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order of the day. Companies operating from any future WTC will most probably have only their core operational team and the rest of the operations will be scattered across the world due to outsourcing and globalization. In such a situation the proposed WTC will be truly a "World Trade Center" for several global firms and businesses, rather than several such complexes at different locations.

The decentralization of businesses in a global economy can neither be controlled nor manipulated to benefit a particular region or a sector of business; it evolves on its own and the marketplace decides. The authors' suggestion on the way to do decentralization is hard to reckon with.

Mix of Residential and Commercial Tenants

Residents in a new WTC complex will find the events of September 11 haunting them and the increasing global terrorist threat as too important to ignore. Again the new WTC may be a potent target for terrorism and the residents will definitely feel insecure and may have a difficult time coping with their daily lives. Nevertheless, that fear should not be misconstrued as all tall buildings are not safe (Sivakumar 2004). With recent efforts in earmarking no-fly airspace zones proving effective, the September 11 type of attacks is unlikely to happen in the future. It is pragmatic to devote the new WTC complex for office and retail space alone.

Environmental

Almost all the environmental concerns on rebuilding the WTC can be addressed if the total project can conform to the "platinum" level accreditation of the LEED Rating System Version 2.0, developed by the U. S. Green Building Council. This helps to eliminate a lot of documentation and hassles in the progress of the project and at the same time ensuring accountability to the environment.

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Sivakumar, K. (2004). "Discussion of 'World Trade Center Collapse-Civil Engineering Considerations', by Bernard Monahan," *ASCE Pract. Period. on Struct. Des. and Constr.*, 9(2), 121.

Closure to "Rebuilding the World Trade Center" by Robert F. Borg, John Gambatese, Kenneth Haines Jr., Chris Hendrickson, Jimmie Hinze, Arpad Horvath, Enno Koehn, Scott L. Moritz, Marvin Mass, and Robert A. Haughney

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The Committee on Social and Environmental Concerns in Construction (CSECC) started work on the captioned paper immediately after the September 11, 2001 events. The paper, which was published in August 2003 in the *Practice Periodical on Structural Design in Construction*, drew on numerous references that were incorporated into the paper as of the latest date of the submission (June 7, 2002).

The several discussions bring forth a great deal of thoughtful material that should be studied and reviewed together with the paper. The writer considers it a privilege to have been able to witness the events and to write about them from the point of view of the social and environmental concerns that are involved in the rebuilding. This subject is so vast that it will be studied by students and scholars for many years to come, and drawing on contemporaneous accounts of this event will be of great value. To the best of the knowledge of the writer, no other engineering organization or committee is reviewing and investigating the rebuilding solely from the social and environmental aspects of the construction.

The writer intends to continue these investigations and research the subject for the next several years. A follow-up paper is now being contemplated that will continue examining the material available since June 7, 2002. It will be divided into 6 categories:

1. Rebuilding designs that are favoring social and environmental concerns in construction;
2. Building safety and health considerations;
3. Terror awareness and prevention;
4. City and regional economic considerations;
5. Memorial, museum, and performance spaces in a park-like setting; and
6. Transportation.

The contemplated follow-up paper will incorporate news stories, photographs, and articles that will continue the narration of the paper and carry it forward from June 7, 2002. The CSECC of the Construction Institute will be devoting its efforts to this subject.

Discussion of "Minimizing Construction Vibration Effects," by Mark R. Svinkin

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In at least 2 locations the author references Jorge DuQuesne, and states on page 110, "Quesne (2001) measured vibrations at exterior walls and corners of exterior masonry walls and found the amplification factors from four to nine times as high as vibrations measured at the ground." The author obtained this from an online Geo Discussion Forum where Mr. DuQuesne asked questions regarding potential damage to homes in South Florida from quarry blasting. In fact, Mr. DuQuesne has not published any studies on blasting in South Florida, and the damages presented by Mr. DuQuesne have not been substantiated. The Miami-Dade County study referenced by Mr. DuQuesne and the author was actually

performed by Corzo, Castella, Carballo, Thompson, and Salman, P.A., in association with D.E. Siskind and Associates, LLC; Parson, Brinkerhoff, Quade, and Douglas, Inc.; and Dunkelberger Engineering and Testing, Inc. This study is dated May 31, 2000, and was prepared for the Miami-Dade County Blasting Task Force. During this study none of the cracks or other conditions observed at the homes were attributed to blasting.

Closure to "Minimizing Construction Vibration Effects," by Mark R. Svinkin

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The writer thanks the discusser for his comments and his reference to the "Blast Vibration Damage Assessment Study and Report" (2000) prepared for Miami-Dade County.

