project included analysis of seismic ground vibration to protect surrounding structures.
  - Winner: Explosive Demolition of the year, 2011
  - Project Spotlight: https://www.appliedscienceint.com/project/castelao-soccer-stadium/

• **University Hospital, Rio de Janeiro, Brazil, December 2010** – Implosion of half a 16 story reinforced concrete hospital while leaving the remaining half intact. Project included analysis of seismic ground vibration to protect surrounding infrastructure and property.
  - Project Spotlight: https://www.appliedscienceint.com/project/university-hospital/
  - Case Study PDF: https://www.appliedscienceint.com/wp-content/uploads/2014/08/Case-Study-University-Hospital-03opt.pdf

• **Women’s Residence Hall, South Carolina, USA, March 2010** – Analysis of manual deconstruction of a 3 story reinforced concrete structure using small excavators on each floor to demolish interior walls.

• **Presidium Prison, Rio de Janeiro, Brazil, 2010**
  - http://www.demolitionanalysis.com/project/Presidio-Frei-Caneca-Implosion

• **Kwinana Boiler, Kwinana Power Plant, Australia, February 2010** – Demolition of an industrial structure by inducing collapse using excavators. Project included analysis of seismic ground vibration to protect surrounding gas lines.

• **Santa Cruz, Santa Cruz, Brazil, November 2009** – Implosion of two, 10 story reinforced concrete structures.

• **Old Humana Building - Louisville, July 2008** – Implosion of an 8 story reinforced concrete structure.

• **Saint Francis Central Hospital, Pittsburgh, USA, 2008** – Evaluation of the potential of failure for the building after an incomplete demolition under the effect of high winds.
  - Project Spotlight: http://www.appliedscienceint.com/project/st-francis-hospital-implosion/

  - Project Spotlight: https://www.appliedscienceint.com/project/newcastle-brown-brewery/

• **Tule Lake Lift Bridge, Corpus Christi, Texas, April 2008** – Demolition of a lift bridge due to procedural weakening & implosion.
  - Project Spotlight: https://www.appliedscienceint.com/project/tule-lake-lift-bridge/

• **Charlotte Coliseum, North Carolina, USA, 2007** – Implosion of a structural steel basketball arena.
  - Project Spotlight: https://www.appliedscienceint.com/project/charlotte-coliseum/
Implosion design for one 15-story and two 12-story reinforced concrete hotels at a waterfront resort. (Bahamas, 2018)