Reference to Quesne (2001)

According to the DESA part of this report, several studies of vibration effects of quarry blasting on 1–2–story homes were made in South Florida during the last 25 years—for example, the study of Rinker Lake quarry blasting and structure responses (Andrews 1979) and the U.S. Bureau of Mines study of blasting at the Weston's Arvida Development, in Broward County, in 1995. Furthermore, the results of other investigations were used in the report: about 83 NW Miami vibration records supplied by the County from their 1999 blast monitoring and approximately 673 other vibration measurements from quarry and construction blasts in Miami-Dade and Broward Counties.

Obviously, Mr. Jorge Quesne, P.E., used data from his own research, which had been started in 1999 according to his assertion, and various studies of blasting effects in Miami-Dade County, and provided somewhat different information than the report. Quesne (2001) described homes, structural damage, and the results of vibration monitoring, and has addressed the following questions in his posting on www.geoforum.com:

1. Is it possible for low-frequency, high-duration seismic vibrations to cause or increase crack formation on a concrete floor, even at PPV lower than 13 mm/s (0.5 in./s)?
2. Are there any publications or research available indicating that vibration damage has been observed below this 13 mm/s (0.5 in./s)?
3. Is it possible that long-duration, low-frequency vibrations at lower PPV than 13 mm/s (0.5 in./s) can produce the type of damage observed in these homes?
4. Is it possible that over 2,000 vibration events, at low PPVs, can cause the brittle elements of this home to exhibit fatigue failure?

The writer replied to the posting, and expressed his opinion in the paper discussed, that quarry blasting can be the cause of cosmetic cracking, and minor and major structural damage.

Comments on "Blast Vibration Damage Assessment Study and Report" (2000)

The discusser wrote, "During this study none of the cracks or other conditions observed at the homes were attributed to blasting." It is necessary to comment on this statement.

The consulting team prepared the report. The prime consultant was Corzo, Castella, Carballo, Thompson, and Salman (C3TS), a consulting engineering and architectural firm specializing in structural engineering and construction practices. Three other companies assisted to the prime consultant: Dunkelberger Engineering and Testing, Inc. (DE&T), a firm specializing in geotechnical engineering; Parsons, Brinckerhoff, Quade, and Douglas, Inc. (PB Water), a full-service national firm with expertise in hydrogeologic investigations; and D.E. Siskind and Associates, LLC (DESA), specialists in blasting, seismology, and acoustic.

All four consulting companies studied the same 10 typical residences selected at five areas in Miami-Dade County for investigation of cracks in various structures of the homes. Distances between the test sites and active quarries were in the 3.2–4.8 km (2–3 mi) range. Vibration measurements of ground and home structure vibrations were made during about a 2-month period from late February to late April 2000. Pre- and postblasting-condition surveys were made before and after vibration monitoring.

The First Report

The scope of C3TS work included additional independent vibration monitoring of ground and structures, testing, and an assessment study of limestone quarry blasting on damage to the neighboring residential structures.

C3TS found that cracking in masonry caused by shear or flexural bending resulted from the effects of such factors as volumetric movements from soil that support structures, settlement of constructed subgrades, or deeper underlying soil strata.

Also, it has been concluded that no structural damage cracking should occur on unreinforced walls with the peak acceleration less than 0.2 g. This statement is incorrect because for the resonance frequency of horizontal home vibrations equal 8 Hz, an acceleration of 0.2 g is equivalent to the peak particle velocity (PPV) of 39 mm/s (1.54 in./s), which can be the cause of crack formation. Furthermore, according to Clough and Chameau (1980), acceleration higher than 0.05 g can trigger dynamic settlement in loose sands with rubble and broken rock.

It is necessary to note that no vibration records are presented in the first report. PPV and frequency values are shown only for two homes with small vibrations.

The Second Report

DE&T made a visual survey of 10 residential homes to identify and evaluate cracks in their structures. They found hairline vertical, horizontal, and diagonal cracks that could not affect structure integrity and serviceability. Site subsurface information was gathered for 6 of 10 homes because their bearing masonry walls exhibited stair-step cracks that were considered an indicator of foundation settlement. It has been concluded that the foundation settlements are due to the compression of the soil layers underlying the footings. The causes of horizontal, vertical, and diagonal cracks were not investigated.

Blasting effects on foundation settlements were also considered, but were ruled out because of the significant horizontal separation between the quarries and the residential areas. This

conclusion is incorrect for several reasons. First, assessment of a distance for potential footing settlements from quarries was connected with a radius of the blast densification zone. The radius was calculated as about 137 m (450 ft) from the point of the blast. However, surface and foundation settlements do extend beyond the zone of densification (Dowding 1996). Second, no vibration measurements were made, though it was important because wave paths have low attenuation in Miami-Dade County. Third, there are various procedures for determining dynamic settlements, for example in Barkan (1962), but no such calculations were made using existing vibration records. Fourth, it is necessary to point out that the peak particle velocity of 2.5 mm/s (0.1 in./s) could be considered as the threshold of possible significant settlements in narrow-graded sands (Lacy and Gould 1985).

The Third Report

PB Water investigated hydrogeologic conditions beneath the area of the study. Attention was brought to the fact that all blasts were done underwater, and this is the significant condition of southeast Florida quarries because water readily transmits the blast shock waves to the surrounding quarry areas.

There is no information about vibration monitoring conducted for this report. However, there is mention that during the first 8 weeks of 2000, mining concerns reported the PPV below 5.1 mm/s (0.2 in./s), which is substantially less than the vibration limit of 19 mm/s (0.75 in./s) for the PPV of ground vibrations. This conclusion could be misleading because the limit of 19 mm/s (0.75 in./s) does not reflect the actual condition of wave propagation and soil-structure interaction in Miami-Dade County. It is necessary to point out that reasonable recommendations have been made regarding new studies for development of blasting methods that could reduce the peak particle velocities. Nevertheless, the authors of the third report believe that such measures could solve a problem of human perception, if not actual structural damage.

The Fourth Report

DESA made a comprehensive study (about 60% of the report volume) of structural vibration damage from quarry blasting. Vibration measurements were made from 42 quarry blasts, and additional 756 vibration records were considered in the study.

The specific condition of wave propagation was found in Miami-Dade County: attenuation with distances is less than that found on similar sites in the north. As a result, the PPV of ground vibrations are relatively high for large distances and charge sizes used.

The DESA report revealed other interesting findings: (1) structure oscillations are superposition of vibrations with various frequencies, including low frequencies of about 8 Hz, which are close to the natural frequencies of home horizontal vibrations, and very low frequencies of 2–4 Hz; (2) structural responses in South Florida are sufficiently different from responses of frame structures studied elsewhere; (3) vibrations are of long duration at the homes with maximum duration of about 17 s; (4) the highest dynamic structure amplification exceeded 6x; and (5) ground vibrations with the PPV of 19 mm/s (0.75 in./s) with structure response of 6.1x would produce a global wall strain that is 1.5 times higher than the strain limit for crack formation.

It was found that 5 of 10 inspected homes have some wall cracks, mostly exterior, which could be from dynamic sources (blasting and wind). For home damage other than wall cracks, blasting was excluded. However, the authors of the fourth report have stated that they would need to have additional tests done to determine the exact causes for every crack and fault.

Summary

Three companies have prepared good reports in the areas of their expertise and explained structural damage by the causes, which did not include dynamic effects from quarry blasting. These conclusions are interesting and important for understanding the effects of environmental forces and construction practice on structures. However, eliminating the vibration causes of structural damage is formal and unfounded. It could be expected, because these companies are not specialized in assessment of blasting effects on structures. Only the DESA report presented the results of the great scope of study of the blasting effects on homes in Miami-Dade County.

C3TS, PB Water, and DESA recommended reducing the allowable PPV in county regulations. It is sensible. According to the Limited Liability of Vibration Criteria section of the paper discussed, and to Svinkin (2003), the existing vibration limit is irrelevant to the condition of wave propagation in Miami-Dade County. Also, it is necessary to underline that County Code (Miami-Dade County 1996) states that vibration limits for the PPV within the urban development boundary may be reduced to 2.5 mm/s (0.1 in./s) after considering relevant historical data, studies, and results obtained during the regulation of blasting operations in Miami-Dade County. Obviously, this criterion was not used in the report.

For three homes built in 1995, 1997, and 1998, wall cracks could be from quarry blasting and wind, but the wind from Hurricane Andrew (1992) could not be the cause of wall damage in these homes. It makes sense to separate structural damage made by blasting from similar damage obtained at the time of hurricanes using a comparison of the condition survey presented in the report with a survey of homes in Miami-Dade County where there are no complaints on blasting.

Vibration effects of quarry blasting in Miami-Dade County on the existing residential structures have been studied for about 25 years, and this problem should be clarified and resolved because of the importance of finding a balance between protecting homes and preserving the viability of a long-established industry.

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